VOLUME 3 NUMBER 1 May 2014
ISSN 2304-7712 (Print)
ISSN 2304-7720 (Online)

International Journal of Advanced Engineering and Science

ELITE HALL PUBLISHING HOUSE

ELITE HALL PUBLISHING HOUSE

International Journal of Advanced Engineering and Science

ABOUT JOURNAL

The International Journal of Advanced Engineering and Science (Int. j. adv. eng. sci. / IJAES) was first published in 2012, and is published semi-annually (May and November). IJAES is indexed and abstracted in: ProQuest, Electronic Journals Library, getCITED, ResearchBib, IndexCopernicus, Open J-Gate and JournalSeek. Since 2013, the IJAES has been included into the ProQuest one of the leading full-text databases around the world.

The International Journal of Advanced Engineering and Science is an open access peer-reviewed international journal for scientists and engineers involved in research to publish high quality and refereed papers. Papers reporting original research or extended versions of already published conference/journal papers are all welcome. Papers for publication are selected through peer review to ensure originality, relevance, and readability.

ISSN 2304-7712

ELITE HALL PUBLISHING HOUSE

International Journal of Advanced Engineering and Science

CONTENTS

ISSN 2304-7712

ELITE HALL PUBLISHING HOUSE

International Journal of Advanced Engineering and Science

Publisher: Elite Hall Publishing House

Web: http://ijaes.elitehall.com/
ISSN 2304-7712 (Print)
ISSN 2304-7720 (Online)

FPGA-based Implementation of ANN for Direct Torque Control of Induction Machine Using Co-simulation

Djalal Eddine KHODJA [(1),(4)] ,

(1)Faculty of technology, M'sila University, Algeria. kdjalaled@gmail.com Tel/Fax: +213 355 519 24

Stéphane SIMARD [(2)],

(2)Applied Sciences Department, UQAC, Canada, stexyz@ymail.com, Tel/Fax:+154185455012

Rachid BEGUENAN [(3)],

(3)Depmt of Electrical, R.Military Cllge, Canada, rachid.beguenane@gmail.com, Tel/Fax:+1613544-8107

Aissa KHELDOUN [(4)]

(4)Signals & Systems Lab, Boumerdes Univ, Algeria. aissa1973@gmail.com, Tel/Fax:+213355 519 24

Abstract - The aim of this paper is to propose design and implementation of Artificial Neural Network (ANN) on a Field Programmable Gate Array (FPGA). This implementation aim is to contribute in the hardware integration solutions in the areas such as control of power system, where the Direct torque Control (DTC) of induction machine is employed. The specialized Simulink tools used and the design procedure are presented. The results obtained by co-simulation of the induction motor drive in Matlab/Simulink and the ANN on the FPGA are satisfactory and very promising.

Keywords - ANN, FPGA, Xilinx, Sigmoid Function, DTC.

Djalal Eddine KHODJA is with Msila university, woks on Implementation of Artificial Neural Networks on reconfigurable circuits used in Control and Diagnosis of Induction Machines.

1. Introduction

Direct torque control (DTC) of induction motor drives offers high performance in terms of simplicity in control and fast electromagnetic torque response. With dominant characteristics, the direct torque controlled induction motor drive is alternative in industrial applications (Y. Kumsuwan et al 2008, M.S. Carmeli et al 2011). Although in these systems such variables as torque, flux moduls and flux sector are required, the resulting DTC structure is particularly simplistic and therefore, becomes its major advantage. The application of the technique of neural networks in machine control is simple and allowed the resolution of several problems related to controlling these systems. In this work, the conventional DTC

ISSN 2304-7712

is controller based on neural networks, where the switch block is replaced with ANN Block.

The fast implementation of the developed methods is necessary needs for the industry and the complex (smart) power systems. These methods may be investigated using several techniques that have different characteristics to solve the encountering problems (Y. Kumsuwan et al 2008, M.S. Carmeli et al 2011, Francesco Ricc et al 2003, S. Vaez-Zadeh et al 2007, Antoni Arias et al 2005). The most commonly used techniques are the artificial intelligence-based techniques such as Artificial Neural Networks (ANN) (Antoni Arias et al 2005, A.TISAN et al 2006, M.T. Tommiska 2007)] that they are easier to implement on electronic circuit board such as: Digital Signal Processing (DSP) chips, Application Specific Integrated Circuits (ASICs) or Field programmable gate array (FPGAs) (DJ.Khodja et al 2005, V.A.Tolovka et al 2001, K. Renovell et al 2001). The aim of the present work is to propose an ANN based algorithm to control the induction motor with the DTC technique, then after successful simulation, convert the Simulink model written using Xilinx blockset with the System generator into Hardware Co-simulation. The generated Block will run on the FPGA Vertex4 XC4VSX35 board and the remaining blocks run on the Matlab/Simulink environment.

The paper is organized as follows: the next section, the suggested topology; training and the generalization stage of the ANN are investigated, this design must lead to less operating time and a minimum logic usage on the FPGA. Section III undertakes the process of using System generator to generate the corresponding VHDL and the co-simulation of the DTC of induction motor using Xilinx Vertex 4. The paper ends up with a conclusion.

2 Application of artificial neural networks for DTC

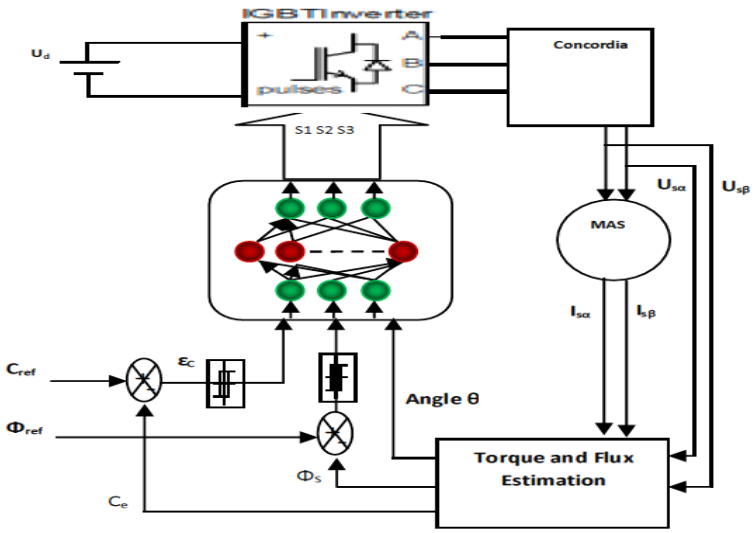


Fig.1. Scheme of Direct Torque Control-based ANN technique.

The application of the technique of neural network in machine control is simple and allowed the resolution of

ISSN 2304-7712

several problems related to controlling these systems.

In this work with DTC, it is easy to use this technique, where the conventional DTC is replaced by controller based on neural networks as is illustrated in Figure.1.

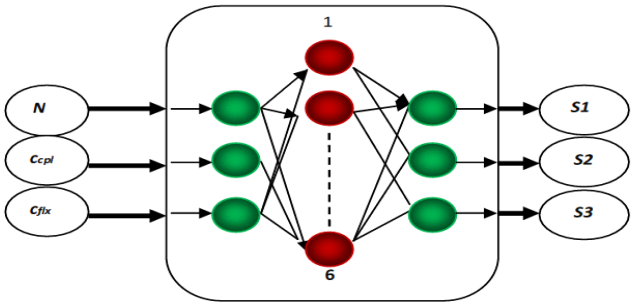


Fig.2 Internal structure of a controller based on neural network.

The proposed neural network is a multilayer network (3-6-3) with the architecture illustrated in fig.2. Each neuron is connected to all neurons of the next layer by connections whose weights are randomly chosen real numbers. We notice that w_{xy} is the weight of the connection between neurons x and y. The following steps are necessary to obtain this ANN:

. ANN topology.

. ANN Learning stage

. ANN validation

Artificial Neural Network Topology

As shown in fig.2, the proposed artificial network consists of three layers, namely: the input layer consists of three neurons, whose function is to transmit the input values that correspond to the input variables to the next layer called hidden layer. The hidden layer is characterized by six neurons with sigmoid shaped activation function. The output layer is composed of three neurons whose output is either 0 or 1.

ANN Learning stage

The second stage in designing the ANN is the learning process which requires a data base defining the ANN input-output mapping. This data base is mostly given under matrix form as to clarify the inputs and the desired outputs according to the switching table of DTC, see table.1.

ISSN 2304-7712

N		$N=1$	$N=2$	$N=3$	$N=4$	$N=5$	$N=6$
cflx	ccpl						
1	1	V_2	V_3	V_4	V_5	V_6	V_1
1	0	V_6	V_1	V_2	V_3	V_4	V_5
0	1	V_3	V_4	V_5	V_6	V_1	V_2
0	0	V_5	V_6	V_1	V_2	V_3	V_4

Table.1 switching table of the conventional DTC

In this application, the input matrix consists of three inputs (lines) corresponding to :

• The first variable is the position of the flux in the reference frame related to the stator.

• The second input variable is used the state variable error flux.

• The third input variable, the state variable error of the couple is used.

This input values are done with this matrix:

a= [1 1 1; 1 1 0; 1 0 1; 1 0 0; 2 1 1; 2 1 0; 2 0 1; 2 0 0; 3 1 1; 3 1 0; 3 0 1; 3 0 0; 4 1 1; 4 1 0; 4 0 1; 4 0 0; 5 1 1; 5 1 0; 5 0 1; 5 0 0; 6 1 1; 6 1 0; 6 0 1; 6 0 0];

The output is represented by the pulses of the inverter switches that represent the values zero or one, there matrix called desired output is done by.

d= [1 1 0; 0 1 0; 1 0 1; 0 0 1; 0 1 0; 0 1 1; 1 0 0; 1 0 1; 0 1 1; 0 0 1; 1 1 0; 1 0 0; 0 0 1; 1 0 1; 0 1 0; 1 1 0; 1 0 1; 1 0 0; 0 1 1; 0 1 0; 1 0 0; 1 1 0; 0 0 1; 0 1 1];

Using Graphical User Interface (GUI) of the Neural Network Toolboox in Matlab, it's easy from a given input – output data to train the proposed ANN. The Levenberg – Marquardt backpropagation algorithm is used to train the proposed network topology. To measure the network performance, we have used the Mean Squared Error between the target and the output of the fitting network. The optimal values of the Neural Network weights have been obtained after 56 iterations with an error of 3.58058e-012, see Figure.3. The error is very small however the obtained Network must be checked using validation test.

ISSN 2304-7712

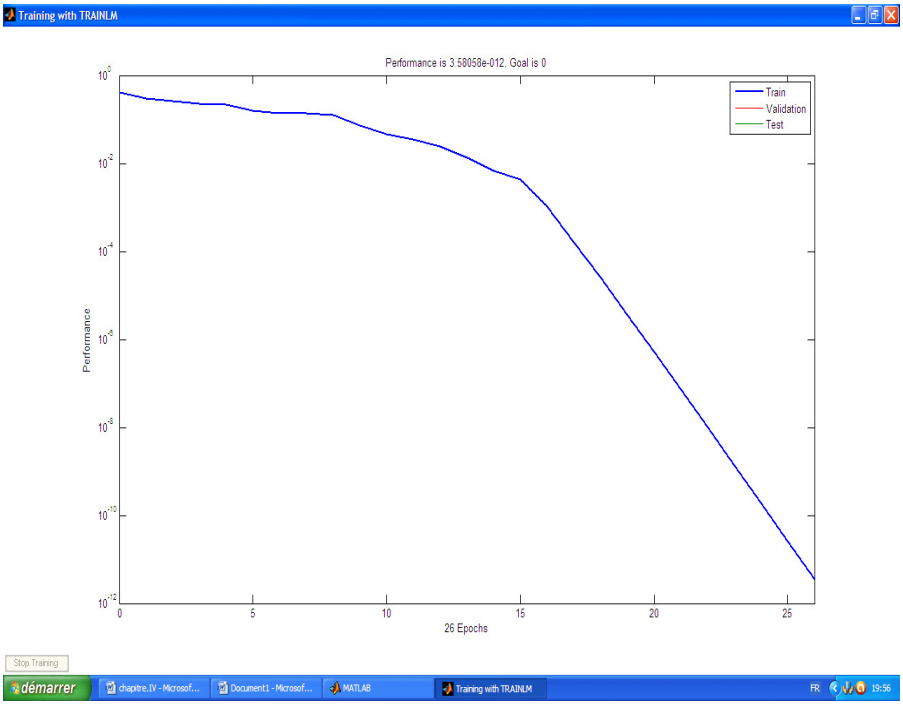


Fig.3. Evaluation of the squared error based on the number of iterations of learning *(using the method of backpropagation gradient).*

The design of ANN in Simulink is shown in the figure.4

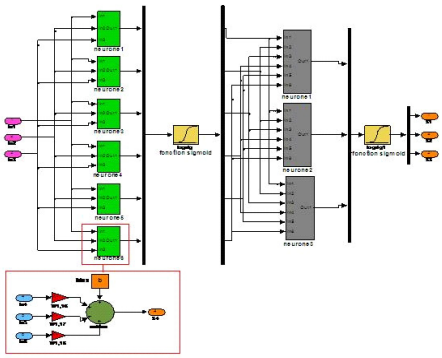
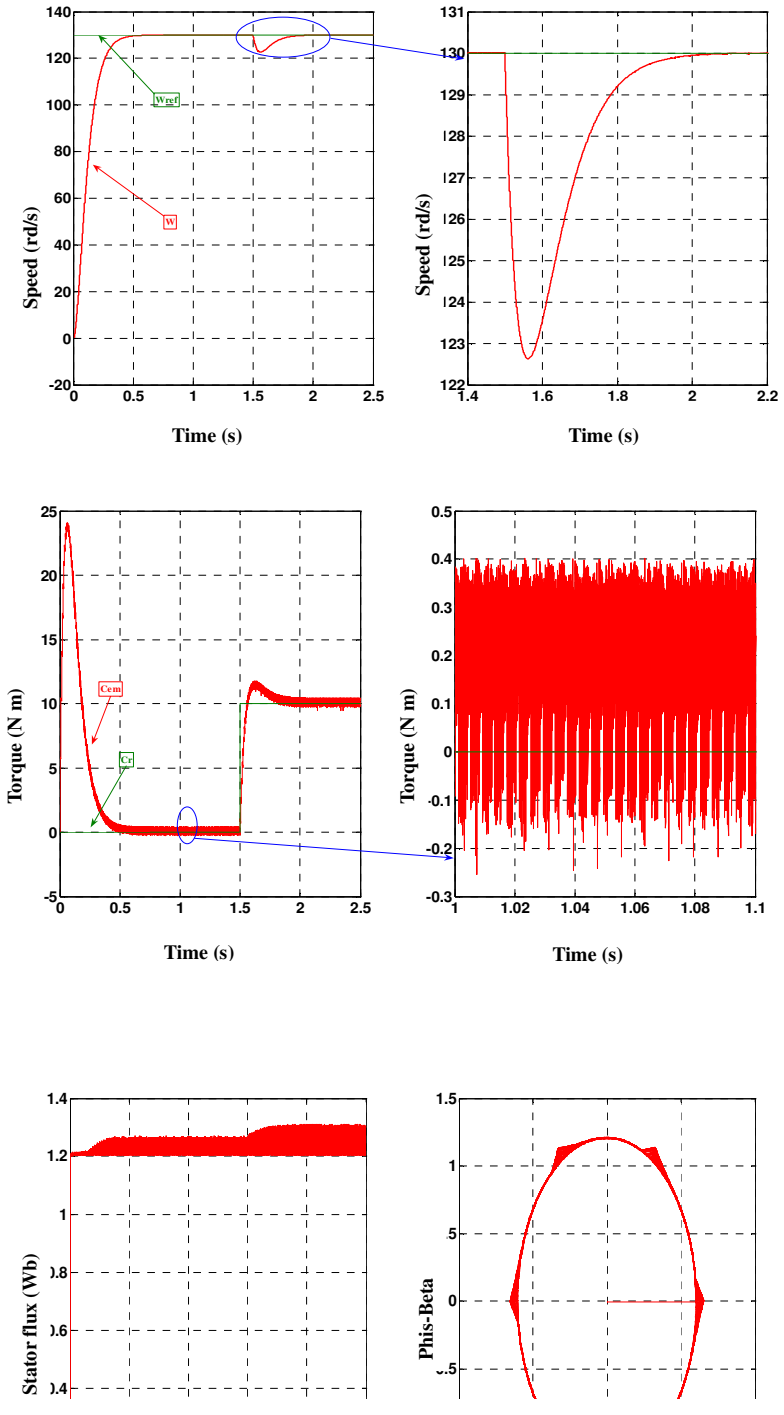


Fig.4. Artificial neural network made by Simulink.

ISSN 2304-7712

ANN validation

In contrast to the method used in Matlab, which consists to use the learning data base for training and the remaining for the validation test. The results given by the trained network and the behavior of the motor are depicted in figure.5. The test result shows the behavior of the structure of the DTC applied to the induction machine of 1.5kW inverter fed by a two-level voltage with two levels of correction for the couple and the stator flux. We can see clearly that there is a decrease on the electromagnetic torque ripple and we also note that the electromagnetic torque accurately follows its reference and it is its response time (0.4 sec)



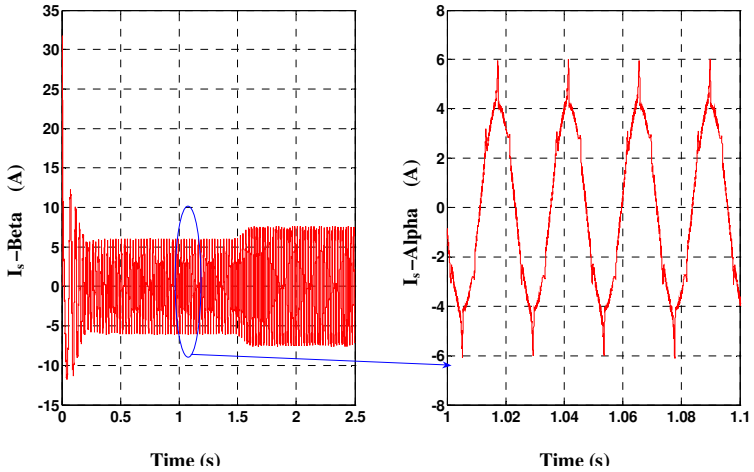


Fig.5. Simulation results with DTC by artificial neural networks.

3. Application of ANN under Xilinx for DTC

In order to perform the co-simulation of ANN for DTC of induction machine using FPGA soft processor, the obtained ANN must run on the FPGA board which requires converting ANN's Matlab code to VHDL. This task is subdivided to three parts, namely:

- Building ANN block in Simulink/ Xilinx;
- Generation the block co-simulation;
- Network testing by co-simulation.

Building ANN block using Simulink /Xilinx

The principle of the library provided by Xilinx is almost the same as of the classical Simulink library. It contains blocks representing different functions that are ready to be connected with each other to form algorithms (DJ.Khodja et al 2005). These blocks do not only serve to simulation, but can also generate VHDL or Verilog code.

In addition, the library provided by Xilinx to Simulink, has all blocks that are necessary for the design of ANN, however some activation functions are not available and an example of them is the sigmoid function.

For this reason, in the paper, the author suggests a method which is based on the Vandermonde's algorithm to implement the sigmoid function (V.A.Tolovka 2001). The sigmoid function is given by the following:

$$f(x) = \frac{1}{1+e^{-cx}}$$

This function can be approximated by second order polynomial equation:

$$f(x) = c + bx + ax^2$$

The only unknowns in this equation are a,b and c which are determined using Vendermond's algorithm (C. Dick 2002, R.Gadeaet al 2000). In order to implement the obtained polynomial function, it is should be to decide on an input accuracy and precision for reasonable output sigmoid function (C. Dick 2002, R.Gadeaet al 2000). As agreed, for the approximation of this equation, we need the bound the domain of *x* as input to adjust the number of bits and the fractional precision. The output current varies between 0 and 1.

It also needs to know the required output accuracy. It should be noted that mathematically, the area of the sigmoid is not bounded. In these models, it uses floating point arithmetic in double precision, so we do not perceive any limit (J.G.Mailoux et al 2007). But in fixed point arithmetic, especially in hardware, it is should be to define fairly tight bounds on the inputs and outputs, and the infinite must be bounded (A. Armato 2011, Miguel Atencia et al 2007). Certainly in practice, the variable *x* does not vary between -infinity and + infinity in the neural network. In general, we must consider the fact that the both ADC and DAC outputs and inputs respectively are all-at-most 16 bits of precision.

One can without difficulty increase the accuracy of the approximation of the sigmoid, but this has a cost. The more accurate is the approximation, the more bulky and slower is the implementation. This must be taken into account and use only the minimum necessary precision in the control circuits. One can use as much blackboxes as we can take care of managing the CLK and CLK_EN signals however according to (J.G.Mailoux et al 2007, Övünç Polat et al 2010, G. Areibi 2007, A. Armato 2011), simulations this way are slower than working in Simulink. If it's more convenient, the code of the approximation of the sigmoid could easily be described with the Xilinx Blockset in Simulink, rather than VHDL, since the form of the equation is not complicated. The only difficulty is finding the right parameters for the approximation (that is to say the coefficients of the equation), but there is a way to do that, then it becomes quite easy to adjust them according to any need (taking into account the cost of the

ISSN 2304-7712

implementation).

Knowing that the output of each neuron is between 0 and 1, we considered several factors, including synaptic weights used in our example. According to a rough estimate, we can conclude that the necessary precision before the decimal point in the sigmoid functions does not exceed 9-10 bits (depending on the application) in the input layer and 6 bits in the other 2 layers. Regarding the precision after the decimal point, given the fact that the effect of a neural network is a global phenomenon, the sigmoid functions need not to be very accurate. It is enough for the approximated function to follow fairly well the sigmoid curve, and a precision of 8-10 bits after the decimal point seems more than enough to give exactly the same output as our final example.

Thus, we have implemented an approximation of the sigmoid in System Generator and have performed several experiments. However, all the parameters mentioned above have to be optimized based on the application. We notice that the number of bits needed before the decimal point is greater in the input layer of neural network than in the other 2 layers. This has a lot of influence on the circuit size. One can adjust the number of bits in the properties editor of the *Gateway In* block in the sigmoid. In the output, precision is fixed to 10 bits after the decimal point.

Modeling the resulting of sigmoid function and its co-simulation block are given by Xilinx as shown respectively in figure.6 and 7:

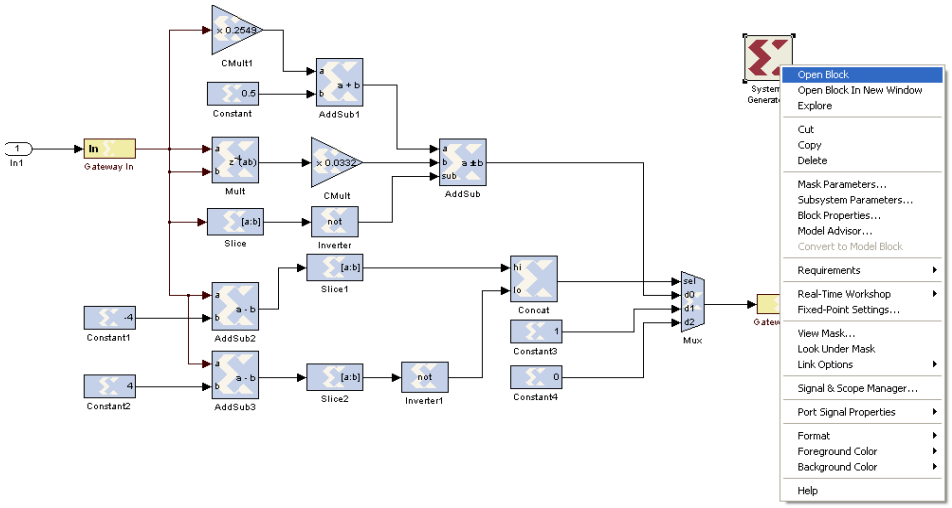


Fig.6 Modeling of sigmoid function

ISSN 2304-7712

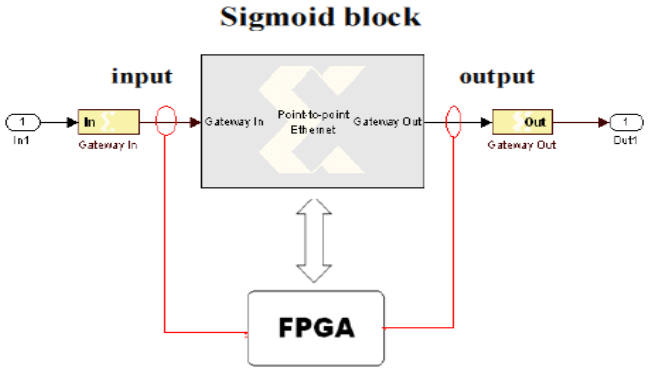


Fig.7 Co-simulation block of Sigmoid under Xilinx

The results of synthesis of obtained sigmoid function are shown in table.2. It can reveal that the VHDL code of sigmoid function occupies only 25 of 30720 Slice Flip Flops of the used FPGA.

Table 2. Results of synthesis of obtained sigmoid function

Device utilization summary: Selected Device : 4vsx35ff668-10		
Number of Slices	25 out of 15360	0%
Number of Slice Flip Flops	38 out of 30720	0%
Number of 4 input LUTs	10 out of 30720	0%
Number of bonded IOBs	75 out of 448	16%
Number of GCLKs	2 out of 32	6%

Modeling the resulting of ANN Block Co-simulation block are given by Xilinx as shown respectively in figure.8 and 9:

ISSN 2304-7712

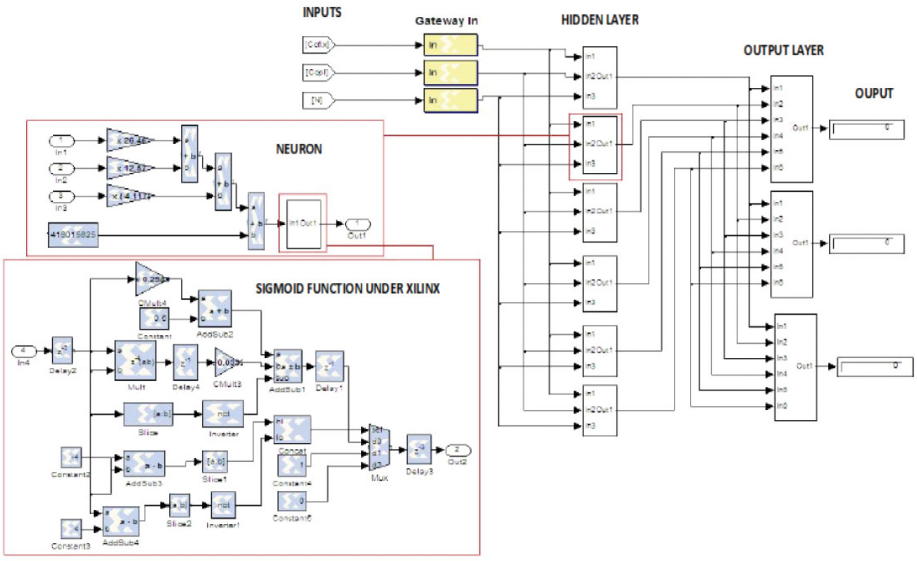


Fig.8 Modeling of ANN under Xilinx

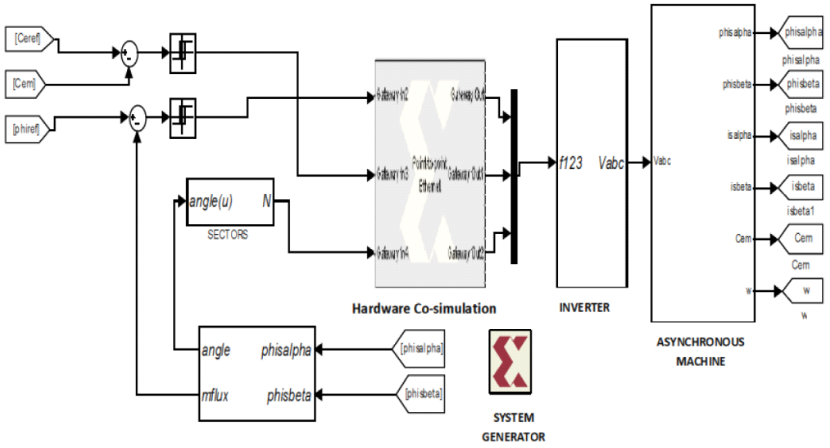


Fig.9 Co-simulation block of ANN under Xilinx

The results of synthesis of obtained ANN Xilinx Bloc is shown in table.3.

ISSN 2304-7712

Table3. Results of synthesis of obtained ANN Block under Xilinx

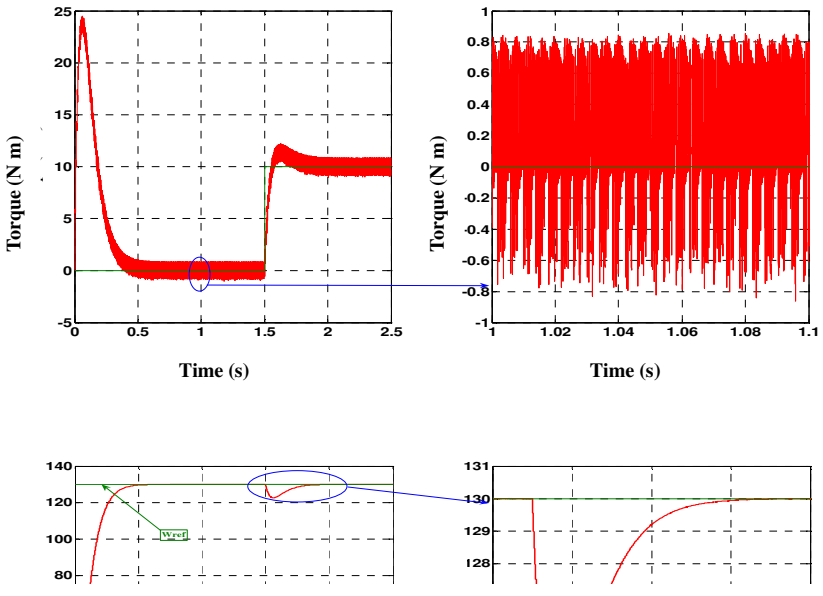
Device utilization summary: Selected Device : 4vsx35ff668-10		
Number of Slices	6613 out of 15360	43%
Number of Slice Flip Flops	6633 out of 30720	21%
Number of 4 input LUTs	11726 out of 30720	36%
Number of bonded IOBs	115 out of 448	25%
Number of GCLKs	1 out of 32	3%

From the results obtained on the table.3 reveals that the VHDL code occupies an area of 21% on FPGA, means that the FPGA type Virtex4 XC4VSX35-1011668 supported this VHDL code.

Simulation Results of DTC by ANN on FPGA

The test result shows the behavior of the structure of the DTC with ANN-Based Xilinx applied to the induction machine. One can see clearly that there is a decrease on the electromagnetic torque ripple and note that the electromagnetic torque accurately follows its reference and it is its response time (0.4 sec).

Otherwise, One can notice that the implemented ANN has generated the right binarry code according to the switching table in the conventional DTC applied to the induction motor. It is easy to filter or eliminate these harmonics during the motor operating.



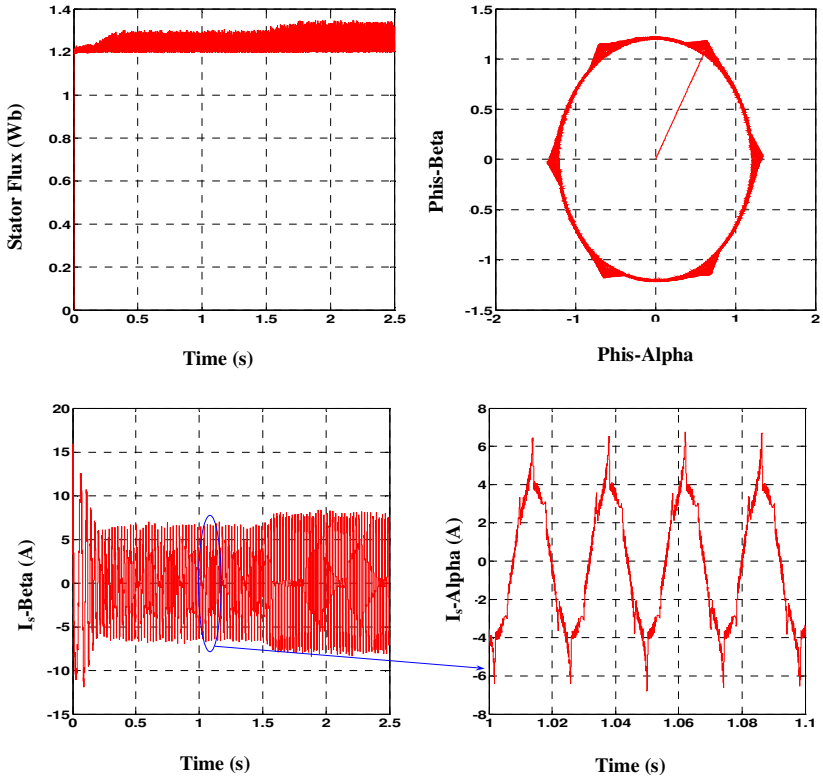


Fig.10. Simulation results with DTC by Co-simulation block of ANN under Xilinx

4. Conclusion

In this work, the neural network that uses simple inputs such as the outputs of the regulators with hysteresis has been studied. For the implementation of the neural network, several parametric studies were performed (choice of network type, choice of inputs, outputs choice ...). These studies were preceded by the operation of data acquisition, which aims to establish the basis for learning neural network.

Furthermore, it was found that neural networks can be used to DTC of induction machine. The effectiveness of these architectures has been demonstrated by examples of simulation and satisfactory results were obtained.

In addition, a simple algorithm was proposed for the implementation of the ANN. The synthetic material of the proposed algorithm was performed by the System Generator. Routing and implementation on FPGA type Virtex4 was carried out by the ISE Foundation.

The use of high-level design tool 'System Generator is very beneficial to check the behavior of the algorithm in Simulink. The simulations for the sigmoid function as well as the neural network reveal that the results in Xilinx gave the same performance as the sigmoid function obtained in Simulink as well as the neural network study.

REFERENCES

Y. Kumsuwan, S. Premrudeepreechacharn, H. A. Toliyat, (2008), **Modified direct torque control method for induction motor drives based on amplitude and angle control of stator flux**, Electric Power Systems Research, Elsevier, 78 1712–1718.

M.S. Carmeli, M. Mauri (2011), **Direct torque control as variable structure control: Existence conditions verification and analysis**», Electric Power Systems Research, Elsevier, 81 (2011) 1188–1196

Francesco Ricci, Hoang Le-Huy (2003), **Modeling and simulation of FPGA-based variable-speed drives using Simulink** , Mathematics and Computers in Simulation, Elsevier, 63 (2003) 183–195.

S. Vaez-Zadeh, E. Jalali (2007), **Combined vector control and direct torque control method for high performance induction motor drives** , Energy Conversion and Management, Elsevier 48 3095–3101

Antoni Arias, Luis Romeral, Emiliano Aldabas, Marcel Jayne (2007), **Stator flux optimised Direct Torque Control system for induction motors,** Electric Power Systems Research, Elsevier, 73 257–265

A.TISAN, S.ONIGA, D.MIC, A.BUCHMAN (2009), **Digital implementation of the sigmoid function for fpga circuits** », ACTA TECHNICA NAPOCENSIS, Electronics and Telecommunications, Volume 50, Number 2, PP.15-20

M.T. Tommiska (2003), **Efficient digital implementation of the sigmoid function for reprogrammable logic** , IEE'2003, Computers and Digital Techniques 150, number 6, pages 403-411.

DJ.Khodja, B.Chetate (2005), D**evelopment of Neural Network module for fault identification in Asynchronous machine using various types of reference signals,** 2nd International Conference PHYSICS and CONTROL, August,24-26, Physcon 2005, St Ptersburg, Russia. pp : 537-542.

ISSN 2304-7712

V.A.Tolovka. (2001) **Neural Networks : Training, Organisation and Useful**. Ed, Establshement journal Redaction 'Radiotekhnika' Moscou<;

K. Renovell, P. Faure, J.M. Portal, J. Figueras and Y. Zorian (2009), ″**IS-FPGA: A New Symmetric FPGA Architecture With Implicit SCAN**″, IEEE ITC International Test Conference, Paper 33.1, 0-7803-7169-0.

Areibi, G. Grewal, D. Banerji and P. Du (2007) ″Hierarchical FPGA Placement″, CAN. J. ELECT. COMPUT. ENG., VOL. 32, NO. 1, Winter.

Altera, Inc., http://www.altera.com.

Xilinx Corporation, Inc., www.xilinx.com.

C. Dick. **The Platform FPGA: Enabling the Software Radio (2002)**. Software Defined Radio Tech. Conf. and Product Expo. (SDR).

R.Gadea, J.Cerdá, F.Ballester, A.Mocholí (2000). **Artificial Neural Network Implementation on a single FPGA of a Pipelined On-Line Backpropagation**. Proceeding ISSS2000 Conference, Madrid, Spain. 2000 IEEE 1080-1082/00 PP :225-230.

J.G.Mailoux, S.Simard, R.Beguenane (2007). **Implementation of Division and Square Root using XSG for FPGA-Based vector control Drives**. IJEPE 2007, ISSN: 1990-7958. PP: 524-529.

A. Armato, L. Fanucci, E.P. Scilingo, D. De Rossi (2011). **Ow-error digital hardware implementation of artificial neuron activation functions and their derivative**. Microprocessors and Microsystems, Elsevier 35 557–567.

Miguel Atencia, Hafida Boumeridja, Gonzalo Joya, Francisco Garci, ´a-Lagos, Francisco Sandoval (2007). **FPGA implementation of a systems identification module based upon Hopfield networks. Neurocomputing**, Elsevier. 70 2828–2835.

Övünç Polat, Tülay Yildirim (2010). **FPGA implementation of a General Regression Neural Network: An embedded pattern classification system**. Digital Signal Processing, Elsevier. 20 881–886.

ISSN 2304-7712

Using Innovation Design of Evaluative Criteria Software for the Best Selection in Product Market

Shih-Chung Liao

Abstract

In this paper, the author uses an evaluative criteria model and their associated criteria status, product evaluative criteria software of results and product objective function of optimal values solution. This study focuses on how to use an evaluative criteria model's imprecise market information by evaluative criteria design software and realizing the synthesis in multi criterion decision making (MCDM), using its searching software capacity to obtain the optimal solution.

Key words: Multi criterion decision making (MCDM), Evaluative criteria model, Digital product design, Fuzzy theory, Products design.

∗Corresponding author, Address: Department of Visual Communication Design, College of Planning and Design, Technology of Taoyuan Innovation Institute, Taoyuan, Taiwan 320.
E-mail: liao1@tiit.edu.tw

1. Introduction

The aim of product design value is to build up the innovative model, to create the maximum product or service value, by using the product innovation method from the user demand in order to solve ideological modes, question, difference, benefit, and so on. It stressed only on understanding clearly the user or consumer's demand, and then proposed the feasible and correct solution to provide the biggest service to the user. However, the organization can hardly exert influence on those sources. Changes in the beliefs, values, attitudes, opinions, and

lifestyles of a society as a whole are seen as social changes (Stefan & Mann 2010).

In this paper, when the enterprise carries on the multi criterion decision-making principle, mainly by the various product designs and the study of primary achievements, to apply the new product business planning to schedule the product specification, it will generate system's transformation of product characteristic to meet the customer demand. Thus, innovation is the smart application of knowledge to transform businesses, driven by market and customer demands, not just by the commercialization of intellectual property from science and research (Narelle 2010).

The Fuzzy integral methods are used for synthetic utility in accordance with subjective perception environment. Empirical experimental results show the proposed model is capable of producing effective evaluation of e-learning programs with adequate criteria that fit with respondent's perception patterns, especially when the evaluation criteria are numerous and intertwined (Tzeng et al., 2007). The conceptual development of product design values for the evaluative criteria model is discussed in the next section, and Constructs design product integrated design plan and Hierarchical system in digital product design industry and evaluative criteria and their associated criteria status for multicriteria decision making (MCDM) problem are derived in the subsequent section. Then, we discussed the application of the evaluative criteria methods for aquatic products processors, and finally, we discuss and show that the MCDM methods in this paper are effective.

The rest of this paper is organized as follows: Product of innovation design in section 2. Case studies: Different products design of evaluative criterion in section 3. Discussion in section 4. and conclusions in the last section in section 5.

ISSN 2304-7712

2. Product of innovation design

Changes are often initiated by innovations. Planning, coordinating and controlling change processes is regarded as change management in this paper. Those innovations start with an idea that seeks to be implemented (Rogers 1995). Recently, research of product design for current innovation is facing the globalization chanllenge. The creative product and the customer value are the keys for the growth of an enterprise.

2.1 Using evaluative criteria software

The Fuzzy criteria competence set analysis was proposed. In order to obtain Pareto solutions, multi-objective evolutionary algorithm is used here. A numerical example with two Fuzzy criteria is also used to illustrate the proposed method (Huang et al., 2006). In real problems, research excavates the customer demand, using the method to construct several design products which just started to be in the Fuzzy stage, then beginning the new product business planning to schedule the product specification based on the customer demand. It will have the system conversion product characteristic first, then launches the system to each organization and all components, as well as the plan manufacture flow by grasping the management key of various stages.

2.2 Integrated product of design systems

Although there is a tendency when thinking of innovation systems, including research systems, to see them as self-organizing and adaptive, the reality is that the pathway to innovation outcomes requires vision, leadership and some element of structure (John 2007). By several design product information methods, we carry on the customer modeling design andnamely participates in the project work, There are several main abilities, including

ISSN 2304-7712

product detail conception, composition order, design conception, basic plan, design confirmation. Table 1 shows several design product integrated design and the plan:

〔**Table 1 Integrated product of design systems**〕

2.3 Multi criterion decision making system for product design

Since the industrial revolution, innovation has generally been perceived as desirable, nearly synonymous with 'progress (Judith 2008). Thus, studies for several design products including features like the type, the function, the outlook, the user, the market area, separate and the different price level, community opinion method, will raise the multi objective questions, and each question will have many uncertainty, the complexity, the risk conflictingly, and so on. In addition, the changeable variable will make the entire decision-making process very difficult. Several design product development flow will be used to provide the elastic appraisal research technique, the improvement product design structure question, and will deduce the system technology using logic which will help the user to face the question, and will make the best resources utilization under the limited resources. Its research development flow is shown as in Figure 1.

〔**Fig. 1 Multi criterion decision making system for product design**〕

2.4 Building product of evaluative criteria software

The application and use of research are intended, among other things, to increase the competitiveness and sustainability of Australian industry through both transformative and incremental research (John 2007). Take several design product's appraisal criterion as the example, use appraisal standard and the union standard state, and divide into producer projects based on standard marketing, production, product, technology, condition,

ISSN 2304-7712

purchase, use, and period. Each project selects its most suitable ownership from Producer criteria (X1) and User criteria (X2) numbers disparity. The result of evaluation software product is shown in Table 2.

〔**Table 2 Product of evaluative criteria software**〕

2.5 Using multi objective decision making

The multi objective decision making, pondering the explanation product question by angle in every way, deduces satisfied consumer's good plan for the long time interval, the gradation, and the working condition of high uncertainty. The application of the multi objective decision making method may satisfy grade of fit in each criterion, may evaluate the best technical program, and provides the policy maker the best pattern.

The production question indicated above by the following pattern is a model of product linear programming:

Goal plan equation $Z=3X1+5X2$, and $X1+X2 \leqq 6$, and $X1+2X2 \leqq 10$

$X1 \geqq 1$, $X1$, $X2 \geqq 0$

The multi- goals plan asks suitable vector, max = [Z1, Z2, Z3 - - -, ZP], usually is a one group gathering but a non spot. The oblique line partially satisfies the ABC limit feasible region, because if takes the policy making variable and coordinates space. This is called the product decision making space.

$Z=d1+d1^{-}+d2+d2^{-}$

$X1+X2 \leqq 6$, and $X1+2X2 \leqq 10$

When $X1 \leqq 4$

$3X1+5X2+d1^{-} - d1=15$ and $2X1-3X2+ d2^{-} - d2=5$

$di, di^{-}, Xi \geqq 0$

ISSN 2304-7712

The hypothesis planed weight appraisal hypothesis plan parameters is the product appraisal not allowed to neglect the question. From the Fuzzy multi goals plan question, melts the general multi goals plan computation. According to studies the motive and comments the accurate policy making and inferential reasoning result.

2.6 Evaluative product of optimize values

More recent policy initiatives have sought to foster industry clusters within these spaces to contribute to economic development and diversification and link this to economic, social and cultural regeneration (Paul et al., 2008), thus, solution of customer's satisfaction, represents the goal, simultaneously arrives with the ideal recently feasible explanation, and when the goal of each unit is provided until user reaching his product s atisfaction (0ABC), as Figure 2.

〔**Fig. 2 Evaluative product of optimize values (0ABC)**〕

3. Case studies: Different products design of evaluative criterion

The case study of evaluative criterion chooses enterprises with 1~6 different products department of sales. Each establishes several design product appraisal criterion and applies in different item. In this example, 30 enterprises have been tested.

The questionnaire survey, according to the product characteristic plan, analyzes from projects based on customer demand, product characteristic, product specification, product block diagram, customer demand and product characteristic correlation matrix.

ISSN 2304-7712

3.1 Problem description

Each enterprise which has 1~6 different products department of sale modeling was inspected whether to conform to to requested condition of the user, the performance, the specification table, the material examination design bad style analysis and so on. Question of spot, the possible bitter experience to carry on the analysis and the countermeasure appraisal, according to the user will be used to confirm that product official modeling and style, and to carry on the product construction model. Widely collecting the user demand, classification of the screening of demand item, the demand item and so on, and by the technological innovation and the creation of strategically competitive advantage, will create the successful product design value. By urging the whole staff to see clearly the customer demand, proposing the solution, and using the variance analysis to create the benefit and the value for the customer and the organization, will show the best design value display and the biggest benefit.

However, the market changes dynamically and the product life cycle reduces gradually. If we develop the new product design from grasping customer's needs and establishing the kinesiology and the multi objective programming pattern, the design product may have the best manufacture procedures. How to strengthen the product business planning for specialized design, the product innovation and the internationalization through high quality and the creativity energy, will be the key to lead the enterprise to integral development.

3.2 Evaluating criteria parameters and perfect matrix

Criteria product1: Handset, Product2: Bicycle, Product3: Computer, Product4: Furniture, Product5: Language machine, Product6: Teacup.

ISSN 2304-7712

Nowadays, the multi criterion decision making perfect matrix is in a high competitive power time, the product policy maker applying the multi criterion decision making analytic method will improve the internal potency. In the actual work process, till factory's product design plan, the ownership of the utilization evaluative criteria software function which discovers various attributes and their relation, and the obtaining the most superior product design procedure evaluative criteria results, are indicated in Table 3.

〔**Table 3 1~6 different products department of sale result**〕

The ownership total score scope, from 45~55 points to is the normal state, may be regarded by the customer as accepted. The experiment appraisal condition, the accumulation counts each score.

3.3 Products expression models identified in the current study can be ranked

The six expression models identified in the current study can be ranked using evaluative criteria model to yield the results presented in Figure 3.

Total Scores: (Product 6) =40, (Product 5) =42, (Product 4) =48, (Product 2) =50, (Product 3) =54, (Product 1) =64.

Product 6 <Product 5< Product 4 <Product 2 < Product 3<Product 1.

〔**Fig. 3 Products expression in the rank**〕

1. Innovation diffusion index: 0.07, 0.09, 0.05, -0.03, -0.02, -0.02

   Product2> Product1>Product3 >Product5> Product6> Product4

   (Bicycle)> (Handset)> (Computer)> (Language machine)> (Teacup)> (Furniture)

2. Innovation uses the index: 1.04, 0.86, 0.85, 0.6, 0.99, and 0.68

Product1> Product5> Product2> Product3> Product6 >Product4

(Handset)> (Language machine)> (Bicycle)> (Computer)> (Teacup)> (Furniture)

3.4 Different products department of optimize values

At the same time, the product multi product of optimize values essence helps the policy maker in the limited feasible plan, according to attribute characteristic of each plan. From the product feasible plan, each plan makes a series of fit and unfit quality arrangement which are appraised and chosen, conforming to the product maker's plan, are indicated in Table 3.

〔**Table 4 Products evaluative criteria of sale score**〕

3.5 Product objective function for optimal values solution

Z= Product max profit (optimal solution)

X1 =Each product amount of use (machine kind A)

X2 =Each product amount of use (machine kind B)

X1+X2≧ Sum total (may use the resources)

X1+X2≧ Producer criteria benefit and user criteria benefit

Followings are 1~6 products department of sale of comparison table.

Z= Product max profit (optimal solution), as Figure 4.

1: Handset department of sale, 2: Bicycle department of sale

3: Computer department of sale, 4: Furniture department of sale

5: Language machine department of sale, 6: Teacup department of sale

〔**Fig.4 1~6 products department of sale table**〕

ISSN 2304-7712

Z = 83.5>72.5> 63> 49.1> 38.1>21

Z = Product 1 (Handset) > Product 3 (Computer) > Product 2 (Bicycle) > Product 4 (Furniture) > Product 5 (Language machine) > Product 6 (Teacup).

4. Discussion

4.1 Evaluative criteria model to response degree

In Figure 4, the customer feeding, using 1~6 different products department of sale evaluative criteria model to response degree, obtain the different product:

1. Innovation diffusion index: 0.07, 0.09, 0.05, -0.03, -0.02, -0.02

   Product 2> Product 1>Product 3 >Product 5> Product 6> Product 4

   (Bicycle)> (Handset)> (Computer)> (Language machine)> (Teacup)> (Furniture)

2. Innovation uses the index: 1.04, 0.86, 0.85, 0.6, 0.99, and 0.68

   Product 1> Product 5> Product 2> Product 3> Product 6 >Product 4

   (Handset)> (Language machine)> (Bicycle)> (Computer)> (Teacup)> (Furniture)

3. Level analytic method

   In Figure 1, Use simple multiattribute comments the quantity technology, the policy maker must consider many kinds of different product attribute to choose product preferred plan. During the process to evaluate the product value for the policy maker the product importance arrangement has to be given first, then the value by chance has to be set based on this importance and finally the policy maker product value function and the relative parameters are obtained.

4. Building the best selection in product decision

ISSN 2304-7712

In Table 1, sets hypothesis of after project evaluation and of the goal parameters, then aims at the product plan to make the graph or the sensitivity analysis. From the numerous plans, chooses satisfaction solution properly, this is also the best product decision scheme.

4.2 The biggest product effectiveness in decision making

Processes the multi objective variables by choosing the biggest product effectiveness in decision making. Apply Fuzzy logic deduction by computer auxiliary computation, if the system's membership function and the rule of designs are good, then the biggest product effectiveness may be stimulated.

4.3 Using multi-criteria decision software of results

When inscribing auspicious company digital product design procedure, three goals including the product design modeling, the product cost, and the productive time are mainly considered as a result of product system regulation work planning and the consideration of overall corporate goal achievements value. Therefore, there are numerous and a diverse approach of project, the policy maker faces the choice to select one kind of good policy making.

The results of Z=1~6 different products department of sale, optimal solution(Z= 83.5>72.5>63>49.1>38.1>21),(Z=Product1:Handset>Product3:Computer>Product2:Bicycle > Product4:Furniture > Product5:Language machine > Product6:Teacup).

5. Conclusion

The traditional enterprise product design takes long time for the process of decision-making in order to get better achievements. In fact, in our changing and complex environment, the decision maker frequently faces many

ISSN 2304-7712

criteria, multi- people and multi-questions, and also some special factors which often affect policy maker's judgment.

In this study, we find that a solution for enterprise product multi goals decision making question is difficult, because during the product designs it usually does not have the mechanism to solve the complexity, the risk, the conflict, and so on. In addition, the changeable factor causes the entire decision making process to be more difficult. If we use the Fuzzy deduction and the correlation technology, appraising the feasible method and the multi goals decision making, the problems of facing the product multi goals and the limited resources situation will be solved, and the best product design resources assignment can be made.

Therefore, after the enterprise product design project analysis, effectiveness and the customer degree of satisfaction must be appraised to obtain the maximum value for the benefit on behalf of the implementation goals, the promotion product level and market competition strength, Therefore, the use of Fuzzy set with the multi attribute policy making method will cause the achievements appraisal system, and can achieve the anticipated strategy goal of the product design. When the hypothesis achievements standard produce the market goal, the best product choice design can be the foundation of the policy making, and may maintain the product competitive advantage for the product development.

References

Judith, L. 2008."SECTION 1: Innovation and the food industry volume."*Innovation Managemen Policy and Practice*, 1(10):2-3.

John, H. 2007."Csiro: Partnering for the future."*Innovation Managemen Policy and Practice*, 2(9): 146–158.

Huang, J., G. Tzeng, and C. Ong. 2006."Optimal fuzzy multi-criteria expansion of competence sets using multi-objectives evolutionary algorithms." *Expert Systems with Application*, 2(30): 739-745.

Narelle, K. 2010."CSIRO and Australian innovation: a business commentary."*Innovation Managemen Policy and*

ISSN 2304-7712

Practice, 2(9):203-214.

Paul, K., M. Ian, and R. David. 2008."Lost in translation? Building science and innovation city strategies in Australia and the UK."*Innovation Managemen Policy and Practice*, 2(10): 211–223.

Stefan, H., and H. Mann, 2010."The role of promoters in effecting innovation in higher education institutions."*Innovation Managemen Policy and Practice*, 2(12): 180-191

Tzeng, G., C. Chiang, and C. Li. 2007."Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL."*Expert systems with Applications*, 4(32): 17.

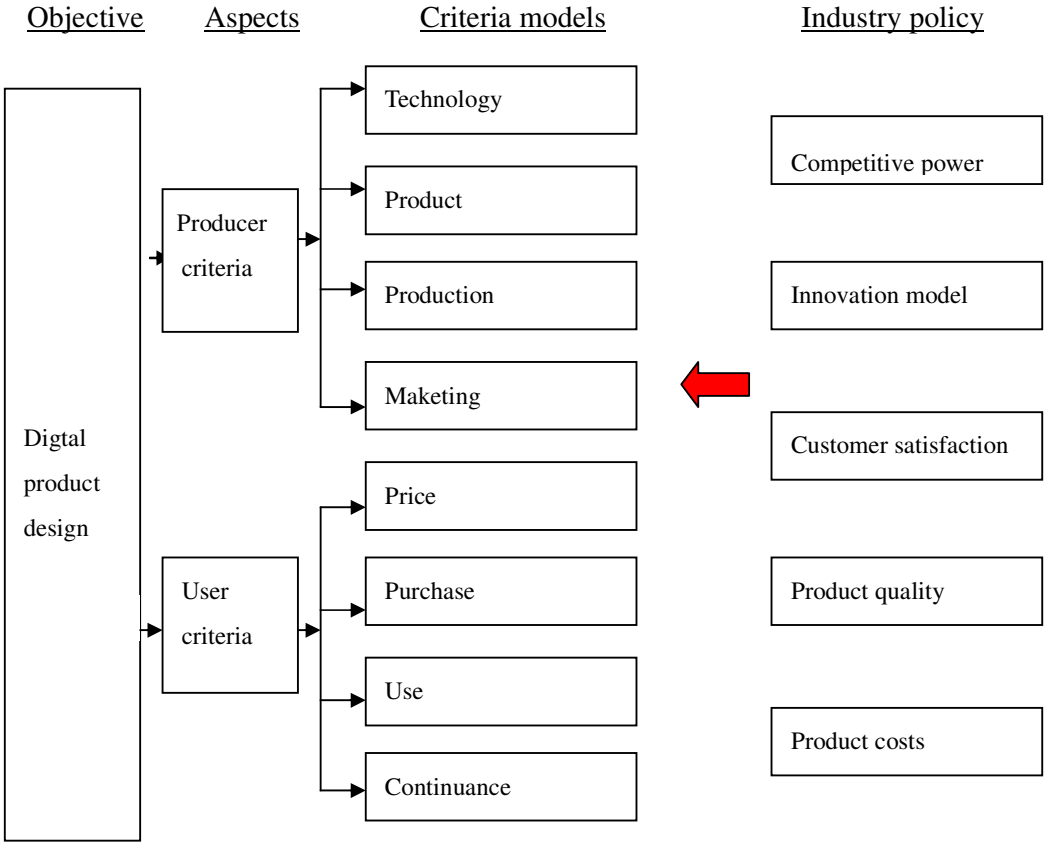
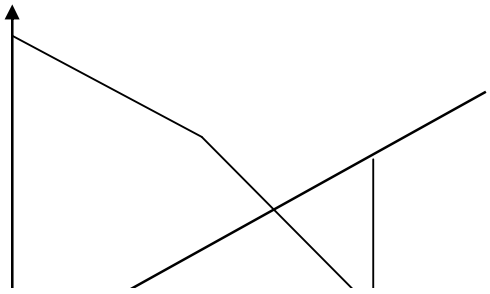


Fig.1 Multi criterion decision making system for product design



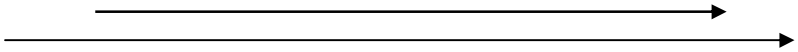


Fig. 2 Evaluative product of optimize values (0ABC)

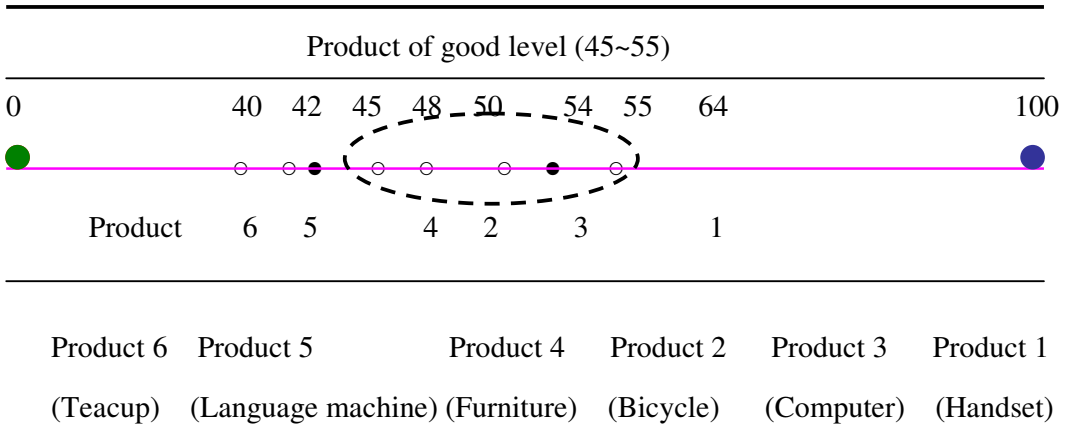


Fig. 3 Products expression in the rank

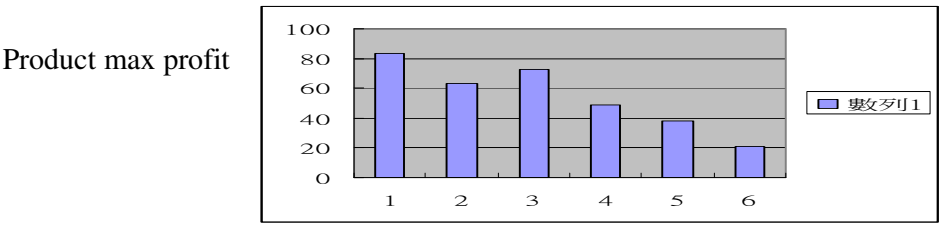


Fig. 4 1~6 products department of sale table

Table1 Integrated product of design systems

1. Product design of model idea

↓

2. Product design of plan

↓

3. Product style, product material, equipment development, production system

↓

4. Product of sample test and cost analysis criticism

5. Produces of multi-criteria decision making

6. Product application to marketing sales and manufacturing

Producer criteria(X1)

TECHNOLOGY

A. SYSTEM CHANGE	B. TECHNOLOGY STATUS
A5.No change or adaptation	B5.Low/current technology
A4.Minor peripheral change	B4.Applied technology
A3.Medium change	B3.Integrated technology
A2.Major core change	B2.High technology
A1.Building new core	B1.New technology

PRODUCT

C. ADVANCEMENT	D. PRODUCT NEWNESS
C5.Radical	D5.New to world
C4.Innovative	D4.New to industry
C3.Incremental	D3.New to category
C2.Substitutive(more choice)	D2.New to company
C1.Imitative(no improvement)	D1.New to product line

PRODUCTION

E. DESIGN SPECIFICATION	F. PRODUCTION BASIS
E5.Free to set an ideal specification	F5.Current process
E4.Major adaptation allowed	F4.Adapted process
E3.Minor adaptation allowed	F3.OEM process
E2.Options to choose matured spec.	F2.New process(to be purchased)
E1.Stick to a strict specification	F1.Dedicated process(to be developed)

MARKETING

G. DISTRIBUTION CHANNEL	O. PRODUCER BENEFIT
G5.Existing channels	O5.Profitability and competitiveness
G 4.Channels to be strengthened	O4.Profitablity largely
G3.Available channels	O3.Competitiveness mainly
G2.Locally new channels spec.	O2.Minor to both
G1.Globally new channels	O1.None to both

User criteria(X2)

PRICE

H. COMPETITION STATUS	P. USER BENEFIT
H5.Absolute leading	P5.Creating or invention
H4.One competitor	P4.Comforting or entertaining
H3.Three competitors	P3.Gainging or enhancing
H2.Mild competition	P2.Convenience or saving
H1.Fierce competition	P1.Supplementing or substituting

PURCHASE

I. MERCHANDISE STATUS	J. NEED STATUS
I5.Convenience goods(expendable)	J5.Both urgent and significant
I4.Convenience goods(durable)	J4.Either urgent or significant
I3.Shopping goods(necessity)	J3.Less urgent and less significant
I2.Shopping good(luxury)	J2.Less urgent or less significant
I1.Specialty goods	J1.Neither urgent nor significant

USE

K. BEHAVIORAL CHANGE	L. USE STATUS
K5.No adaptation/learning	L5.New functions + new applications
K4.Minor to auxiliary operations	L4.Improved functions + new appli.
K3.Medium chang	L3.New functions mainly
K2.Major to critical operations	L2.Improved functions only
K1.Complete adaptation/learning	L1.No major contributions

CONTINUANCE

M. PRODUCT WHOLENESS	N. ADOPTER STATUS
M5.Whole product(full service)	N5.For personal use
M4.Basic product or subsystem	N4.For family use
M3.Component or accessory	N3.For work use
M2.Supply or material	N2.For public use
M1.Concept or message	N1.For rarely use

Table 3 1~6 different products department of sale result

	1~6 different products department of sale result					
Evaluative criteria	Product1 (Handset)	Product2 (Bicycle)	Product3 (Computer)	Product4 (Furniture)	Product5 (Language machine)	Product6 (Teacup)
Producer criteria(X1)						
Technology	A2	A1	A2	A4	A1	A5

Product

Production

Maketing

User criteria(X2)

Price

Purchase

Use

Continuance

Table 4 Products evaluative criteria of sale score

Evaluative criteria	1~6 different products department of sale score					
	Product1 (Handset)	Product2 (Bicycle)	Product3 (Computer)	Product4 (Furniture)	Product5 (Language machine)	Product6 (Teacup)
Producer criteria(X1)						
Technology	2	1	2	4	1	5
	3	5	3	5	4	5
Product	4	4	4	4	4	1
	5	4	5	1	4	3
	2	2	4	5	2	5

Production	
Maketing	
Scores	
User criteria(X2)	
Price	
Purchase	
Use	
Continuance	
Scores	
Total scores	

Creating Optimal Product Design of Educational Management for Social and Economical Development

Shih-Chung Liao

Abstract

Current product design of educational management focus has been shifted to the innovation application to really catch and meet the customers' consumption changes in time. Thus, in this paper, taking innovative design on telephone as an experimental case, it is possible to investigate how to lead the product to market oriented and customized management concepts which creative design ability is utilized for a product. Accompanied with an innovative product value chain, the product can animate the progress of the development of the enterprise management, which has become the main issue of the social and economical development in every developed country.

Keywords: Enterprise development, Educational management, Product design, Multi criteria decision making (MCDM), Innovative design.

∗Corresponding author, Address: Department of Visual Communication Design, College of Planning and Design, Technology of Taoyuan Innovation Institute, Taoyuan, Taiwan 320.

E-mail: liao1@tiit.edu.tw.

1. Introduction

When facing this competitive era on product and globalization, it is important to create new designs. The new designs may break the stereotype of traditional designs. This situation leads the designing team into innovation competition. On the other hand, the enterprises now face many management dilemmas and must take the team into internationalization, which means the enterprises must apply the creative product design to produce the varieties, functions, appearance, user, market compartment, price diversity,

etc. in order to satisfy the consumers' needs. Basically, the process from taking the mode into practice to reveal the good fortune and convenience can precisely predict the technique development in the future, demand, and service time (Tseng 2002).

In order to help enterprises today dealing with multi purposes in the market, the modification of organization in product strategy is needed. The product design not only requires expansion on dimensions, but also the extent in different development levels. Pursuit of high productivity is a crucial step for an enterprise. Companies are sharpening their focus and looking for greater value, for example by investing in start-ups later when they have a stronger track record rather than simply based on acceptable business plan. In the developing world, solutions to local or national problems are increasingly relevant to international markets (Collins 2010).

The research model on traditional product design process is based on an optimization mechanism of choice. In substance, the calculation is based on a sequence of product design establishment. However, the strategy makers cannot understand the essence of the problem while facing a structural strategy problem, whether or not the optimization could calculate the result of product design. Whereas multi criteria decision making (MCDM) analyses tend to focus on the arrangement and distribution of purposes, especially under the situation that few coherent strategies were made (Carlos 2004).

Previous researchers have developed various approaches to address this problem. For example, in the recent years, self learning and material exploring have become two of effective studying tools. While research in innovation management has provided many insights into specific aspects of innovation, the encompassing problems confronting general managers, especially managers of small and medium-size firms, have been overlooked in the development of innovation management tools (Igartua et al., 2010).

Next, according to analytical hierarchy process, this study set up a product decision making expect system, Fuzzy set theory, and the multi criteria decision making analysis in order to produce the best quality and best service for consumers, to establish the marketing predominance in the market, and to create the best benefit in product, for detail in Figure 1.

〔**Fig.1 A decision making for educational management**〕

The rest of this paper is organized as follows. The review of strategic proposed method is discussed in section 2. Case studies 1: Data analysis and results in section 3. Case studies 2: Product decision

ISSN 2304-7712

making expect system in section 4. Section 5 presents a discussion of implementation and conclusions.

2. Proposed method

This research obtains valid questionnaires to be the research target samples. The researchers mainly focus on evaluating the preference of values among users. So the goal is to create a feasible progress chart in the shortest time to deal with problems encountered.

Because the model of innovative product design is a totally new challenge for enterprises, the difficulty and risk of failure are much higher than those long period routine tasks. Learning the research method of creative product designing can be beneficial to the design control of new products to complete goals successfully. This article divides the research methods into four stages as shown in Figure 2.

〔**Fig.2 Create product design stages for educational management**〕

2.1 Concept development of product design and Fuzzy theory

Adequate information and data are needed while strategy maker's face the problems during the procedure of product design. However, the data or information may contain multi-uncertainty or Fuzzy situations; hence, they have to be adapted by Fuzzy theory and MCDM theory analysis which are programs and techniques of designing plan to solve the problems in product designing. Therefore, the enterprise can be recreated in the future.

The main point of the research of Fuzzy theory is that we can possibly obtain intelligent brief system within access and set a matrix. By the result, the model can apply the linear and non-linear recursive methods during the period. In fact, the problems can be solved with using the well-formed concept, knowledge, information, and technique in designing. These methods depend on good knowledge models and expansion ability, which focus on limited, but effective sustainable learning (Hu et al., 2003).

2.2 Fuzzy measure and aggregation

The purpose of Fuzzy theory is to assist strategy makers in realizing the product quality for consumers' demands including safety, usability, price, function, material, main faculty, ~~and~~ etc., and also in simplifying the product. In addition, the product designers can know the demand model of consumers with using various design techniques and methodologies to complete the synthetic drill by analyzing the appearance and color in nowadays in various products. Therefore the designers can solve the existing

ISSN 2304-7712

problems for product users; moreover, these processes can promote the design of product creation.

For example, several well-known models regarding competence set expansion have focused on the development of effective methods for generating learning sequences with minimum learning. For each decision problem, a competence set is necessary and consists of ideas, knowledge, information, and skills for successfully solving the problem (Hu et al., 2003). Evaluation methods not only are taken as a solution to the traditional product design, but also to modify the efficiency of the design itself. Therefore, strategy makers can get the division by dividing the available questionnaire replies according to their features, as like Figure 3.

〔**Fig.3 Building product design for educational management**〕

The application of innovative design can stimulate the product design. Therefore, how to efficiently apply the innovative interface, to explore new usages, and to facilitate the users to use the interface intuitively have become the mainstream of design. An empirical case of R&D innovation performance will be illustrated to show that the rough sets model and the flow network graph are useful and efficient tools for building R&D innovation decision rules and providing predictions (Wang et al., 2010).

This study shows that the results are identical. It also shows that the satisfaction of human computer interaction is the highest after the measurement, representing human computer interaction is more beneficial than others. For example, goal programming is an analytical approach devised to address decision making problems where targets have been assigned to all the attributes and where the decision maker is interested in minimizing the non-achievement of the corresponding goals (Carlos 2004).

2.3 Improve product design process, and to create optimal efficiency

Techniques for machine learning have been extensively studied in recent years as effective tools in data mining. Although there have been several approaches to machine learning, we focus on the mathematical programming approaches in this paper. The environment of decision making changes over time.

3. Case studies 1: data analysis and result

1. Problem description

Analyze the demand of telephones according to Fuzzy situation. With the technological design, the

ISSN 2304-7712

product must be friendly designed in its human computer interaction. It will be more popular in the screen of analysis. Innovative design telephone products can strongly accelerate the product design to new trend.

The esthetic value is highly praised in the innovative design. With the combination of wisdom, fashion, and various materials, it can definitely get out of the stereotype of traditional ones to create a classic one made in high quality and humanized. By forming the inferring for the innovative designed phone, we can list the rankings as Intelligence, Brand, Vogue, Touches controls, Price, Texture, Function, Pixel, Weight, Style, Esthetics, Interface etc.

2. Analysis on survey on customer in four stages objective situation

According to Figure 2, the analysis task comprised of four stages:

(1) Analysis on survey on customer in Fuzzy situation.

(2) Multi criteria decision making core evaluation system.

(3) Innovative strategy management.

(4) Create product design management.

Stage 1: analysis on survey on customer in Fuzzy situation

1. Concept development of product design

It is observed that the least number of descriptions being used is 60. The majority of the subjects were utilized within 60 descriptions. In usage of 60 descriptions, the choice of purchasing telephones was made most frequently for telephone ages/3 years, as Figure 4.

〔**Fig.4 Frequency distribution and purchase telephone ages/3 years**〕

2. Expression in telephone activity modes

Regarding to 60 descriptions, Figure 4 displays that the frequency distribution of descriptions are listed as purchases telephone brands, features in Market activities, Users' customs, Product developments, and expression support numbers. For example, innovative designed telephone screen and the features of innovative designed telephone play two of critical factors in the experimental outcome. This shows that the solution lies in the combination of feature design brand, A, B, C, and D in Figure 5.

〔**Fig.5 Expression in telephone activity brands**〕

The outstanding performance of innovative designed telephone brand in the competitive market is accomplished within the promising R&D and design according to the market.

ISSN 2304-7712

3. Telephone brand

The outstanding performance of innovative designed telephone brand in the competitive market is accomplished within the promising R&D and design according to the market and customer demands. Therefore, it is important to specifically realize the demand of customers according to their various demands, and to satisfy individual demands among all sorts of consumers. The 60 descriptions were mingled randomly and then provided to each expert.

The combination of designed in innovative designed telephone brand (A) gets the optimal efficiency in product design. It contains a completely profound function and system.

4. Determining of evaluating criteria of designed telephone

The researchers set up telephone brand decision system by decomposing the problem into a hierarchy of interrelated elements Table1.

〔**Table 1 Telephone brand and feature**〕

These 60 descriptions were evaluating criteria of designed telephone provided to each element, as Table 2.

〔**Table 2 Innovative designed telephone for evaluating criteria**〕

To combine the designed feature in innovative designed telephone for evaluating criteria Product development, 46% of the 60 descriptions reach the optimal evaluating criteria frequency in product design.

Stage 2: multi criteria decision making core evaluation system

1. Evaluating criteria of designed telephone

This stage generates input telephone data consisting of pairwise comparative judge of decision elements. The plan tested individually on Mode 1 Market activities: Intelligence A(11), Brand A(12), Vogue A(13), Touches controls A(14), Mode 2 Users customer: Price B(11), Texture B(12), Function B(13), Pixel B(14), Mode 3 product development: Weight C(11), Style C(12), Esthetics C(13), Interface C(14) etc, as Table3.

〔**Table 3 Evaluating criteria of designed telephone**〕

To combine the designed feature in evaluating criteria of designed telephone for evaluating

ISSN 2304-7712

criteria 30~40 ages, 9.8 from all descriptions get the optimal evaluating criteria of users customer in product design.

2. Calculating synthetic utilities

(1) Determine the aggregating of the decision elements to arrive at a set of ratings for the alternatives and strategies.

(2) Show the overall number of descriptions supplied in each modes and customs like depending on mode product innovative development and get the optimal purchase in product design.

(3) The purchase telephone design of interface and elements

First of all, horizontal line represents that the battery is full of electronic energy, and the user hasn't made a call. Second, as the communication frequency grows, the curve of drop down expresses the consumption of the battery. This represents that under the consumption, the innovative designed telephone mode product developments can extend its using time.

Due to the variety of telephones, the designer adapts the innovative design process to get the overall information through the interface and elements. This will be used to construct the function structure model, and to study the virtual construction to make it into practice.

(4) The decision system of more than targets in purchase product

Depending on 60 descriptions, the discrimination is 6 customer groups, and 4 mode-4 product developments: Machine weight, Style quality, Esthetics, and Interface. Using the decision system of more than targets decides the preference of product. The first group emphasizes interactive benefit; the second emphasizes quality, and the third emphasizes functions. Their preferences are style quality and esthetics. So a chart is made to show the group preferences in Table 4.

〔**Table 4 Consumers preference of products**〕

(5) Create product optimal technology management

Calculating data from 60 descriptions, 6 customer groups demonstrate five main means which are 0.06, 0.15, 0.21, and 0.58 as their preference values. In addition, Machine weight is 0.06, Style quality 0.15, Price 0.21, and Function 0.58 in Table 5.

〔**Table 5 Number of descriptions supplied in each customer group**〕

ISSN 2304-7712

In Table 5, in order to get the final question point and then to solve the problem in Function, the researchers design the research method to achieve customer purchase product satisfaction.

Stage 3: innovative product design for educational management

According to Table 5, using data from 60 descriptions, this analysis discloses on the elements of innovative designed telephones: Mode 1 Market activities: Intelligence A(11), Brand A(12), Vogue A(13), Touches controls A(14), Mode 2 User's custom: Price B(11), Texture B(12), Function B(13), Pixel B(14), Mode 3 Product innovative development: Weight C(11), Style C(12), Esthetics C(13), and Interface C(14).

Depending on the development of telephone industry, the necessity of low cost, high flexibility in the superiority of production, and the demand of humanized product should be controlled to influence the concept of design and the development of crucial modules enormously, as Table 6.

〔**Table 6 Establish the user's telephone of performance matrix**〕

The results in Table 6 establish the user's telephone of performance matrix. Fuzzy sets are adapted in the strategy of business administration. Take telephones for an example, there are creative designs to choose in the establishment of production, all of which point to the division in humanized interface, user standpoint, model change, instinct manipulation, control combination, material change.

Hence, according to the criteria quantification, it chooses the innovative plan as the optimal plan. It is optimal production. Considering the elements of price, benefit, and usage, it has more chances to choose the most appropriate plan. Therefore, in the actual design process, this study adapts the membership functions in Fuzzy Theory for searching the relevance between each feature and obtains the best result in quantification, as Table7.

〔**Table 7 Calculating telephone of synthetic utilities**〕

In Table7, in order to calculate telephone of synthetic utilities and then solve the problem in evaluation strategy, the researchers design to achieve telephone values of criteria.

Stage 4: create optimal product design for educational management

According to Table 7, calculating telephone synthetic utilities results, Fuzzy synthetic utilities to innovative product design, and telephone values strategies, the strategy establishes good collecting

ISSN 2304-7712

telephone values of criteria. This is the best strategy when telephone customer and enterprise would like to engage in Mode 1 Market activities: Intelligence A (11)4.6, Brand A (12)5, Mode 2 User's custom: Price B (11)5.4, Function B (13)5.4, and Mode 3 Product innovative development: Style C (12)5.5 and Esthetics C (13)4.6, if the criteria are substitutive and independent, as Figure 6.

〔**Fig.6 Result of creative optimal product design for educational management**〕

4. Case studie 2: building a optimal product design for educational management

1. Product objective

According to Figure 3, the product design model is adapted for stimulating the proper solution to satisfy consumers with various points of views. However, multi decision making theory would be widely adapted in the long term, uncertain environment. With this strategy, the decision maker can realize the optimal mode of the solutions to problems.

So the designer must realize and analyze the features of product before making design drawing, including striking a balance between the relationship of cost and user satisfaction, which is highly emphasized in this research.

2. Activity modes

According to the telephone industry market and the coming Innovative management trend, the competition in the innovative telephone market will be for sure in the future. This activity mode include product design position and market strategy, product management, creation of R&D value, design of organization structure of R&D, performance management and development mechanism. So the decision maker must set the industry goal and strategy to reflecr market competition.

3. Evaluative system

Through using 60 descriptions and data from the user questionnaire survey form, in order to analyze innovative designed telephone, the product market can be divided into Market activities: value chain (A1), wise management (A2), product quality (A3), and research & development (A4); for User's custom: product management (B1), customized service (B2), marketing (B3); and for Product innovative development: R&D structure technique (C1), service quality (C2), management model (C3), and market environment (C4). Telephone enterprise management ranks into 5 points. Which incluse: product scarce for 1 point, product difficulty in imitation for 2 points, product not substitution for 3 points, and product

ISSN 2304-7712

value for 4 points, And the result reveals that product not substitution and product value are optimal in innovative designed telephone, as Table 8.

The combination of Innovative expect system and management of designed telephone for Market activities: wise management (A2), User's custom: Product management (B1) and Product innovative development: Service quality (C2) gets the optimal innovative product designed management in design.

In Table 8 Innovative product designed expect system product not substitution and product value get the highest grades in the sum up. The result can be applied to realize the category of innovative management.

〔**Table 8 Results of innovative product designs for educational management**〕

4. Result of create optimal product design for educational management

Create optimal product design for expect management, according to Table 7 and 8, the evaluation of products requires the intent combination of design techniques and user's demand, complete understanding of industry dynamics, application of management of innovative designed telephone management to users, integration of the interior and exterior resource, and establishment of organization construction. Therefore, it is necessary to create optimal product and customer value during enterprise transformation, as Figure7.

〔**Fig.7 Results of create optimal product design for educational management**〕

5. Educational management is a successful application in the Taiwan industry

In Taiwan industries, it is constantly broadening the range of devices it offers- introducing devices to support specific applications and new form factors that meet the increasingly diverse needs of its customers and partners. Besides, product portfolio offers easy-to-use solutions that embrace the full range of mobile multimedia resources, wireless anytime and Internet on the go.

It has invested in a strong R&D team accounting for 25% of the total headcount and a World-class high-volume manufacturing facility, both based in Taiwan industries.

In Taiwan, according to 2006 industry and commercial statistical reports, Used expect system, and its successful application in specialized design are shown as Figure8 and Table 9.

〔**Fig.8 Educational management is a successful application in the Taiwan industry**〕

ISSN 2304-7712

〔**Table 9 Educational management is a successful application in the Taiwan industry**〕

5. Discussion

As discussed, with the change of consumer's usage, the design trend of innovative designed telephones changes as well. Hence, the new touch screen technologies have shown up. In the present study, we wish to improve the human-computer interaction benefit from the innovative screen. Therefore, how to explore the potential function demand of consumers providing innovative solutions and integrating the systems has become the challenge of designers.

In Figure 3, strategical system in innovative designed telephone, discusses the confirmation of demand items first by the method of evolution of innovative designed telephone, including making the demand items of users, collecting the demand widely, selecting the demand items, categorizing the demand item etc. Depending on these procedures, this study successfully creates the design value of production through technological innovation and creation of competitive advantages in strategy. And then the researchers observed the customer demands and proposed the solution. Meanwhile, this study also applied diversity analysis to provide optimized expect system by initiation of product expect management and value.

In Figure 5, innovative telephone synthetic innovative measurements had shown telephone values of Fuzzy performance score with respect to criteria. This study explains that why the evolution of innovative designed telephone becomes the highest amongst the satisfaction of consumers, knowing that the top priority is the price and the second one is the function.

In Table 4, at least four expression modes for the preference of product which consumers has shown are used for thorough analysis to understand the crucial customer demand of innovative telephone. Then with the relative analysis of combination of exterior demand and interior quality production, the key and the implicative variables were controlled to improve the quality to these crucial points, like web phone, which has been highly emphasized in its vocal quality and delicate simple style.

Therefore, in Figure 6 and 7, the research of innovative design telephone is in Fuzzy field in the beginning. MCDM system is mainly applied in using strategy to make product design and in setting the product standard. First, we systematically transform customer demand into product feature, and then

ISSN 2304-7712

expand to every part, and to plan the production process, controlling the manage points in each stage.

6. Conclusion

Due to the competitive product market, designers should consider the factors like function, appearance, market compartment, and price diversity, etc. to create diverse products that make various consumers satisfy. Accordingly, it is a great challenge for designers in this competitive environment. It is singnificant that how they analyze the market status and performance to draw up the product positioning and strategy for creating new product value. The designers also need to understand costumers' requirements. With the change of consumer's usage, the design trend for innovative designed telephones changes as well. Hence, the new technology has shown up. This present study expects to improve the telephone interaction benefit from the product innovation. Therefore, how to explore the potential function demand of consumers, that is, providing innovative solutions and integrating different systems, has become the challenge for designers.

A decision making expect system for industries management, uses product innovation technology, promotes the diversification, implements the phases of the proposed methods, builds a hierarchical system in innovative designed telephones, innovative telephone synthetic innovative measurements, product strategy, and rich product creation for customer needs, and raises production efficiency and elastic delivery opportunity. In digtal product design industries development and in accordance with adapting environment vicissitude, the industry promotes the new plans from improving organization constructions and adopts the authority of labor division and the effectiveness of research results in order to accelerate to achieve the industrial pursuing operation objectives. Taking the case study of innovative designed telephones, this study has adapted the quantification solution like Fuzzy theory, product optimal expect management, and product competition. Also, this study emphasizes customers' needs to solve the problems, to design the optimal solution, to create the diversity to competitors, and to pursue the maximum sum.

Hence, in the competition, it becomes significant to apply fashion aesthetics as technological innovation for successfully achieving the goal of the delicate and creative design. So, this study establishes the trend in product innovative design, observes customer needs, controls the innovation, and stimulates the design ability. Lastly, it achieves the goal of users'

ISSN 2304-7712

satisfaction toward the products.

References

Carlos, R., (2004). A general structure of achievement functions for a goal programming model. *European Journal of Operation Research*, 3(153), 675-686.

Collins, L., (2010). Recession Pushing Innovation in New Directions. *Research Technology Management*, 2 (52), 35-39.

Collins, L., (2010). Nokia to Give Away Ideas and Innovations. *Research Technology Management*, 5(52), 19-32.

Hu, Y.C., Chen, R.S., Tzeng, G.H., Yu, J. C., (2003). Acquisition of Compound Skills and Hirotaka, N., Yun, Y., Asada, T., Yoon, M., 2005. MOP/GP models for machine learning, *European Journal of Operation Research*, 3(166), 756-768.

Igartua, J. I., Garrigos, J. A., Jose, H.O., (2010). How Innovation Management Techniques Support an Open Innovation Strategy. *Research Technology Management*, 3(53), 41-52.

Tseng, F.M., Tzeng, G.H., (2002). A Fuzzy seasonal ARIMA model for forecasting. *Fuzzy Sets and Systems*, 3(126), 367–376.

Wang, C.H., Chin, Y.C., Tzeng, G.H., (2010). Mining the R&D innovation performance processes for high-tech firms based on rough set theory, *Technovation*, 7(30), 447-458.

ISSN 2304-7712

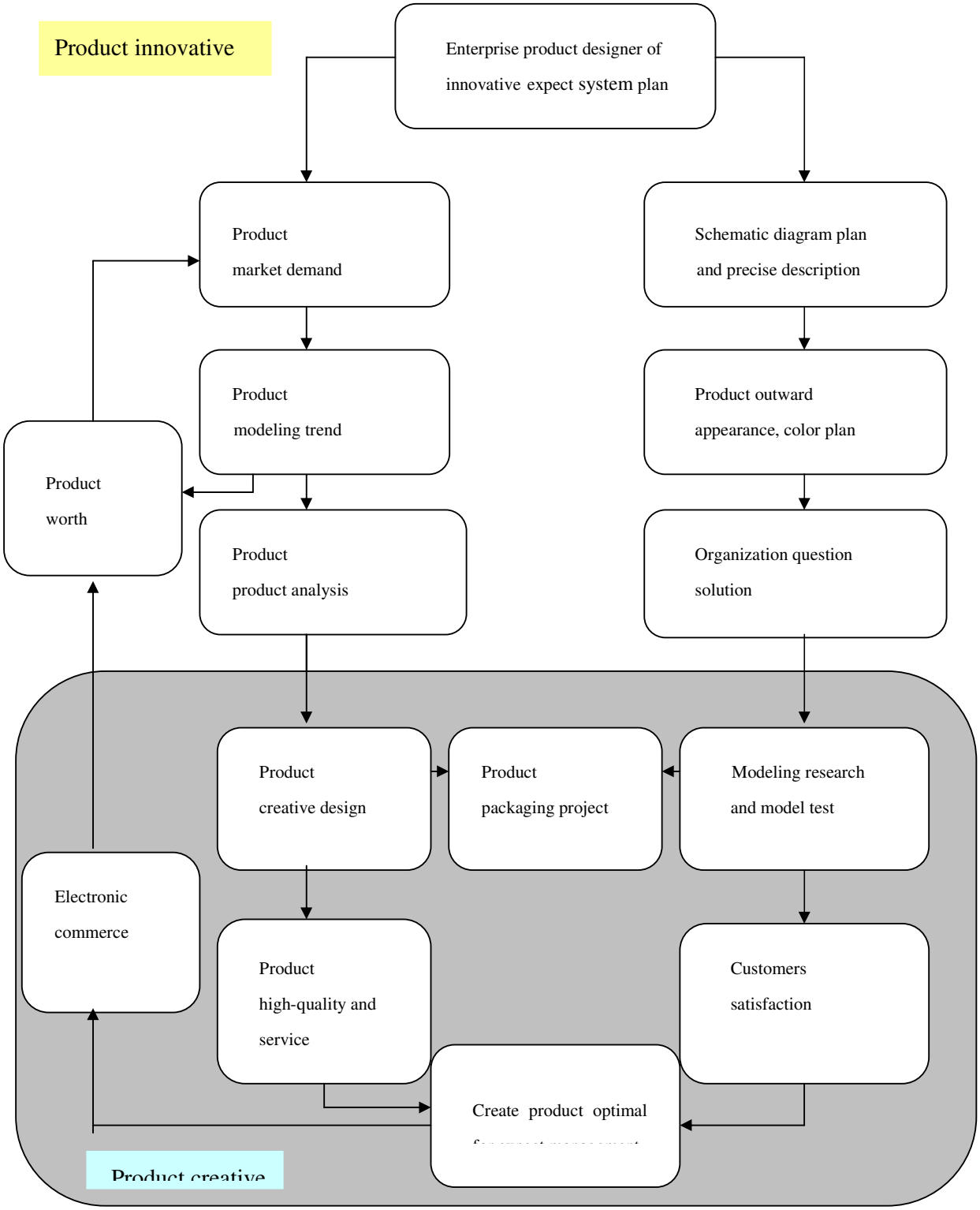


Fig.1 A decision making for educational management

Stage I	**Stage II**
Analysis on survey on customer in Fuzzy situation	Multi criteria decision making core evaluation for expect system

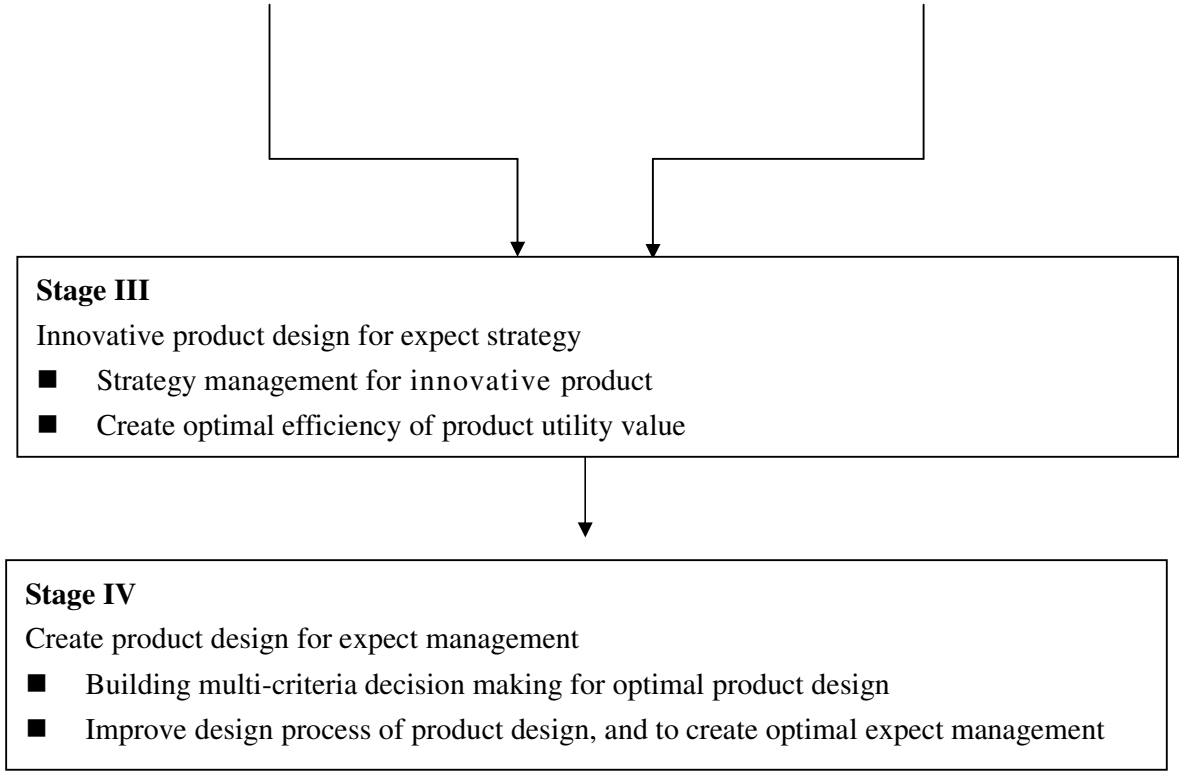
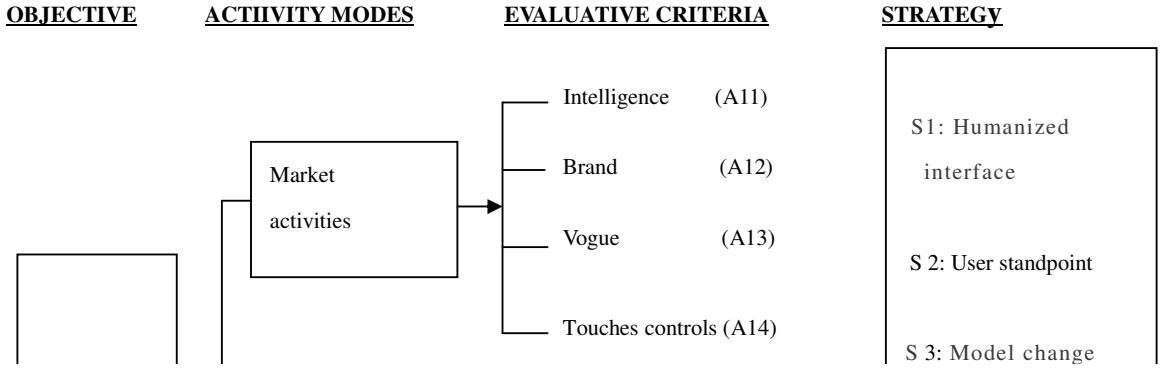


Fig.2 Create product design stages for educational management



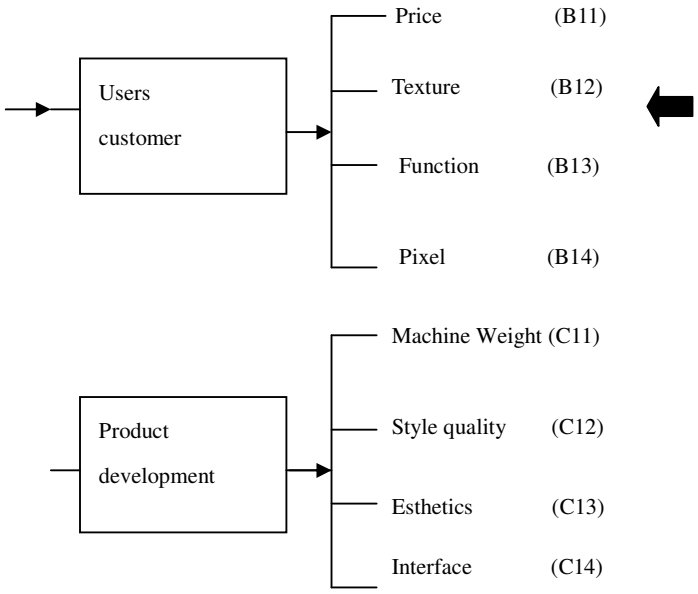


Fig.3 Building product design for educational management

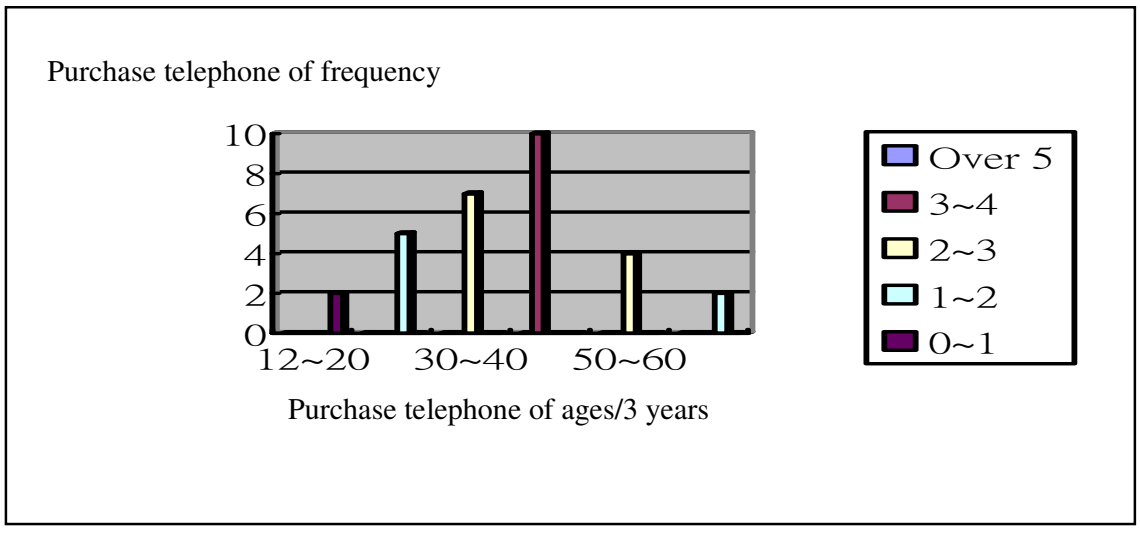


Fig.4 Frequency distribution and purchase telephone ages/3 years

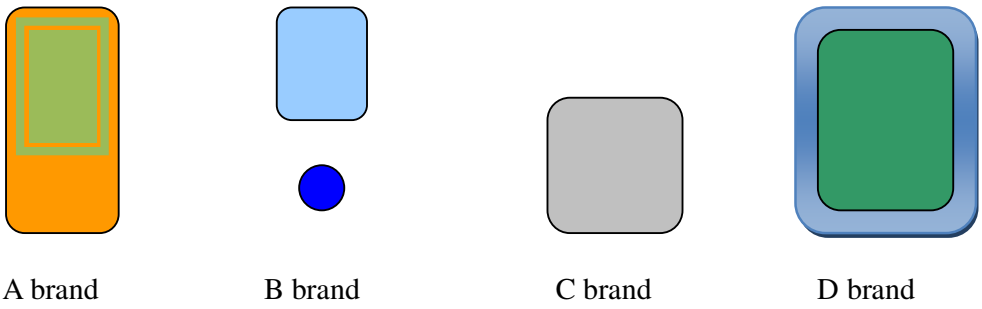


Fig.5 Expression in telephone activity brands

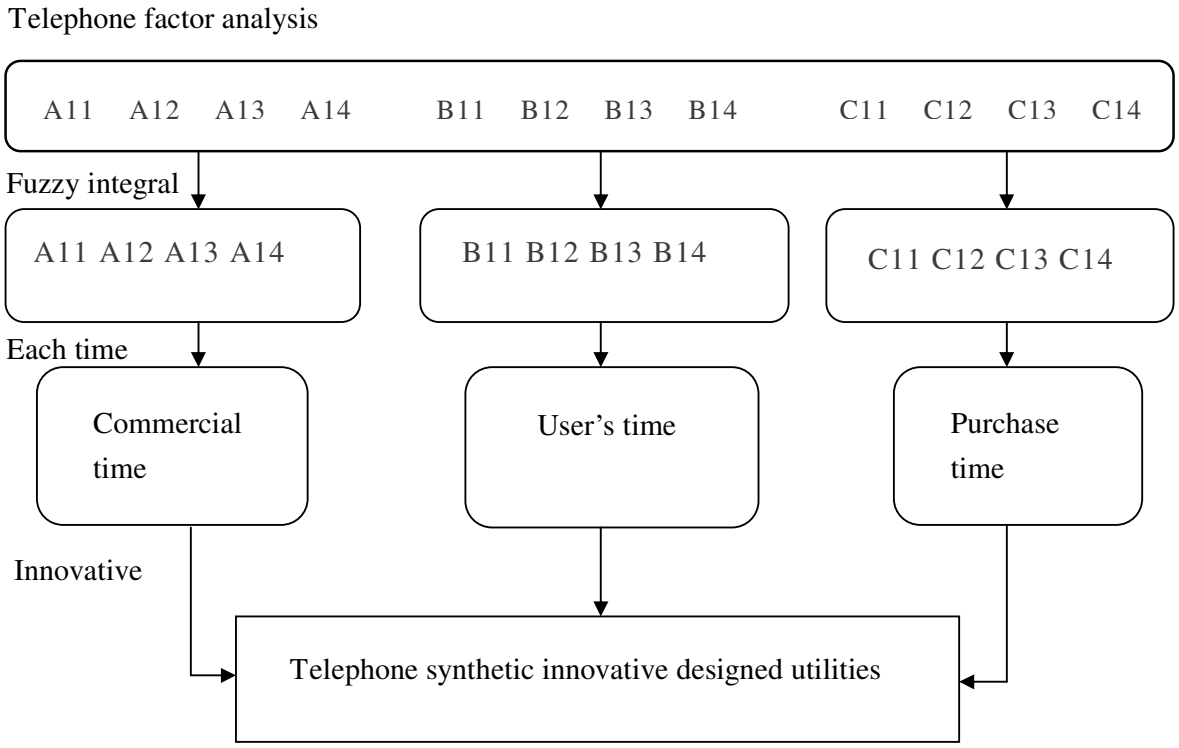
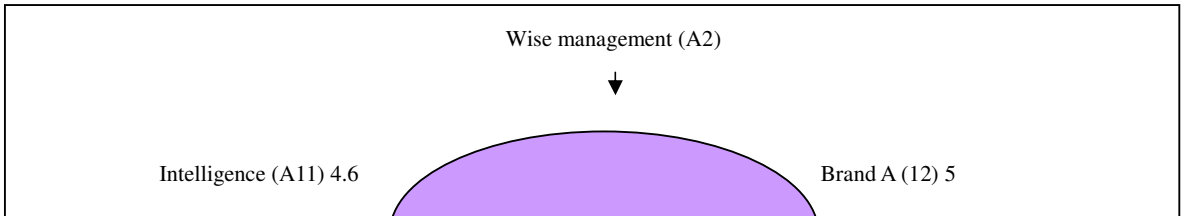


Fig.6 Result of creative optimal product design for educational management



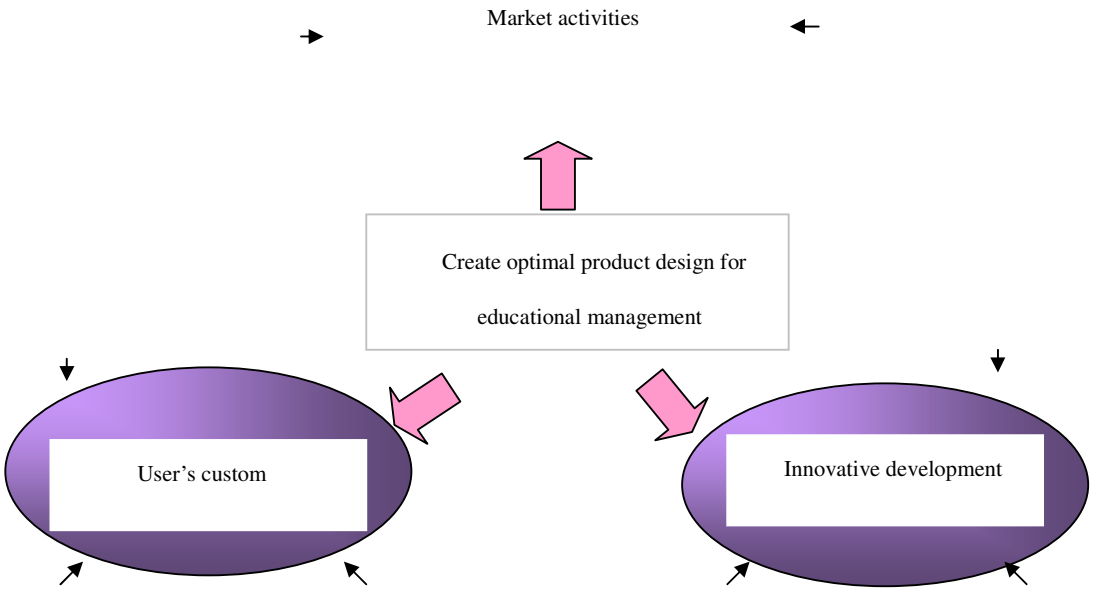


Fig.7 Results of create optimal product design for educational management

(Unit: new Taiwan dollar and hundred million yuan)

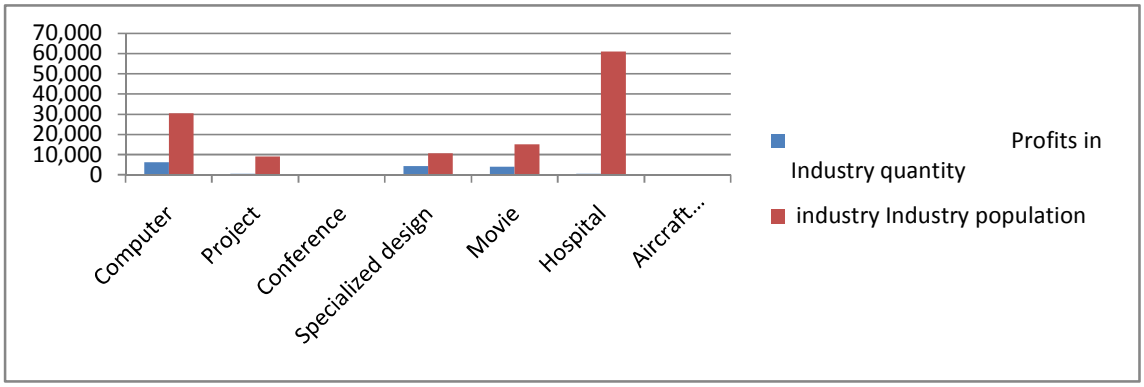


Fig.8 Educational management is success application in the Taiwan industry

Table 1 Telephone brand and feature

Telephone brand and feature

Brand	Market activities	Users customer	Product development
A	34	32	30
B	13	10	11
C	2	1	1
E	6	6	7

Table 2 Innovative designed telephone for evaluating criteria

Innovative designed telephone for evaluating criteria		
Elements	Frequency	Percentage
Market activities	6	10%
Users customer	23	44%
Product development	24	46%

Table 3 Evaluating criteria of designed telephone

Evaluating criteria of users customer				
Evaluating criteria elements	20~30Ages	30~40Ages	40~50 Ages	Mean
1. Market activities				
Intelligence	0.8	0.7	1.0	0.83
	0.9	0.9	0.7	0.83

Brand

Vogue

Touches controls

2. Users customer

Price

Texture

Animation Function

Pixel

3. Productdevelopment

Machine Weight

Style quality

Interface

Total

Table 4 Consumers preference of products

Group user hobby	User values
First group mode	Machine weight
Second group mode	Style quality
Third group mode	Price
Four group mode	Function

Table 5 Number of descriptions supplied in each customer group

	Customer groups						
Third group mode	1	2	3	4	5	6	Mean
Machine weight	0.08	0.05	0.07	0.05	0.05	0.06	0.06
Style quality	0.16	0.14	0.15	0.14	0.15	0.14	0.15
Price	0.21	0.18	0.24	0.21	0.19	0.23	0.21
Function	0.54	0.59	0.63	0.58	0.57	0.57	0.58

Table 6 Establish the user's telephone of performance matrix

Evaluation	Use's telephone of performance matrix											
Strategy	A11	A12	A13	A14	B11	B12	B13	B14	C11	C12	C13	C14
S1: Humanized Interface	(0.8,0.6)	(0.8,0.7)	(0.7,0.7)	(0.8,0.8)	(0.9,0.9)	(0.6,0.6)	(0.9,0.9)	(0.6,0.6)	(0.5,0.5)	(0.9,0.9)	(0.8,0.8)	(0.7,0.7)
S 2: User standpoint	(0.8,0.8)	(0.7,0.9)	(0.8,0.8)	(0.8,0.8)	(1,0.9)	(0.5,0.6)	(0.8,0.8)	(0.7,0.7)	(0.6,0.7)	(0.9, 0.9)	(0.7,0.7)	(0.8,0.8)
S 3: Model change	(0.6,0.6)	(0.6,0.9)	(0.8,0.8)	(0.7,0.7)	(0.9,0.9)	(0.7,0.8)	(0.9,1)	(0.6,0.6)	(0.7,0.7)	(1,1)	(0.8,0.8)	(0.6,0.6)
S 4: Instinct Manipulation	(0.8,0.7)	(0.8,0.7)	(0.6,0.7)	(0.7,0.7)	(0.8,0.8)	(0.8,0.7)	(0.8,0.9)	(0.8,0.7)	(0.7,0.7)	(0.9,0.8)	(0.7,0.7)	(0.7,0.7)
S 5: Control combination	(0.8,0.5)	(0.7,0.8)	(0.5,0.6)	(0.8,0.7)	(0.9,0.9)	(0.7,0.7)	(1,0.9)	(0.7,0.7)	(0.7,0.8)	(0.9,0.9)	(0.8,0.9)	(0.7,0.6)

Table 7 Calculating telephone of synthetic utilities

Evaluation	Telephone values of criteria												
Strategy	A11	A12	A13	A14	B11	B12	B13	B14	C11	C12	C13	C14	Mean
S1: Humanized Interface	0.8	0.8	0.7	0.8	0.9	0.6	0.9	0.6	0.5	09	0.8	0.7	0.7
S 2: User standpoint	0.8	0.9	0.8	0.8	1	0.6	0.8	0.7	0.6	0.9	0.7	0.8	0.8
S 3: Model change	0.6	0.9	0.8	0.7	0.9	0.8	0.9	0.6	0.7	1	0.8	0.6	0.77
S 4: Instinct manipulation	0.8	0.8	0.7	0.7	0.8	0.8	0.9	0.8	0.7	0.9	0.7	0.7	0.78

Table 9 Educational management is success application in the Taiwan industry table

(Unit: Taiwan dollar and hundred million yuan)

	Profits in industry	
	Industry quantity	Industry population
Service	4,050	15,093
Computer	6,288	30,476
Project	645	9,030
Conference	104	353
Specialized design	4,385	10,792
Movie	4,119	14,985
Hospital	535	61,061
Aircraft maintenance	40	-
Total	20,165	141,790

Intruder Detector

Jonnathan M. Acuzar,
Paulo Angelo T. Chan,
Gerald Joe M. Datingaling,
Philip Vonn P. Malaluan,
Princes P. Tumambing,
Jake M. Laguador
jakelaguador@yahoo.com

Computer Engineering Department, Lyceum of the Philippines University, Batangas City 4200, PHILIPPINES

ABSTRACT

This design project aimed to develop a system that will improve the security at home or in any establishment. Results showed that this project gave more security not only to home properties but most especially to the lives of people. The physical design of the system is very similar to the real door of the house and the placement of the devices is placed according to uses. All components used in the design acted effectively and providing quality service to the main users. The infrared sensor detects properly and does not result any errors as tested. Also, the RFID reader and tags are very efficient and accurate. The motor door lock is very useful as representation of a real electronic door lock. The Microcontroller processes all the signals very accurately and does not result any errors. All the devices give a very effective and quality service. The serial communication of the MCU and the monitoring computer through USB port is very effective for the transferring of signals. The software application in the main computer is a friendly user program that is easy to use. The use of this design and any of this system is very useful for security of places like houses, offices, businesses or any place that needed a full time security.

Keywords: RFID, Microcontroller, Door Lock System

INTRODUCTION

Almost everywhere, the use of technology like infrared and RFID are very used today. One of best example is in security. With the immense increase in crime rate throughout the world, there is an intensive need of security. Every individual feels insecure and wants his personal as well as his surrounding life to be peaceful and secured. Security is an important and major resource in any company, banks, homes, and its proper utilization is vital in attaining security objectives. The amount of security necessary in the contact day to day operations has dramatically increased over the year that banks, companies and homes focused in the development, design and used such of security devices in order for them to be secured. We think of security because most of the time, we are

ISSN 2304-7712

unarmed and in any order to be free from danger, fear financial or property loses, we think of security.

An Infrared security system is a great way of dealing the case of intruder. With "Intruder Detector ", it varies that the person who will enter the house is the owner or an intruder. Two sensors are used to build this system, Infrared Sensor and RFID sensor. If the infrared detects a person inside the detection area, the person should present RFID tag for a given time limit so that he/she will not be considered as intruder. If the device detected the main RFID tag, the device will not alarm but if the sensor detects no ID, it will alarm and communicate with the main security office and serves as the signal for an intruder attempt. The aim for this research is for the improvement of security for our homes, etc. Combining software engineering knowledge, experience in access control and electronics, the proponent build a total intruder security system that will give us more security.

Home security systems vary almost as much as the homes they protect. Simple systems can be made yourself for little more than a few dollars, while elaborate systems provide extensive high-tech motion detectors and alerts for any possible emergency. The system which is best for you depends on the property you wish to protect, the means you intend to use, and the money you have to spend [1].

Home security door sensor works with magnets, but there are several different mounting options. The sensor mechanism is housed in one side of the unit, and the magnet is housed in the other side. When the metallic parts lose contact with each other, the sensor sends a signal to the alarm. Door sensors can be small, rectangular units attached to the door jamb and wall. This is a good option for renters. A more permanent and less visible option is to have the sensors recessed in the door and door jamb. Another variety rests on top of the door to keep the sensor out of sight [2].

Vaux [1] suggested that the ideal security system is one which has more than one deterrent. Burglar alarms with motion detectors can cover the basics, but you may want to consider an installed safe to protect your valuables within the home. In addition, inside locks on key doors (especially the bedroom door, which is the place burglars tend to target most frequently) are strongly recommended. The aim is first to deter burglars from targeting your home in the first place, and then to slow them down to the point where they are forced to flee before the authorities arrive.

Infrared light is a type of electromagnetic radiation at a lower frequency than visible light. Every warm object emits infrared radiation, and the frequency and intensity of that radiation can be used to detect what type of object is emitting it. Detecting infrared is extremely useful, and infrared detectors can be used to see in the dark, detect objects in distant galaxies, secure homes and businesses from intruders or take your temperature in the doctor's office [3].

The third era of RFID started in 1998, when researchers at the Massachusetts Institute of Technology (MIT) Auto-ID Center began to research new ways to track and identify objects as they moved between physical locations. This research, which has a global outlook, centered on radio frequency technology and how information that is held on tags can be effectively scanned and shared with business partners in near real time [4].

Radio Frequency Identification is a means of identifying a person or object using a radio frequency transmission. The technology can be used to identify, track, sort or detect a wide variety of objects. The technical advancement of appliances is the invention of air conditioning unit. It has become a necessity of modern life. Residential and commercial space-cooling demands are increasing steadily throughout the world as what once was

ISSN 2304-7712

considered a luxury is now seemingly a necessity [5].

Irani et. al [6] emphasized that with the rapidly decreasing price of the RFID tag, its adoption and utilization is increasing swiftly in various contexts including organizations for supply chain management, hospitals for various types of uses and other public sector organizations. In line with its rapid adoption, researchers from various academic fields are investigating development and management related issues. Nowadays, RFID is popularly known as a technology for the automatic identification by radio frequency of physical objects and people. Therefore, a large number of studies have appeared but scattered in a number of unrelated publishing outlets which may hamper the use of such published resources. This provided motivation to analyze the existing research for categorizing and synthesizing it in a meaningful manner. Hence, the aim of this paper is to provide a comprehensive and systematic survey of the literature pertaining to RFID related research issues in order to ascertain the current 'state of play' of the field along a number of dimensions.

OBJECTIVES OF THE STUDY

The study aimed to design a system through the use of Infrared Sensor and RFID Sensor for security purposes; to design an automatic door locking system for more security purposes; to build a system that has a capability for the Microcontroller to communicate with the main security computer to detect intruder, and to design a program for the user to view the house vicinity with the use of camera.

MATERIALS AND METHOD

This study is a hardware and software development research which aimed to build a system and prototype what would analyze the functionality and efficiency of the ideas created. The proponents considered stages from planning to testing until the project worked. Through comprehensive analysis of the existing designs, the proponents brought out the conclusion of having the same concept and chose the kind of technology that will be applied in enhancing the design. The proponents applied the principles in electronics and even in communication to arrive at the final framework of the project.

Hardware Design

The hardware part of system was designed to detect the person entering the area using an Infrared Sensor and to determine whether the person is an intruder or not using the RFID Sensor and processed it by the Microcontroller. The prototype is designed like a real door and assembled with the devices such as Microcontroller, RFID Sensor, Infrared Sensor and Servo motor. For the output screen monitoring, the prototype used a desktop computer.

The hardware design of the system was used to control all the components of the system by the MCU and have it an interface with the monitoring PC. Microcontroller is like the brain of whole system. Without it, communication in all the components would not be possible. The Microcontroller receives data or signals from the two sensors, the "Infrared Sensor" and "RFID Sensor" and process it to determine whether the detected

ISSN 2304-7712

person is an intruder or not. This is the key to the system, to determine if the person detected by the infrared is an intruder or not by using the RFID Sensor and RFID tags for the identification of the person. The Microcontroller also controls the Servo Motor that acts as the door lock controller. A desktop computer is used as the main monitoring computer for the security guard on duty that communicates serially with the microcontroller through USB cable. The Microcontroller has a program that will be the process algorithm of the design.

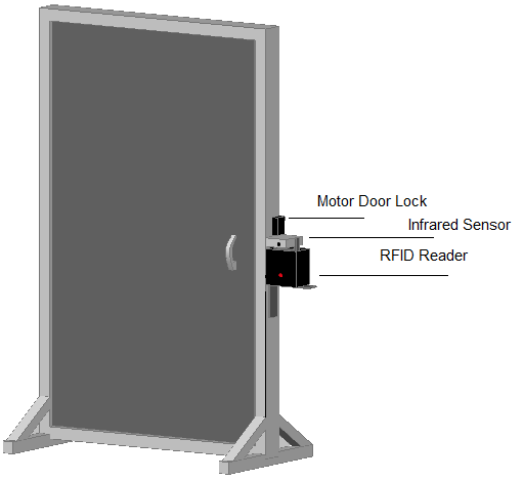


Fig. 1 Front View of the Prototype Door

Home door is the physical design of the prototype. It is 6 ft in height and 3 ft. in width. The front view of the prototype door is shown in Fig. 1, and all the devices are placed in specific location with proper label. The Infrared Sensor is placed at the top of the RFID so that it can detect any person near the door.

The RFID Sensor is located near the door knob so that it is easy for the person to present the RFID Tag. An Infrared sensor (IR sensor) is an electronic device that measures infrared (IR) light radiating from objects in its field of view. All objects above absolute zero emit energy in the form of radiation. Usually, infrared radiation is invisible to the human eye but can be detected by electronic devices design for such purpose. The Infrared Sensor will be the key part of detection which communicates with the MCU using wires connected to its OUTPUT pin and GND pin going to the Digital Pin 10 and GND pin of the Gizduino. The Infrared Sensor is powered by a 9 volts dc battery.

A typical RFID tag consists of a microchip attached to a radio antenna mounted on a substrate. The chip can store as much as 2 kilobytes of data. To retrieve the data stored on an RFID tag, you need a reader. A typical reader is a device that has one or more antennas that emit radio waves and receive signals back from the tag. The RFID reader and RFID tag will be the devices for determining the person detected whether he/she is the owner or an intruder. The RFID tag of the owner is registered in the RFID reader so it can determine it as owner's tag. The RFID reader also is the one to activate the motor door lock if the registered RFID tag is presented. The RFID reader is connected to the MCU using wires. The digital pin 12 in the MCU is connected to the will and receive all the signal coming from the Digital pin 0 of the RFID reader. The RFID reader is powered by a 9 volts dc battery.

ISSN 2304-7712

RESULTS AND DISCUSSION

Software Design: MCU Program

The software part of the system is also its soul. The system will rely with the software installed to the MCU in order to receive and send data to its components. The program installed to the MCU is programmed using a Wiring-based language (syntax and libraries), similar to C++ with some simplifications and modifications, and a Processing-based integrated development environment. The main design of the software is to receive data from the two sensors the "Infrared Sensor" and "RFID Sensor" to the MCU and process it. The signals coming from the two Sensors are determined either HIGH or LOW. First, the program will determine if the door is locked or unlocked. Two RFID tags are used, one is for unlocking and the other is to lock the door. If the door is unlocked, the LED of the RFID is turn on, it means that the system is not activated and will not give a signal to the monitoring computer because the program will declare that the owner deactivated the security system. If the door is locked, the LED is turned on and the system will start the whole program for monitoring the place because the program declares that the owner activated the system.

In the activated system, if there is no person or anything is detected by the IR sensor, the Infrared sensor will signal HIGH to the MCU and nothing will happen and keeps monitoring the area. If a person or anything blocks the sensor, it will signal LOW to the MCU. If this happens, the MCU is programmed to wait for a given time limit for the person to present the RFID tag to the RFID reader. If a valid RFID tag is presented, the RFID reader will send a signal of HIGH to the MCU and the program will consider the person as the owner and the MCU will send signal to the motor door lock to be unlocked. After this, the system will now be on its deactivated state. If the owner wants to activate again the system, he/she needs to lock the servo motor door lock.

In other case, if after the time limit and no valid RFID tag is presented to the reader, the program will declare the event as an alarm. The MCU will now send signal to the monitoring computer that an intrusion has occurred. The servo door lock will stay locked and the system is still in its activated state.

If infrared signals LOW, the program will give 5 seconds for the person to present his/her RFID tag to the RFID reader. If after 5 seconds and no registered tag is presented, the MCU will signal the computer the "Intruder Alert Signal". If the person presented the registered tag for the given time limit, the program will consider the person as the owner and gives signal to the motor to rotate and unlock the door. The LED of the RFID will also be turned off and the system will be deactivated. If the owner wants to activate again the system, he/she should lock the door using the tag for locking.

Monitoring Program

The software installed in the main monitoring computer is designed using Visual Basic 2008, a high level programming language that is very common and useful. The design of the program is to communicate and received signal coming from the microcontroller via serial port and process it. The reading of the serial port will start once the checkbox is checked. It will continuously read all the data coming from the usb serial port that the microcontroller sends. The key design of this program is to have a display of the camera to the monitoring

ISSN 2304-7712

computer and automatically capture image of the surrounding if an intrusion occurs. It has also buttons for manually capturing images of the surrounding if user is present and using the computer. After the whole process and capturing of the intrusion attempt, the program will restart and checkbox is to be check if user wants to start monitoring again.

Hardware Development

Upon developing the design, the proponents first considered all the objectives of the proposed design. The main purpose is to have security system that will be used for houses and other establishments. The proponents decided to produce a life-sized door prototype. The design was built in accordance with the features of real door with security components also assembled to it. The purpose of the real life sized door is to see and test the detection of the infrared if it is used in actual. The Infrared Sensor detects the person entering the detection area, the RFID reader and tag will be used to determine whether the person is intruder or not. The servo motor is used as the motor door lock and the Gizduino microcontroller is the main controller of the system. The desktop computer is used to monitor the place by the use of a USB camera. The microcontroller receives all the data coming from the two sensors and communicates with the desktop computer via USB cable.

Each component of the system design is tested before completely assembled to the prototype door. Connecting wires are used to connect all the devices for receiving and sending signals to one another. Upon assembling the devices to the prototype door, it is considered that devices should be placed according to uses and ease for the user.

Software Development

The software design of the "Intruder Alarm" is composed of two parts; the program that is installed into the Microcontroller and the software application for the monitoring system which will be installed to the main computer.

The program installed to the microcontroller is programmed using Arduino Alpha, a Wiring-based language (syntax and libraries), similar to C++ with some simplifications and modifications, and a Processing-based integrated development environment. The program will process all the inputs and outputs of the microcontroller.

Each code in the program will be the controller of the pins of the MCU so that all the signals coming from the two sensors will be processed and also it will give signal to other components like the LEDs and the motor door lock. Each pins programmed to receive and send data to all the components of the design. The MCU is also programmed to have a communication with the main computer through the use of serial communication. The communication medium used is the USB cable that is plugged in to both devices in USB serial port.

The second part of the program is the software application that is used to monitor the surrounding and alarm signal which is installed into the main computer. The application is built in Visual Basic 2008, a high level programming language that is very useful today. It is designed to have a serial communication with the MCU. Developing the software part of the design is very crucial as we need to consider the needs of the user. The application is designed to have the view of the camera placed on the door so the user can monitor the surrounding.

ISSN 2304-7712

Also, it can capture image and save it for more advance design.

CONCLUSION AND RECOMMENDATION

The development and creation of various technologies is probably one of the most contributing factor that brought changes in people's way of living. It is a fact that man greatly depend almost his everyday activity with this technological creation. This technologies like the Infrared Sensor and RFID Sensor is very useful and is widely used today. One of the best applications of this kind of technology is for security.

The "Intruder Alarm" is a representation of a useful design that can be used for securing not only the properties of the user but also their lives. This study focuses on how to improve the security on a specific place by the use of high technology devices. The design system is composed of the devices such as Infrared Sensor, RFID reader, MCU (microcontroller) and Servo motor that will serve as the door lock system. This design project intended to show us how such devices are combined to be able to use when it comes on security purposes.

The MCU (microcontroller) will accept all the input signals coming from the two sensors, the IR and the RFID sensor. Processing all the signals inside the MCU is possible by the use of software written in C++ language installed to it. The system is designed to have two states when it comes to monitoring, the activated state and the deactivated state. To deactivate the system, the owner needs to unlock the motor door lock and leave it unlocked. In deactivated state, no monitoring will happen. Even the sensor sends signals to the MCU, still, no intruder alarm message will be sent to the computer. The purpose of this design is to stop the monitoring system because there are times that the owner of the house is in the house and doesn't need to be monitored all the time. If the owner wants to activate the monitoring, he/she should lock the door using the locking tag.

The software application that is installed in the monitoring computer is written in Visual Basic 2008, a high level language that is very useful today. The design of the application is to receive signal coming from the microcontroller via serial communication. If it detects alarm signal, it will automatically sound an alarm siren and open the camera so that the user can see the surroundings. Also, it will automatically capture image of the surroundings.

For further improvements of designing an intruder alarm, the proponents of the study recommended the following: the use of IP camera for viewing and capturing image. Thus, it can be used as wireless and communication camera; for actual utilization, every part or vicinity of the house or establishment should have this device; have a network communication with the houses and the main security office and a device that will receive the entire alarm signal coming from them; using more accurate Infrared Sensor; the use of more long ranged frequency RFID reader and tag; the use of electronic door lock; adding more features to the application like video capturing; and in actual use, every house should have their own camera preview.

REFERENCES

ISSN 2304-7712

Vaux, Robert (2011). "What Is the Best Home Security System?", URL: http://www.ehow.com/about_4698611_what-best-home-security-system.html#ixzz1o8qIbsQN, date retrieved: March 4, 2012.

Terry, Rachel (2011), "About Home Security Door Sensors", url: http://www.ehow.com/about_4675064_home-security-door-sensors.html#ixzz1o8pCppY5, date retrieved: March 4, 2012.

David, Isaiah (2011), "Types of Infrared Sensors", url: http://www.ehow.com/list_6755794_types-infrared-sensors.html#ixzz1o8oI4GqV, date retrieved: March 4, 2012.

Holloway, Simon (2006), "RFID: An Introduction", url: http://msdn.microsoft.com/en-us/library/aa479355.aspx, date retrieved: March 4, 2012.

Basit, Ederlyn G., De Ade, Kenneth Jay D., Isla, Roland A., Tungcul, Charelyn G. (2009), "PC-Based RFID Classroom Energy Management", Undergraduate Thesis, Lyceum of the Philippines University, Batangas City.

Irani, Z., Gunasekaran, A., & Dwivedi, Y. K., (2010), "Radio frequency identification (RFID): research trends and framework", International Journal of Production Research, Volume 48, Issue 9, Special Issue: RFID Technology and Applications in Production

ISSN 2304-7712

FEASIBILITY STUDY OF COSCIFERA METHYL ESTER

Jaquemay D. Malabanan,
Keycelyn L. Perlas and
Carissa Mae B. Ramirez,
Nemy H. Chavez
jakelaguador@yahoo.com

Industrial Engineering Department, Lyceum of the Philippines University, Batangas City, Philippines

ABSTRACT

Coscifera Methyl Ester was made from coconut oil as an additive to diesel fuel. It is a kind of biodiesel that undergoes the process of esterification. CME has much better lubricating and higher cetane ratings than today's lower sulphur fuels. Adding biodiesel also helps in reducing fuel system wear. The biodiesel properties increase the life of the fuel injection equipment. Giving better lubricity and more complete combustion increases the engine energy output, thus partially balancing for the higher energy density of petrodiesel. There is a good opportunity for the establishment to enter the coconut biodiesel manufacturing industry since there is an insufficient supplier of biodiesel in the Batangas Province Area. The firm could also help both environment by producing an environment-friendly product and also help the people in terms of providing employment by giving an opportunity to coconut farmers to have extra money by selling coconut to the establishment.

Keywords: Methyl, Ester, Coconut Oil, Petrodiesel, Coscifera

INTRODUCTION

Various global worries such as the dwindling crude oil reserve, global warming and climate change, air pollution and public health, and more prominently the steady rise in the cost of fossil fuel, have altogether received rapidly growing concern in the use of renewable fuels. For all diesel engines, alternative renewable fuels are vegetable oils referred to as bio-oils and transesterified bio-oil also known as biodiesel. Transesterification is the process of transforming one ester into another ester. Esters are chains of hydrocarbons that will bond with other molecules. Molecules of vegetable oil are composed of three esters bonded to a molecule of glycerin. This type of molecule is called a triglyceride. Vegetable oil is relatively thick and sticky because the legs of the molecules get tangled up with each other. To reduce the viscosity of the oil we need to break the molecule apart, remove the glycerin molecule, and bond each individual ester with a molecule of alcohol. After being transesterified vegetable oil becomes biodiesel.Biodiesel is a "diesel like" fuel which means it has properties very close to conventional diesel and can be used in land transport and stationary engines.(www.bio-oil.com)

Medium speed diesel engines can operate well on the use of straight and unprocessed vegetable oil such as

ISSN 2304-7712

coconut oil. Compared to the use of biodiesel, vegetable oils will considerably reduce fuel cost in such engine.

As vegetable oils have differences in carbon chain composition, oil must necessarily be evaluated separately. In most cases, however, vegetable oil especially coconut oil have been proven to be very clean fuels with excellent combustion properties.

The growing global concern about environmental issues has increased the interest in alternative fuels paving the way to greater funding and effort for research studies. Greenhouse gases produce the so-called "greenhouse effect," which traps heat near the Earth's surface. Many human activities increase the amount of greenhouse gases in the atmosphere, which can result in a gradual increase in the Earth's surface temperature. The increasing amount of greenhouse gases such as C02 which is causing global warming and climate change, as well as the declining reserves of fossil fuels, and more significantly, the high fuel prices have strongly increased the interest in the use of bio-oils and biodiesel for land transport and power generation.

Biodiesel is one of the available alternative fuels in the market. Coconut oil is one of the sources of biodiesel and of all the other sources, it would be best in tropical countries such as here in the Philippines where coconut tree is one the primary native crops.

Coco – Methyl Ester (CME) is a kind of biodiesel derived from coconut oil used in a 100% pure fuel formation as blending component with petroleum derived diesel. It has major features such as; a renewable and indigenous source of energy; operates on conventional engines; environment – friendly (no sulphur and less smoke); and safe on storage. It is a kind of biodiesel that is and additive to the ordinary diesel fuel. The major raw materials come from coconut oil that undergoes the process of esterification and methanol to produce methyl ester, thus becoming CME.

Coco – Biodiesel is just one of the solutions to pollution and emission problems. To ensure optimum engine performance, a vehicle owner or driver should still carry out regular maintenance and practice good driving habits.

The proponents thought on what could be done to help the environment. Researchers found out that coco biodiesel is one of the helpful products that can help reduce negative effect on the environment. This information leads to generate the coscifera biodiesel which supports the environment and lessen the amount of green house gasses which cause global warming. The KCJ Manufacturing Firm founders do think the use of coscifera biodiesel that will help the world to relieve from pollution.

The firm offer the consumers not only having environment friendly biodiesel, but a product with outstanding quality as well. The KCJ Manufacturing Firm will be located at Batangas City. The firm gets their supply in Quezon Province, two hours in travel, where the major raw material which is coconut is abundant. Two different Depots in Batangas will be the target market of the firm.

KCJ Manufacturing Firm products will be called "Coscifera Methyl Ester" where the name came from the scientific name which is cocosnuscifera with refers to vegetable oil. The coscifera methyl ester is made from coconut sap known as copra, the dried flesh of nut. The company is trying to be known in producing coconut biodiesel not only in Batangas City but also in other provinces. The firm aims to be connected not just on local refineries but also to the biggest refineries in the other country. Supplying coscifera biodiesel to the other manufacturing companies as a source of energy is also one of the plans of the firm. The researchers use questionnaire method in gathering information.

ISSN 2304-7712

This study emphasizes the concern of petroleum companies to our environment-friendly product. As the researchers attaining the satisfaction is the foremost intention of this study not as profit maximization. The proponent's objective is to gain knowledge in establishing a business.

METHODS

Descriptive method is used to this study to gather information and utilized as self-made questionnaire distributed to their respondents. Descriptive method is concerned with the description of data and characteristics about a population. Data in descriptive survey research are mostly susceptible to alteration through introduction of bias into research design. The population for the study must be carefully chosen, clearly defined and specially delimited in order to set precise parameters for ensuring discreteness to the population.

RESULTS AND DISCUSSION

Name of the Product

Coscifera Methyl Ester was chosen to manufacture environment friendly diesel that can be used as one of the solutions to pollution and emission problems and to ensure optimum engine performance which will be named Coscifera Methyl Ester.

Location

The manufacturing firm was located at Brgy. Pinamucan Ibaba, Batangas City, an industrial zone area. The proponents choose the location because it is far from the residential area and near to the river and creek where we can conduct our waste disposals.

Project's Long Range Objectives

After five years of start up the firm will extend the distribution of their products all over CALABARZON Area. During the progress of operation the firm will introduce a new product like the coconut oil monoethanolamide (CMEA) that is widely used in solid soapand soap powder, washing powder, liquid detergent, emulsification stabilizer, and emulsifying shampoo. By the end of ten years, coscifera methyl ester will be known as one of the best biodiesel product and extend the production in all over Philippines.

Investment Cost

The initial capital of KCJ Manufacturing Firm is Php 39,000,000.00 that will be contributed by the partners in equal amount.

Market and Demand Analysis

Initially, the product will be distributed in the selected oil refineries in the province of Batangas. The target market of the business will be the oil refineries such as Petron Depot and Phoenix Petroleum Philippines Inc.

The proponents gathered information through surveys that shows an increase on the demand of the product in the market. Based on the outcomes, Coscifera Methyl Ester is mounting in recognition due to its similar

ISSN 2304-7712

characteristics to conventional diesel but it produces less emission and it is mandated by the law that every diesel should have a blend of 1%, 5% or 10% CME.

Technical Feasibility

This study covers the entire materials and designs that will be used in establishing the business. It also tackles the features and specifications of the equipment's and processes that will be needed in the operation.

Financial Feasibility

This section provides a detailed presentation of computed assets of the company and the expenses of the construction, acquisition of the machineries; supplies and equipment's will be deducted. It also tackles the major assumption of the company and the forecast sales of the company for the next five years.

Management Feasibility

The group discussed the organizational structure, form of ownership, duties and responsibilities of the employees. The business adopted partnership because partnership agreements should cover all possible business situations that could arise during the lifetime of the partnership, the documents are often complex, and lawyers well-versed in drafting and reviewing the finished contract is generally recommended.

Socio Economic Feasibility

Our business will considered as a major step in upgrading the country's agricultural industry, remarks another space toward industrialization, employment opportunities, help to increase the government revenues, motivate employees in producing local products, and customers will gain clean and affordable coconut biodiesel.

CONCLUSION

The performance and quality of a product should always considered in providing services and products to the valuable customers. To have a good relationship to the customers, delivery on time and good quality of work should consider. Putting the right people with the proper position gives high percent of productivity and business competency. And benefits, proper wages, work appreciation and incentives give extra impact, so that the employees are motivated to continue its excellent performance. Proper scheduling, process and planning of materials is the common motivation of a productive company. Kaizen or continuous improvement should always be practiced and applied in the production enable to reach and exceed the expectations f customers. In order to protect the business, the company should comply with the ethical environmental and social standard of business operation.

RECOMMENDATION

The project be implemented, since the establishment is proven to gain profit from the operations based on the financial measure computed. That the company never stops in continuous improvement of production and the proper process should not be neglected. Company should give priorities in dealing and communicating to the customers to maintain the good relationship between the company and to the consumers. Research on how to

ISSN 2304-7712

improve product quality and performance should never be impeded. Safety of employees must be one of the concerns of the company. The proponents should conduct proper practice of waste disposal in order to comply with the requirements regarding with the sanitation of the local government.

REFERENCE

Demand Media Inc. Job Search & Employment (1999-2012)), url: http://www.ehow.com, date retrieve: August 15,2012.

Demand Media Inc.Job Search & Employment,url: http://www.ehow.com, date retrieve: September 19,2012.

Cardiol, J Am Coll (2006),Biodiesel from Coconut Oil, Coconut Oil as Bio-diesel, Biofuel - Reference & Resources,url: http://www.oilgae.com/energy/sou/ae/re/be/bd/po/coc/coc.html, date retrieve: April 16,2012.

Job Responsibilities (2012). ttp://www.jobresponsibilities.org, date retrieve: July 18,2012.

Land O' Lakes,Inc.Corporate Social Responsibilities (2011), url: http://landolakesbds.com, date retrieve: September 17,2012.

Nelson Cesar (2007),New Biodiesel Technology,url: http://biodiesel-making.blogspot.com/2007/11/coco-biodiesel-faqs-in-philippines.html, date retrieve: October 3,2012.

Pure Essence International, Inc. (2007), manufactures BioDiesel (Coco Methyl Ester), Soap Noodles from different oil blends and quality Toilet / Bath Soaps,url: www.pure-essence.biz, date retrieve: April 18,2012.

Rajib Singha(June 6,2011),Biodisel vs. Diesel, url: http://www.buzzle.com, date retrieve: May 9,2012.

Robinson, Michael T. (1997-2012), Carreer Planner.com,Job Description,url: http://job-descriptions.careerplanner.com, date retrieve: July 25,2012.

Take Free Courses. Earn College Credit, (2003-2012), url: http://educationportal.com, date retrieve: August 6,2012.

Wikipedia, The Free Encyclopedia(2012), An amazingly comprehensive, dynamic, user-edited encyclopedia that is based on the concept of harnessing "the wisdom of crowds."On this page: Biodegradation to Biodyl,url: http://wiki.answers.com, date retrieve: May 14,2012.

ISSN 2304-7712

IMPROVED ANT COLONY SEARCH ALGORITHM FOR SOLVING OPTIMAL REACTIVE POWER OPTIMIZATION PROBLEM

K. Lenin[1],

[1]Research Scholar, Jawaharlal Nehru Technological University Kukatpally,

Hyderabad 500 085, India.

gklenin@gmail.com

Dr.B.Ravindranath Reddy[2],

[2]Deputy Executive Engineer, Jawaharlal Nehru Technological University Kukatpally,

Hyderabad 500 085, India.

www.jntu.ac.in

Dr.M.Surya Kalavathi[3]

[3]Professor of Electrical and Electronics Engineering,Jawaharlal Nehru Technological University Kukatpally, Hyderabad 500 085, India.

www.jntu.ac.in

Abstract

The paper presents an (IACSA) Improved Ant colony search Algorithm for Optimal Reactive Power Optimization and voltage control of power systems. ACSA is a new co-operative agents' approach, which is inspired by the observation of the behaviour of real ant colonies on the topic of ant trial formation and foraging methods. This presented paper proposes an improved ant colony optimization algorithm with two highlights. First, candidate set strategy is adapted to rapid convergence speed. Second, a dynamic updating rule for heuristic parameter based on entropy to improve the performance in solving reactive power problem. From our experiments, the proposed algorithm has better performance than the conventional ACO algorithm and the results of the proposed algorithm are found to be satisfactory. The IACSA is applied for optimal reactive power optimization is evaluated on standard IEEE, 30, 57, 191 (practical) test bus system. The proposed approach is tested and compared to genetic algorithm (GA), Adaptive Genetic Algorithm (AGA).

Keywords: Reactive power optimization, Ant colony search algorithm, Global optimization.

ISSN 2304-7712

1. Introduction

The reactive power optimization problem has a significant influence on secure and economic operation of power systems. The reactive power generation, although itself having no production cost, does however affect the overall generation cost by the way of the transmission loss. A procedure, which allocates the reactive power generation so as to minimize the transmission loss, will consequently result on the lowest production cost for which the operation constraints are satisfied. The operation constraints may include reactive power optimization problem. The conventional gradient based optimization algorithm has been widely used to solve this problem for decades. Obviously, this problem is in nature a global optimization problem which may have several local minima and the conventional optimization methods easily lead to local optimum. On the other hand, in the conventional optimization algorithms, many mathematical assumptions, such as analytic and differential properties of the objective functions and unique minima existing in problem domains, have to be given to simplify the problem. Otherwise it is very difficult to calculate the gradient variables in the conventional methods. Further, in practical power system operation, the data acquired by the SCADA (Supervisory Control and Data Acquisition) system are contaminated by noise. Such data may cause difficulties in computation of gradients. Consequently, the optimization could not be carried out in many occasions. In the last decade, many new stochastic search methods have been developed for the global optimization problems such as simulated annealing, genetic algorithms and evolutionary programming. Here a new search algorithm IACSA is proposed to find the global solution for reactive power optimization problem. For the last few years, the algorithms inspired by the observation of natural phenomena to help solving complex combinatorial problems have been increasing interest. In analyzing the behaviours of real ants, it was found that the ants are capable of finding shortest path from food sources to the nest without using visual cues. In the application of this method to our reactive power optimization problem, the initial population of colony can be first randomly generated within the search space of problem. Then, the fitness of ants is individually assessed based on their corresponding objective function. With the selection of trail, the ant dispatch can be activated based on the level of pheromone and distance of the selected trail in order to find the best tour or the shortest path [1]. ACO can be used to find the solutions of difficult combinatorial optimization problems and it enjoys a rapidly growing popularity. Although ACO has a powerful capacity to find out solutions to combinatorial optimization problems, it has the problems of stagnation and

ISSN 2304-7712

premature convergence and the convergence speed of ACO is always slow. Those problems will be more obvious when the problem size increases. Therefore, several extensions and improvements versions of the original ACO algorithm were introduced over the years. Various adaptations: an algorithm based on the basis of the ant evolution rules [3], dynamic control of solution construction and mergence of local search ([4], [5], [6]), new pheromone updating strategies [7], max-min ant system [8], a strategy is to partition artificial ants into two groups: scout ants and common ants [9], using candidate lists strategies ([10], [11]), dynamic ant colony system with three level updates ([12-13]) and using the path selection controlled by information entropy [15] are studied to improve the quality of the final solution and lead to speedup of the algorithm. All these studies have contributed to the improvement of the ACO to some extent, but they have little obvious effect on increasing the convergence speed and obtaining the global optimal solution. In the proposed system, the main modifications introduced by ACO are the following. First, ACO is more effective as the candidate set strategy is adopted. This modification reduces the size of the search space for the ant colony algorithm. Second, information entropy is introduced which is adjust the algorithm's parameters. In this paper, a modified ant colony system for solving reactive power problem using candidate set strategy and dynamic updating of heuristic parameter is developed.

2. Problem Formulation

The objective of the reactive power optimization problem is to minimize the active power loss in the transmission network as well as to improve the voltage profile of the system. Adjusting reactive power controllers like generator bus voltages, reactive power of VAR sources and transformer taps performs reactive power scheduling.

$$\min P_L = \sum_{i=1}^{NB} P_i(X, Y, \delta) \quad \ldots \quad (1)$$

Subject to

i) The control vector constraints

$$X_{min} \leq X \leq X_{max} \quad \ldots \quad (2)$$

ii) The dependent vector constraints

$$Y_{min} \leq Y \leq Y_{max} \quad \ldots \quad (3)$$

ISSN 2304-7712

and

iii) The power flow constraint

$F(X, Y, \delta) = 0$ … (4)

where

$X = [V_G, T, Q_C]$ … (5)

$Y = [Qg, V_L, I]$ … (6)

NB - number of buses in the system.

δ - vector of bus phase angles

P^i - real power injection into the i^{th} bus

V_G - vector of generator voltage magnitudes

T - vector of tap settings of on load transformer tap changer.

Q_C - vector of reactive power of switchable VAR sources.

V_L - vector of load bus voltage magnitude.

I - vector of current in the lines.

P_L - vector of power loss in the transmission network.

---

3. Ant colony search algorithm

Here we, presents an Ant colony search algorithm for optimal reactive power optimization problem. ACSA is a new cooperative agents approach which is inspired by the observation of the behavior of real ant colonies on the topic of ant trial formation and foraging methods. For the last few years, the algorithms inspired by the observation of natural phenomena to help solving complex combinatorial problems have been increasing interest. In analyzing the behaviors of real ants, it was found that the ants are capable of finding shortest path from food sources to the nest without using visual cues. In the application of this method to our reactive power optimization problem, the initial population of colony can be first randomly generated within the search space of problem. Then, the fitness of ants is individually assessed based on their corresponding

ISSN 2304-7712

objective function. With the selection of trail, the ant dispatch can be activated based on the level of pheromone and distance of the selected trail in order to find the best tour or the shortest path. [17].

3.1 ACSA paradigm

Ant colony search (ACS) studies are inspired from the behavior of real ant colonies that are used to solve function or combinatorial optimization problems. Currently, most work has been done in the direction of applying ACS to combinatorial optimization. The first ACS system was introduced by Marco Dorigo [1], and was called "ant system". Ant colony search algorithms, to some extent; mimic the behavior of real ants. As is well known, real ants are capable of finding the shortest path from food sources to the nest without using visual cues. They are also capable of adapting to changes in the environment; for example, finding a new shortest path once the old one is no longer feasible due to a new obstacle. The studies by ethnologists reveal that such capabilities are essentially due to what is called pheromone trails", which ants use to communicate information among individuals regarding path and to decide where to go. Ants deposit a certain amount of pheromone while walking, and each ant probabilistically prefers to follow a direction rich in pheromone rather than a poorer one. [1]

3.2 Ant Colony System

3.2.1 ACS state transition rule

In ACS the state transition rule is as follows: an ant positioned on node *r* chooses the city *s* to move to by applying the rule given by Eqn. (7).

$$S = \begin{cases} \text{Arg} \quad \max_{w \in} J_{k(r)} \{ [\tau(r,u)] . [\eta (r,u)]^{\beta} \} , \text{if } q \leq q_0, \text{ (exploitation)} \\ \qquad\qquad \ldots \\ \text{S, otherwise (biased exploration)} \end{cases} \qquad (7)$$

Where

q is a random number uniformly distributed in [0 …1]

q_0 is a parameter ($0 \leq q_0 \leq 1$)

S is a random variable selected according to the probability distribution given in Eqn. (7)

The state transition rule used by ant system, called a random-proportional rule, is given by Eqn. (7), which gives the probability with which ant *k* in city *r* chooses to move to the city *s*.

$$P_k(r,s) = \begin{cases} \dfrac{[\tau(r,s)] \bullet [\eta(r,s)]^{\beta}}{\sum_{\mu \in J_k(r)} [\tau(r,u)] \bullet [\eta(r,u)]^{\beta}}, if\ s \in J_k(r) \\ 0, otherwise \end{cases} \quad \ldots \quad (8)$$

where:

τ is the pheromone

$J_k(r)$ is the set of cities that remain to be visited by ant *k* positioned on city *r* (to make the solution feasible)

β is a parameter, which determines the relative importance of pheromone versus distance ($\beta > 0$)

$\eta = I/\delta$ is the inverse of the distance δ (r,s).

3.2.2 ACS global updating rule

Global updating is performed after all ants have completed their tours. The pheromone level is updated by applying the global updating rule of Eqn. (9)

$$\tau(r,s) \leftarrow (1-a).\tau(r,s) + \alpha.\Delta\tau(r,s) \quad \ldots \quad (9)$$

Where;

$$\Delta\tau(r,s) = \begin{cases} (L_{gb})^{-1} \text{ I } f\ (r,s) \in \text{ global-best -four} \\ 0 \text{ , otherwise} \end{cases}$$

α is the pheromone decay parameter ($0<\alpha$ 1) L_{gb} is the length of the globally best tour from the beginning of the trial.

3.2.3 ACS local updating rule

While building a solution of the TSP, ants visit edges and change their pheromone level by applying the local updating rule of Eqn. (10).

$$\tau(r , s) \leftarrow (1 - p) \tau (r , s) + p.\Delta\tau(r ,s) \quad \ldots \quad (10)$$

Where ;

p is a heuristically defined coefficient ($O<p < 1$)

$\Delta\tau (r , s) = \tau_0$,

τ_0 is the initial pheromone level

3.2.4 ACS parameter setting

For the traveling salesmen problem the following sections the numeric parameters, except when indicated differently, are set to the following values: $\beta = 2$, $q_o = 0.9$, $\alpha = p = 0.1$, and $\tau_0 = (nL_{nn})^{-1}$, where L_{nn}, is the tour length produced by the nearest neighbor heuristic and n is the number of cities. Based on the (TSP) above procedure, we propose a new ACSAapproach for the Reactive Power Optimization problem.

4. Improved Ant Colony Optimization Algorithm

4.1 Dynamic Candidate List Strategy

Candidate list is a strategy that tries to improve the performance of an ant algorithm. It was proposed by Gambardella and his colleague to accommodate searching procedure of ACS on larger data. The proposed candidate list is a dynamic candidate list procedure which captures a suitable number of nodes based on the total number of nodes. It is a static data structure that lists a limited number of preferred closed cities to be visited order by increasing distance. In the ACS algorithm, when the ant chooses the next city, the probability of its transfer from city i to city j needs to be computed, and then the city whose transfer probability (decision process) is first need to consider those preferred cities listed in the candidate list. Only when an ant cannot find suitable city to choose then the decision to choose a city will consider those which are outside the candidate list.

ISSN 2304-7712

The numbers of closest cities that allowed being included into the candidate list were different from one algorithm to another. Due to the purpose of improving algorithm performances, the proposed system is also applying candidate list. However, it would not allow ants to venture into cities outside the candidate list. The number of cities or the size of the candidate list is also restricted to one fourth of the cities *n*. For example, seven was chosen resulting from the candidate list computation to determine the size of candidate list element for Oliver30 data.

The candidate list procedure is as follows

*candidate_list=n/4 /*size of candidate list*/*

determine cities that not yet visited

do

for i=1 to n

if city s is not yet visited

determine distance between city r and city s

if distance < distance of previous city s

move city s into node_list

end for

candidate_list=node_list

while (until candidate_list is full)

4.2. Heuristic Parameter Updating

In ACO algorithm, the heuristic information is very important in generating high quality tours in the initial search stages. Because the value of the pheromone trails do not have much information in the early stage of learning and cannot guide the artificial ants in constructing good tours. In this situation, the heuristic parameter may be set to a large value. On the other hand, in the later stage, the heuristic parameter may need a small value because the pheromone trails may have collected enough information to behavior as required and the heuristic information may mislead the search due to its locality. Thus, in this

ISSN 2304-7712

situation, we may need a small value for the heuristic parameter. The heuristic parameter is set as a constant in traditional ACO algorithms. In this study, a high value of heuristic parameter can always provide high quality tours. This means that the influence of pheromone is greatly reduced, and ants are able to search other paths in constructing feasible solutions. It is evident that a small value of the heuristic parameter may result in bad performance in the early stage of learning. Nevertheless, a small value of the heuristic parameter can have good performance when the search process lasts long enough. Thus, it is intuitive to use an adaptive heuristic parameter for ACO. In this study, we intend to propose a way of designing an adaptive heuristic parameter for ACO such that the search performance can be better. When ant colony algorithm begins to run, the amount of information on every path equals to each other, information entropy is maximum at this time, but as an enhancement of pheromone on the path, the entropy will be decreased gradually. If the entropy is not controlled currently, the entropy will eventually reduce to 0, that is, the pheromone on only one path is maximum, and the final solution will be mistaken, thus bringing about the premature. In order to overcome the easily-occurred precocious defects for solving complex combinatorial optimization problems with the basic ant colony algorithm, a proposed ant colony algorithm based on information entropy is discussed, using the heuristic parameter value selection controlled by information entropy. Each trail is a discrete random variable in the pheromone matrix. The entropy of a random variable is defined as

$$\mathbf{E(X)} = -\sum_{i=1}^{r} P_i \log P_i \qquad (11)$$

where p_i represents the probability of occurrence of each trails in the pheromone matrix. For a symmetric n cities TSP, there are $n(n-1)/2$ distinct pheromone trails and $r= n(n-1)/2$. It is easy to see that when the probability of each trail is the same, E will be the maximum (denoted as E_{max}) and is given by

$$\mathbf{E_{max}} = -\sum_{i=1}^{r} P_i \log P_i = -\sum_{i=1}^{r} \frac{1}{r} \log \frac{1}{r} = \log r \qquad (12)$$

We propose to use the entropy value as an index to indicate the degree about how much information has been learned into the pheromone trails and then the heuristic parameter can be updated accordingly. Notice that in this study, the heuristic parameter β is set to be an integer so as to avoid complicated computation because β is used as a power in Eqs. (9) and (10). Hence, we propose that β is update according to the rule given by

ISSN 2304-7712

$$\beta = \begin{cases} 5 & \text{threshold} \quad X < E` \leq 1 \\ 4 & \text{threshold} \quad Y < E` \leq X \\ 3 & \text{threshold} \quad Z < E` \leq Y \\ 2 & \text{threshold} \quad 0 < E` \leq Z \end{cases}$$

$$E` = 1 - \frac{E_{max} - E_{current}}{E_{max}} \qquad (13)$$

Where E' is the entropy value for the current pheromone matrix and X, Y and Z are thresholds according to the city size. In study, threshold X is set within 0.8~0.9(according to the city size) and threshold B is within0.75~0.55 (according to the city size), and threshold Z is decided heuristically based on the value of Y.

Procedure for proposed improved ACO algorithm

Set parameters, initialize pheromone trails

Calculate the maximum entropy

Loop / at this level each loop is called iteration*/*

Each ant is positioned on a starting node according to

distribution strategy (each node has at least one ant)

*For k=1 to m do /*at this level each loop is called a step */*

At the first step moves each ant at different route

Repeat

Compute candidate list

Select node j to be visited next (the next city in the

candidate list) according to solution construction

A local updating rule (10) is applied

Until ant k has completed a tour

End for

Local search (2-opt, 2.5 opt) apply to improve tour

A global updating rule (9) is applied

Compute entropy value of current pheromone trails

Update the heuristic parameter

Until end_condition

end

4.3. Improved Ant Colony Search Algorithm for Reactive Power Dispatch

It is a combinational optimization problem at back step the ants make a probabilistic decision according to some discrete probability distribution. Since, our problem is a continuous optimization problem the domain changes from discrete to continuous. The logical adaptation would be to also move from using the discrete probability distribution to a continuous one - the Probability Density Function (PDF). Instead of choosing at step i single solution component, the ants would generate a random number according to a certain PDF.

One of the most popular functions that is used as PDF for estimating distributions is the normal (or Gaussian) function

$$g(X,\mu,\sigma)=\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(X-\mu)^2}{2\sigma^2}} \quad \ldots \quad (14)$$

The pheromone distribution is based on a mixture of normal kernels. It is defined as a weighted sum of several normal PDFs, and denoted as Gaussian function:

$$P(X)=G(X,\omega,\mu,\sigma)=\sum_{j=1}^{k}\omega_j.g(X,\mu_j,\sigma_j) \quad \ldots \quad (15)$$

Where ω is the vector of weights associated with the components of the mixture, μ is the vector of means, and σ is the vector of standard deviations. The dimensions of all those vectors are equal to the number of normal PDFs constituting the mixture. For convenience we will use parameter k to describe this number dimension of ω = dimension of μ = dimension of σ = k.

Such a distribution allows for reasonably easy generation of random numbers according to it, and yet it provides a much increased flexibility in the possible shape.

$P^i(X^i)$ to indicate the I_{-th} mixture of normal kernel PDFs: $P^i(X^i)=G(X^i,\omega^i, \mu^i, \sigma^i)$ and $P^i_j(X^i)$ to indicate the j_{-th} single normal PDF: $P^i_j(X^i) = g(X^i, \omega^i_j, \mu^i_j, \sigma^i_j)$ being part of the i_{-th} mixture.

Therefore:

$$P^i(X^i) = \sum_{j=1}^{k^i} \omega^i_j . P^i_j(X^i) \quad \ldots \quad (16)$$

4.4 Algorithmic steps

The detailed explanation of algorithmic steps for solving RPO problem is explained below:

(a) Initialization of Pheromone Distribution

Let n be the total number of control variables (sum of generator bus voltages and switchable var sources and tap settings of on-load tap changer of transformers). Pheromone distribution for each control variable consists of mean μ, weight ω and standard deviation σ used for creating different mixture of normal kernel probability density functions. Each mixture consists of same number $k=k^{1, 2., n}$ of normal PDFs. The value of μ^i for each control variable is chosen uniformly in the interval $[X^i_{max} - X^i_{min}]$ and ω^i is chosen as unity.

The value of σ for each control variable X is computed by

$$\sigma = (X^i_{max} - X^i_{min})/k. \quad \ldots \quad (17)$$

Where k is total number of normal PDFs in the mixture.

(b) Initialisation of ants

Let N_a be the total number of ants. Each ant generates the random number according to the i-th mixture $P^i(X^i)$. This is accomplished in two stages. First, an ant chooses probabilistically a single normal PDF $P^i_j(X)$ from the mixture $P^i(X^i)$ with probability p^i_j proportional to ω^i_j.

$$p^i_j = \frac{\omega^i_j}{\sum_{l=1}^{k^i} \omega^i_l} \quad \ldots \quad (18)$$

Following that, an ant generates a random number according to the chosen $P^i_j(X)$. This may be done using a random number generator that is able to generate random numbers according to a parameterized normal distribution. Due to the nature of the

ISSN 2304-7712

PDF used, it is possible that some of the generated solutions will fall outside of the search domain [$X^{i}_{max} - X^{i}_{min}$]. In such cases, X^{i} becomes

$$X^{i} = \begin{cases} X^{i}_{min} & \text{if } X^{i} < X^{i}_{min} \\ X^{i}_{max} & \text{if } X^{i} > X^{i}_{max} \end{cases} \quad \ldots \quad (19)$$

(c) Fitness function evaluation

Load flow is run for each ant and the system transmission loss, reactive power generations of the generator buses and load bus voltages are evaluated. The fitness function for each ant is computed as

$$f_a = P^{a}_{L} + c_1 \sum_{j=1}^{NG} Q^{lim,a}_{G,j} + c_2 \sum_{j=1}^{NL} V^{lim,a}_{L,j} \quad ; a = 1,2.., \ N_a \quad \ldots \quad (20)$$

where,

c1 and c2 are penalty factors for the constraint violations.

$P_{L,i}$ is the total real power losses of i-th ant

$$Q^{lim,a}_{G,j} = \begin{cases} Q_{G,min} - Q^{a}_{G,j} & \text{if } Q^{a}_{G,j} < Q_{G,min} \\ Q^{a}_{G,j} - Q_{G,max} & \text{if } Q^{a}_{G,j} > Q_{G,max} \end{cases} \quad \ldots \quad (21)$$

and

$$V^{lim,a}_{L,j} = \begin{cases} \left| V^{a}_{L,j} \right| - V_{L,max}, & \text{if } \left| V^{a}_{L,j} \right| > V_{L,max} \\ 0 & \text{otherwise} \end{cases} \quad \ldots (22)$$

The values of penalty factors c1 and c2 are chosen such that if there are any constraints violations the fitness function value corresponding to that ant will be ineffective. The best solution is computed for given ants size for the first iteration (S_{Ibest}). The global best solution S_{Gbest} (best of S_{Ibest} and previous S_{Gbest}) is initially as taken as first iteration's best solution.

(d) Pheromone Update

Pheromone update is a process of modifying the probability distribution used by the ants during the construction process, so that it can guide the ants towards better solutions. This process traditionally consists of two actions:

(i) Positive update: reinforcing the probability of the choices that lead to good solutions and

(ii) Negative update: decreasing probability of other choices i.e. forgetting bad solutions.

At each iteration, iteration best solution is used for pheromone update. The positive update may be accomplished by

ISSN 2304-7712

incorporating in the mixture $P^i(X^i)$, an additional normal PDF $P^i_j(X^i)$ for each solution used for the update. The mean μ^i_j of this new distribution should be equal to the value of the solution component X^i used for updating the probability distribution $P^i(X^i)$. The values of ω^i_j and σ^i_j may be chosen based on the state of the search, or the quality of the solution used for the update. The number of normal PDFs k^i constituting the mixture $P^i(X^i)$ should be appropriately increased: $k^i = k^i + n_s$ where n_s is the number of solutions used for the update. For each dimension i =1…n the update is given by:

$$\begin{cases} P^i(X^i) = P^i(X^i) + \sum_{j=1}^{n_s} P^i(X^i) \\ k^i = k^i + n_s \end{cases} \quad \ldots(23)$$

Negative update method is the opposite of the positive update method. Just as any new normal PDF $P^i_j(X^i)$ may be added to the mixture $P^i(X^i)$, in the same manner any existing one may be removed. More formally the process of removing a set of $N_s \subset \{1 \ldots k^i\}$ normal PDFs for each dimension $i \in \{1...n\}$ may be presented as follows:

$$\begin{cases} P^i(X^i) = P^i(X^i) - \sum_{j \in Ns} P^i(X^i) \\ k^i = k^i - n_s \end{cases} \quad \ldots \quad (24)$$

(e) Stopping criterion

The process of generation of ants and their fitness evaluation and pheromone update are continued until a chosen maximum number of iteration is reached. If the chosen maximum number of iterations is small then there will be a premature convergence. The maximum number of iteration to be chosen is problem dependent. The value for maximum number of iterations is to be arrived from trial studies. A number of different values of maximum number of iterations are chosen and for each chosen maximum number of iterations, 100 trial studies are made for the same problem. The maximum number of iterations for the stopping criteria is identified as the one for which if the maximum number of iterations is decreased below that then there would not be a convergence (reasonable minimum real power loss without any constraint limit violation) in any one or more of the100 trial studies.

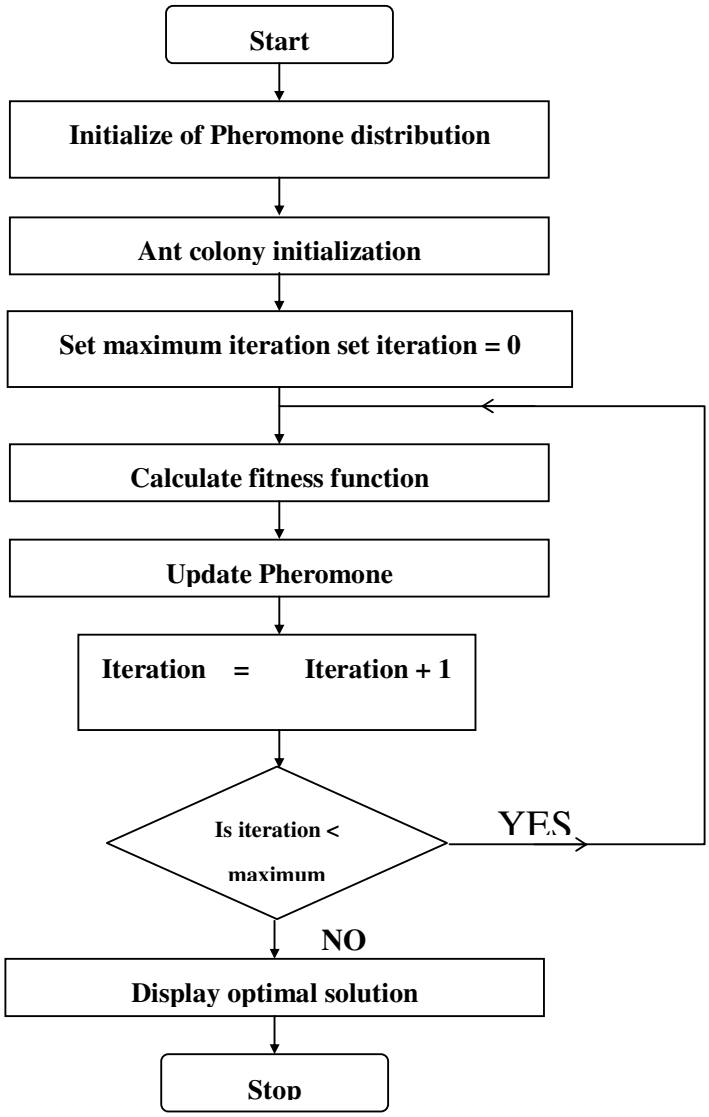


Figure1. Flow chart of IACSA for RPO problem

5. Simulation study

The proposed IACSA is evaluated on Standard IEEE 30-bus test system is compared with AGA, GA & ACSA algorithms.Moreover the fast convergence rate of the IACSA insists us to evaluate in larger system. And ACSA evaluated on Standard IEEE 57-bus system, practical 191 Standard utility (Indian) systems.

For IEEE 30-Bus

Table .1 Optimum Reactive Power schedule values obtained for IEEE 30-bus system

NG = 6, ***NL*** = 41, ***NB*** = 30, ***NTR*** = 4

	AGA[6]	**GA[6]**	**ACSA[6]**	**IACSA**
No. of Iterations	65	75	25	22
Population size	24	24	30	30
Time (sec)	15.7	20.2	4.51	4.24
Loss (MW)	9.5680	9.6770	9.478	9.398

For IEEE 57-Bus

NG = 7, NB = 57, NTR = 17 NQ = 5

Table .2 Optimum Reactive Power schedule values obtained

For IEEE 57-bus system

	GA[6]	**AGA[6]**	**ACSA[6]**	**IACSA**
No. of iteration	125	100	76	71
Population size	24	24	30	30
Time (sec.)	22.7	18.9	4.62	4.32
Loss (MW)	26.7890	25.0012	24.7752	24.6003

For Practical 191-Bus

NG = 20, NL = 200, NB = 199 NTR = 55

Table 3 Optimum Reactive Power schedule values obtained For practical 191 utility (Indian) system.

ISSN 2304-7712

	GA[6]	AGA[6]	ACSA[6]	IACSA
No. of iteration	149	125	102	98
Population size	24	24	30	30
Time (sec.)	59.7	45.7	6.920	6.259
Loss (MW)	149.772	149.001	148.241	147.982

V_{min} - 0.95, V_{max} - 1.05, T_{min} - 0.9, T_{max} - 1.1, sus_{max} - 0.15, sus_{min} - 0.0

Table. 4 Optimal Control values of Standard IEEE 30-bus system

VG1	**VG2**	**VG3**	**VG4**	**VG5**	**VG6**	**T1**	**T2**	**T3**	**T4**
1.05	1.03	1.01	1.01	0.98	1.09	0.95	0.94	1.02	0.93

Table .5 Optimal Control values of Standard IEEE 57-bus system

VG1	1.05
VG2	1.03
VG3	1.04
VG4	1.03
VG5	1.03
VG6	1.02
VG7	1.02

T1	1.05
T2	0.93
T3	0.92
T4	0.93

T11	0.99
T12	0.94
T13	0.90
T14	0.93

T5	0.93		**T15**	0.94
T6	0.90		**T16**	0.93
T7	0.92		**T17**	0.97
T8	0.91			
T9	0.93			
T10	0.91			

Q1	**Q2**	**Q3**	**Q4**	**Q5**
0.04	0.02	0.05	0.04	0.07

Table .6 Optimal Control values of Practical 191 utility (Indian) system

VG1	1.19		VG 11	0.91
VG 2	0.83		**VG 12**	1.02
VG 3	1.07		**VG 13**	1.06
VG 4	1.01		**VG 14**	0.99
VG 5	1.11		**VG 15**	1.01
VG 6	1.19		**VG 16**	1.09
VG 7	1.13		**VG 17**	0.90
VG 8	1.03		**VG 18**	1.01
VG 9	1.11		**VG 19**	1.14
VG 10	1.06		**VG 20**	1.11

ISSN 2304-7712

T1	1.02	T21	0.90	**T41**	0.90
T2	1.08	**T22**	0.98	**T42**	0.93
T3	1.09	**T23**	0.99	**T43**	0.97
T4	1.10	**T24**	0.98	**T44**	0.99
T5	1.03	**T25**	0.95	**T45**	0.98
T6	1.08	**T26**	1.00	**T46**	0.92
T7	1.05	**T27**	0.97	**T47**	0.98
T8	1.07	**T28**	0.94	**T48**	1.06
T9	1.06	**T29**	1.07	**T49**	0.95
T10	1.03	**T30**	0.93	**T50**	0.96
T11	0.98	**T31**	0.97	**T51**	0.99
T12	1.07	**T32**	0.94	**T52**	0.97
T13	1.09	**T33**	1.07	**T53**	1.03
T14	1.04	**T34**	0.93	**T54**	0.94
T15	1.01	**T35**	0.90	**T55**	0.91

6. Conclusion

In this paper IACSA has been developed for determination of global optimum solution for reactive power optimization problem. The performance of the proposed algorithm demonstrated through its evaluation on IEEE 30, 57 & 191 practical utility test bus power system shows that IACSA is able to undertake global search with a fast converges rate and a future of robust computation. From the simulation results it clearly shows the IACSA algorithm reaches best optimal solution when compared to other algorithms. IACSA converges fast combustion rate with minimum number of iteration. When compared to all other remaining algorithms IACSA approach is most successful method of reaching the best optimal solution for RPO problem.

ISSN 2304-7712

7. References

[1] C. M. Dorigo, V. Maniezzo, and A. Colorni, "The ant system: Optimization by a colony of cooperating agents," *IEEE Transactions on System, Man, and Cybernetics*, Part B, vol.26, pp. 29-41, 1996.

[2] C.Blum, "Ant Colony Optimization: Introduction and recent trends," Science Direct, Physics of Life Reviews 2(2005)353-373.

[3] W. Tsai and F. Tsai, "A New Approach for Solving Large Traveling Salesman Problem Using Evolutionary Ant Rules," *IJCNN 2002, IEEE.*

[4] H. Md. Rais, Z. A. Othman, and A. R. Hamdan, "Improved dynamic ant colony system (DACS) on symmetric Traveling Salesman Problem (TSP) ," *International Conference on Intelligence and Advanced Systems, IEEE,* 2007.

[5] J. Han and Y. Tian, "An improved ant colony optimization algorithm based on dynamic control of solution construction and mergence of local search solutions," *Fourth International Conference on Natural Computation*, IEEE, 2008.

[6] K.Lenin , M.R.Mohan "ant colony search algorithm for optimal reactive power optimization", serbian journal of electrical engineering vol. 3, no. 1, june 2006, 77 –88.

[7] C.-M. Pintea and D. Dumitrescu, "Improving ant system using a local updating rule," *Proceedings of the Seventh International Symposiumand Numeric Algorithms for Scientific Computing (SYNASC'05), IEEE* 2005.

[8] T. Stutzle and H. H. Hoos. "MAX-MIN ant system and local search for the traveling salesman problem," in *IEEE Int'l Conf. on Evolutionary Computation*. Indianapolis: IEEE Press, 1997.309~314.

[9] R. Gan, Q. Guo, H. Chang, and Y. Yi, "Improved ant colony optimization algorithm for the traveling salesman problems," *Jouranl of Systems Engineering and Electronics*, April 2010, pp 329-333.

[10] C.-X. Wang, D.-Wu. Cui, Y.-K. Zhang, and Z.-R. Wang, "A novel ant colony system based on delauney triangulation and self-adaptive mutation for tsp," *International Joural of Information Technology*, Vol.12, No.3, 2006.

[11] Z. A. Othman, H. Md. Rais, and A. R. Hamdan," Strategies DACS3 increasing its performances," *European Journal of Scientific Research*, 2009.

[12] Z. A. Othman, H. Md. Rais, and A. R. Hamdan, "DACS3: Embedding individual ant behavior in ant colony system," World Academy of Science Engineering and Technology 44 2008.

[13] H. Md. Rais, Z. A. Othman, and A. R. Hamdan, "Improvement DACS3 searching performance using local search,"

ISSN 2304-7712

Conference on Data Mining and Optimization, IEEE, 27-28 October 2009.

[14] L. Li, S. Ju, and Y. Zhang, "Improved ant colony optimization for the traveling salesman problem", international conference on intelligent computation technology and automation, IEEE, 2008.

[15] X. Wei, "Improved ant colony algorithm based on information entropy," *International Conference on Computational and Information Sciences, IEEE,* 2010, 987-0-7695-4270-6.

[16] K. S. Hung, S. F. Su, and S. J. Lee, "Improving ant colony optimization for solving traveling salesman problem," *Journal of Advanced Computational Intelligence and Intelligent Informatics*, 2007.

[17] D. X. Yu, "Hybrid ant colony optimization using memetic algorithm for traveling salesman problem," in *Proceedings of the 2007 IEEE Symposium on Approximate Dynamic Programming and Reinforcement Learning* (ADPRD 2007).

[18] L. Min and J. Yant, "A shortest path routing based on ant algorithm," *Journal of Communication and Computer*, ISSN1548-7709, USA, September 2005.

[19] M. Dorigo and L. M. Gambardella, "The colony system: A cooperative learning approach to the traveling salesman problem," *IEEE Transactions on Evolutionary Computation*, vol.1, no.1, April, 1997.

[20] M. Dorigo, M. Birattari, and T. Stuzle, "Ant colony optimization, artificial ants as a computational intelligence technique," IEEE computational intelligence magazine, November 2006.

[21] TSPLIB WebPage, available: http://www.iwr.uniheidelberg.de/groups/comopt/software/TSPLIB95 /tsp/.

[22] TSPLIB WebPage, http://www2.iwr.uni-heidelberg.de/groups/comopt/software/TSPLIB95/tsp/

[23] T. Stutzle, H.H. Hoos. *MAX-MIN ant system and local search for the traveling salesman problem*, In: IEEE Int'l Conf. on Evolutionary Computation. Indianapolis: IEEE Press, 1997.309~314.

[24] X-song, B. LI, H. YANG, *Improved Ant Colony Algorithm and Its Applications in TSP*, Proceedings of Sixth International Conference on Intelligent Systems Design and Applications (ISDA'06), IEEE, 2006.

[25] Y. Zhang, Z-l. Pei, J-h. Yang, Y-c. Liang, *An Improved Ant Colony Optimization Algorithm Based on RouteOptimization and Its Applications in Traveling Salesman Problem*, IEEE 2007. 1-4244-1509-8.

[26] Z. A. Othman, H. Md. Rais, A.R. Hamdan, *DACS3: Embedding Individual Ant Behavior in Ant Colony System*, World Academy of Science Engineering and Technology 44 2008.

[27] Z. A. Othman, H. Md. Rais, A.R. Hamdan, *Strategies DACS3 Increasing its Performances*, European Journal of

ISSN 2304-7712

Scientific Research, 2009.

K.Lenin has received his B.E., Degree, electrical and electronics engineering in 1999 from university of madras, Chennai, India and M.E., Degree in power systems in 2000 from Annamalai University, TamilNadu, India& Working as Asst professor in sree sastha collge of engineering .At present pursuing Ph.D., degree at JNTU, Hyderabad,India.

Bhumanapally. RavindhranathReddy, Born on 3rd September,1969. Got his B.Tech in Electrical & Electronics Engineering from the J.N.T.U. College of Engg., Anantapur in the year 1991. Completed his M.Tech in Energy Systems in IPGSR of J.N.T.University Hyderabad in the year 1997. Obtained his doctoral degree from JNTUA,Anantapur University in the field of Electrical Power Systems. Published 12 Research Papers and presently guiding 6 Ph.D. Scholars. He was specialized in Power Systems, High Voltage Engineering and Control Systems. His research interests include Simulation studies on Transients of different power system equipment.

M. Surya Kalavathi has received her B.Tech. Electrical and Electronics Engineering from SVU, Andhra Pradesh, India and M.Tech, power system operation and control from SVU, Andhra Pradesh, India. she received her Phd. Degree from JNTU, hyderabad and Post doc. From CMU – USA. Currently she is Professor and Head of the electrical and electronics engineering department in JNTU, Hyderabad, India and she has Published 16 Research Papers and presently guiding 5 Ph.D. Scholars. She has specialised in Power Systems, High Voltage Engineering and Control Systems. Her research interests include Simulation studies on Transients of different power system equipment. She has 18 years of experience. She has invited for various lectures in institutes.

ISSN 2304-7712

Create an Automated Query Generation by Using Parse Tree Query Language as a Solution for Incremental Information Extraction

Gayatri Naik,
Lecturer, ComputerEngg Department, YTIET College of Eng., Mumbai University
Mumbai, Maharashtra
gayatri8984@gmail.com

Prf. Amole Pande ,
HOD, Computer Eng. Department, Datta meghe College of Engg,Mumbai University
Thane, Maharashtra
hodcomp@dmce.co.in

Harish Bhabad,
HOD, Computer Eng. Department, Shatabdi College of Eng., Pune University
Nasik,Maharashtra
bhabadharish@gmail.com

Surekha Naik
Lecturer, ComputerEngg Department, YTIET College of Eng, Mumbai University
Mumbai, Maharashtra
Surekha.naik@tasgaonkartech.com

Abstract

Information extraction systems are traditionally implemented as a pipeline of special-purpose processing modules targeting the extraction of a particular kind of information. A major drawback of such an approach is that whenever a new extraction goal emerges or a module is improved, extraction has to be reapplied from scratch to the entire text corpus even though only a small part of the corpus might be affected. In this project, we describe a novel approach for information extraction in which extraction needs are expressed in the form of database queries, which are evaluated and optimized by database systems. Using database queries for information extraction enables generic extraction and minimizes reprocessing of data by performing incremental extraction to identify which part of the data is affected by the change of components or goals. Furthermore, our approach provides automated query generation components so that casual users do not have to learn the query language in order to perform extraction. To demonstrate the feasibility of our incremental extraction approach, we performed experiments to highlight two important aspects of an information extraction system: efficiency and quality of extraction results.

Keywords: *Text mining, query languages, information storage and retrieval.*

ISSN 2304-7712

1. Introduction

Text mining is inter disciplinary field which draws on information retrieval, data mining, machine learning, statistics, and computational linguistics. As most information (common estimates say over 80%) is currently stored as text, text mining is believed to have a high commercial potential value. Increasing interest is being paid to multilingual data mining: the ability to gain information across languages and cluster similar items from different linguistic sources according to their meaning.

Text mining, sometimes alternately referred to as text data mining, roughly equivalent to text analytics, refers to the process of deriving high-quality information from text. High-quality information is typically derived through the divining of patterns and trends through means such as statistical pattern learning. Text mining involves the application of techniques from areas such as information retrieval, natural language processing, information extraction and data mining. These various stages of a text-mining process can be combined together into a single workflow.

1.1. Information Extraction:

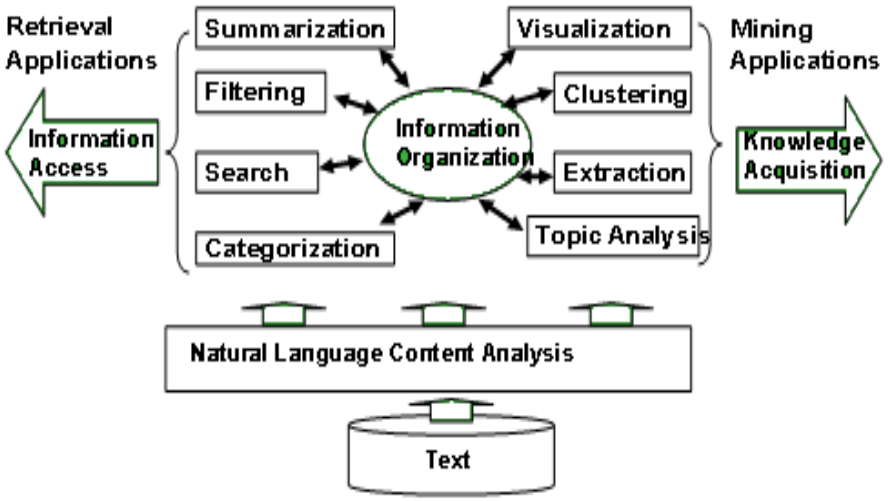


Fig1: Conceptual Framework of Text Information System

Fig shows the Conceptual Framework of Text Information System consist the Retrieval applications & Mining

ISSN 2304-7712

applications. Natural language content analysis access text and send it to information organization, which perform operations like Topic analysis, Extraction, Clustering, Visualization, Summarization, Filtering, Search, Categorization etc. Information organization provide information access & knowledge acquisition.

1.3 Basic Generality Techniques

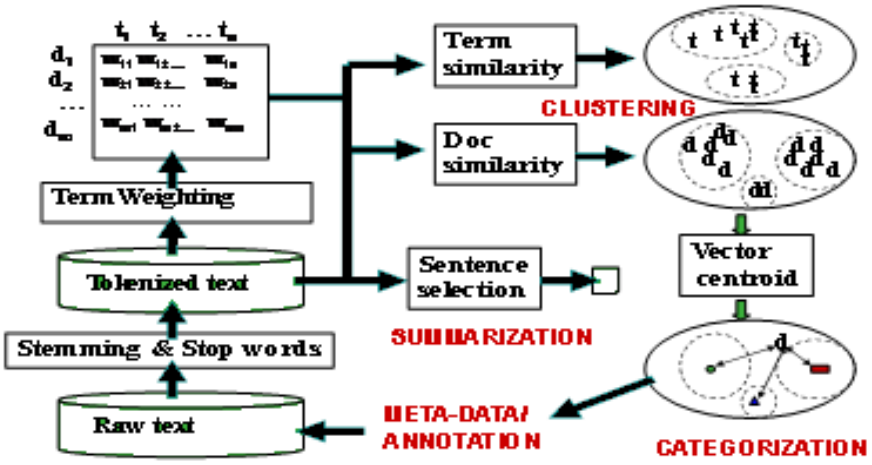


Fig2: Basic Generality Techniques

IE has been an active research area that seeks techniques to uncover information from a large collection of text. Examples of common IE tasks include the identification of entities, extraction of relationships between entities and extraction of entity attributes from text.

Information extraction (IE) is the task of automatically extracting structured information from unstructured and/or semi-structured machine-readable documents. In most of the cases this activity concerns processing human language texts by means of natural language processing (NLP).Information extraction systems are traditionally implemented as a pipeline of special-purpose processing modules targeting the extraction of a particular kind of information. A major drawback of such an approach is that whenever a new extraction goal emerges or a module is improved extraction has to be reapplied from scratch to the entire text corpus even though only a small part of the corpus might be affected.

ISSN 2304-7712

1.4 Workflow

A typical IE setting involves a pipeline of text processing modules in order to perform relationship extraction. These include:

1. Sentence splitting: identifies sentences from a paragraph of text.

2. Tokenization: identifies word tokens from sentences.

3. Named entity recognition: identifies mentions of entity types of interest.

4. Syntactic parsing: identifies grammatical structures of sentences.

5. Pattern matching: obtains relationships based on a set of extraction patterns that utilize lexical, syntactic, and semantic features.

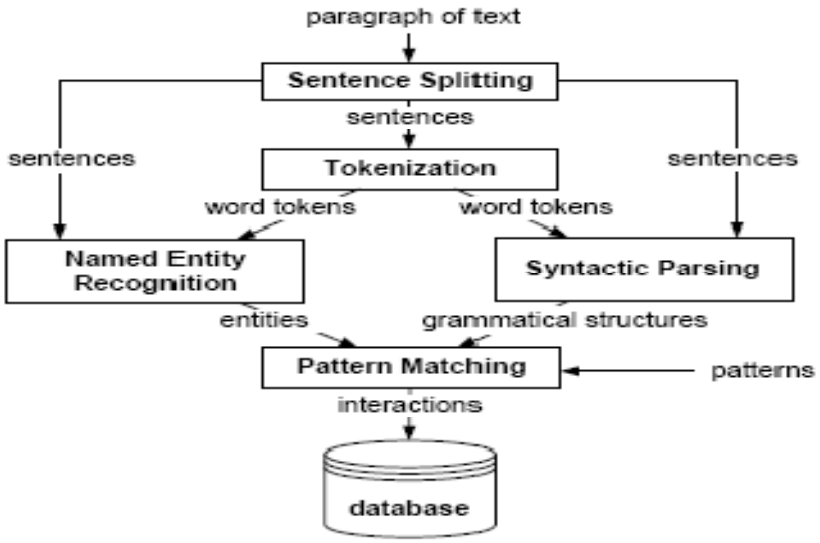


Fig.3. A workflow of text processing modules that takes a paragraph o f text as input to perform relationship extraction.

Fig.3. illustrates a typical text processing workflow in order to perform extraction of relationships.

Extraction patterns are typically obtained through manually written patterns compiled by experts or automatically generated patterns based on training data. Different kinds of parsers, which include shallow and deep parsers, can be utilized in the pipeline. In our work, the Link Grammar parser is utilized as part of our extraction approach. Extraction patterns are typically obtained through manually written patterns compiled by experts or automatically

ISSN 2304-7712

generated patterns based on training data. Different kinds of parsers, which include shallow and deep parsers, can be utilized in the pipeline. In our work, the Link Grammar parser is utilized as part of our extraction approach.

2. Link Grammar

2.1 Introduction

Link grammar (LG) is a theory of syntax by Davy Temperley and Daniel Sleator which builds relations between pairs of words, rather than constructing constituents in a tree-like hierarchy. There are two basic parameters: directionality and distance. Link grammar is similar to dependency grammar, but dependency grammar includes a head-dependent relationship, as well as lacking directionality in the relations between words. The Link Grammar parser is a dependency parser based on the Link Grammar theory. Link Grammar consists of a set of words and linking requirements between words. A sentence of the language is defined as a sequence of words such that the links connecting the words satisfy the following properties:

1) The links do not cross

2) The words form a connected graph.

3) Links satisfy the linking **requirements** of each word in the sentence.

2.2 Linkage

The output of the parser, called a linkage, shows the dependencies between pairs of words in the sentence. For example “RAD53, which activates DNA damage, positively regulates the DBF4 protein.”

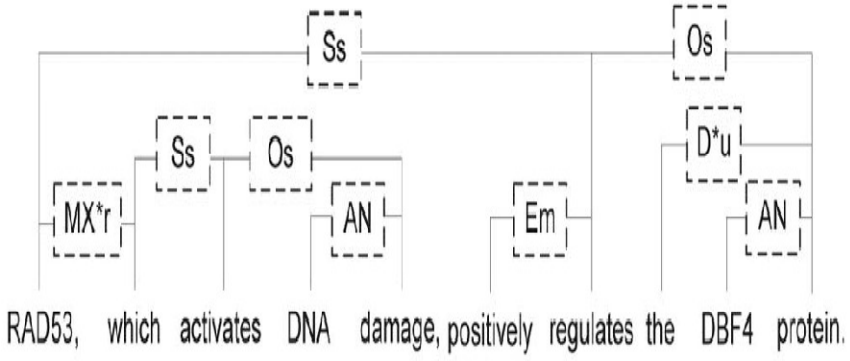


Fig4. Linkage of the sentence “RAD53, which activates DNA damage, positively regulates the DBF4 protein.”

ISSN 2304-7712

3. System Approach

Our approach composed basic two phases:

- Initial phase: for processing of text and
- Extraction phase: for using database queries to perform extraction.

The Text Processor in the initial phase is responsible for corpus processing and storage of the processed information in the Parse Tree Database (PTDB). The extraction patterns over parse trees can be expressed in our proposed parse tree query language. In the extraction phase, the PTQL query evaluator takes a PTQL query and transforms it into keyword-based queries and SQL queries, which are evaluated by the underlying RDBMS and information retrieval (IR) engine. To speed up query evaluation, the index builder creates an inverted index for the indexing of sentences according to words and the corresponding entity types. Fig illustrates the system architecture of our approach.

Our approach provides two modes of generating PTQL queries for the purpose of information extraction:

1. Training set driven query generation.
2. Pseudo-relevance feedback driven query generation.

3.1 System Architecture

To generate a set of patterns for information extraction using the training set driven approach, the pattern generator first automatically annotates an unlabeled The framework includes the parse tree database for storing intermediate processed information and the query evaluator for the evaluation of PTQL queries through filtering and translation to SQL queries. Document collection with information drawn from a problem-specific database. This step necessitates a method for precise recognition and normalization of protein mentions.

ISSN 2304-7712

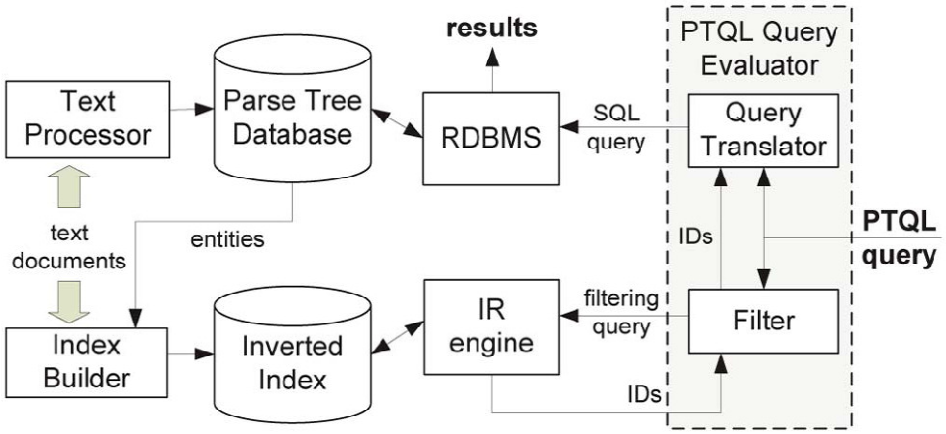


Fig5: System architecture of the PTQL framework.

From this labeled data, initial phrases referring to interactions are extracted. These phrases are then refined to compute consensus patterns and the resulting PTQL queries are generated by the query generator. However, training data are not always readily available for certain relationships due to the inherent cost of creating a training corpus. In that regards, our approach provides the pseudo relevance feedback driven approach that takes keyword based queries, and the PTQL query generator then finds common grammatical patterns among the top-k retrieved sentences to generate PTQL queries.

3.2 Parse Tree Database

We propose a new paradigm for information extraction that utilizes database management systems as an essential component of our extraction framework. Database management systems become a logical framework of choice that can serve such dynamic extraction needs over file-based storage systems. As illustrated in Figure 1, text processing components such as named entity recognizers and syntactic parsers are deployed for the entire collection.

The intermediate output of the processing modules is stored in a relational database known as the parse tree database. Extraction then becomes a matter of issuing database queries in the form of parse tree query language (PTQL). In the event of a change of extraction goals or a module update, the responsible module is deployed for the entire text corpus and the processed data is populated into the parse tree database with the previously processed data. Incremental extraction is performed so that database queries are issued to identify sentences with newly recognized mentions. Once the affected sentences are identified, extraction can then be performed only on such

ISSN 2304-7712

sentences rather than the entire corpus.

By storing the processed data, our approach avoids the need to reprocess the entire collection of text unlike the file-based pipeline approaches. Avoiding reprocessing of data is particularly important for extraction. We highlight the technical contributions of the architecture proposed Novel Database-Centric Framework for Information Extraction. Unlike traditional approaches for IE, our approach is to store intermediate text processing output in a specialized database called the parse tree database. Extraction is formulated as queries so that it is no longer necessary to write and run special-purpose programs for each specific extraction goal. Our approach minimizes the need of reprocessing the entire collection of text in the presence of new extraction goals and deployment of improved processing components.

3.3 Information Extraction Frame Phases

Our information extraction framework is composed of two phases:

1. Initial Phase:

We perform a one-time parse, entity recognition and tagging (identifying individual entries as belonging to a class of interest) on the whole corpus based on current knowledge. The generated syntactic parse trees and semantic entity tagging of the processed text is stored in a parse tree database (PTDB).

2. Extraction Phase:

Extracting particular kinds of relations can be done by issuing an appropriate query to the PTDB. To express extraction patterns, we designed and implemented a query language called parse tree query language (PTQL) that is suitable for generic extraction. Our system not only allows a user to issue PTQL queries for extraction, but it can also automatically generate queries from training data or user keyword-based queries.

ISSN 2304-7712

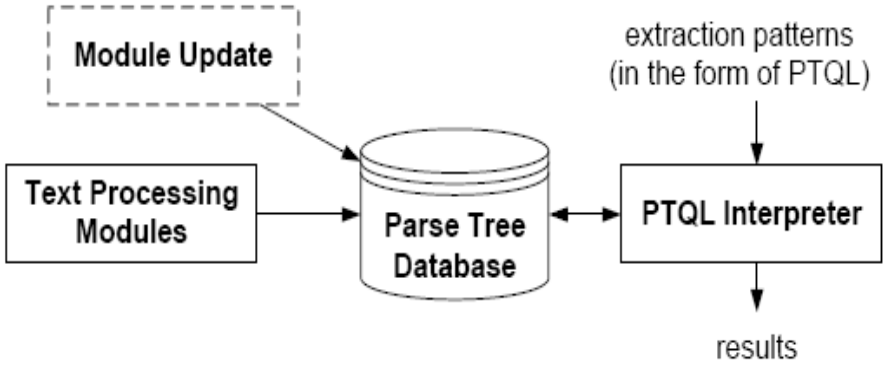


Fig6: Parse tree database use for extraction & update of modules

A fundamental design criterion for the query language is the ability of expressing linguistic patterns based on constituent trees. Standard XML query languages such as XPath and XQuery seem to be the ideal candidates for querying parse trees. An additional design criterion for the query language is the ability to express linguistic patterns based on dependency grammar, such as Link Grammar. Links and link types can be useful in linguistic patterns, such as the type MXsr connects a relative pronoun to its corresponding noun. However, languages such as XQuery and LPath can only express ancestor descendant and sibling relations between nodes.

One of the novel features of our proposed query language PTQL is the ability to express links and link types between pairs of nodes, so that PTQL can be used to express linguistic patterns based on constituent trees and links, as well as link types. We propose a high level extraction query language called PTQL. PTQL is an extension of the linguistic query language LPath that allows queries to be performed not only on the constituent trees but also the syntactic links between words on linkages.

A PTQL query is made up of four components:

1. Tree patterns,

2. Link conditions,

3. Proximity conditions, and

4. Return expression.

ISSN 2304-7712

1. Tree pattern: describes the hierarchical structure and the horizontal order between the nodes of the parse tree.

2. Link condition: describes the linking requirements between nodes.

3. Proximity condition: is to find words that are within a specified number of words.

4. Return expression: defines what to return. We start with the basic element of PTQL queries called node expressions.

4. Query Evaluation

Our approach for the evaluation of PTQL queries involves the use of IR engine as well as RDBMS. The role of the IR engine in query is to select sentences based on the lexical features defined in PTQL queries, and only the subset of sentences retrieved by the IR engine are considered for the evaluation of the conditions specified in the PTQL queries by RDBMS.

We summarize the process of the evaluation of PTQL queries as follows.

4.1. Translate the PTQL query into a filtering query.

4.2. Use the filtering query to retrieve relevant documents D and corresponding sentences S from the inverted index.

4.3. Translate the PTQL query into an SQL query and instantiate query with document id 2 D and sentence id s 2 S.

4.4. Query PTDB using the SQL query generated in Step 3.

4.5. Return the results of the SQL query as the results of the PTQL query.

5. Query Generation

An important aspect of an IE system is its ability to extract high-quality results. In this section, we demonstrate the feasibility of our approach by first describing two approaches in generating PTQL queries automatically:

1. Training set driven query generation

ISSN 2304-7712

2. Pseudo-relevance feedback driven query generation.

The first query generation approach takes advantage of manually annotated data to generate PTQL queries for the extraction of protein-protein interactions. As training data are not always available, we introduce the latter approach that identifies frequent linguistic structures to generate PTQL queries without the use of training data.

We illustrate our approach with an application of protein-protein interaction extraction using a set of syntactic patterns that are expressed in PTQL queries. To generate a set of patterns for information extraction, the annotator component is applied to automatically annotate an unlabeled document collection with information drawn from a problem-specific database. This step necessitates a method for precise recognition and normalization of protein mentions. From this labeled data, the pattern generator identifies relevant phrases referring to interactions in order to generate patterns. These initial patterns are then used to compute consensus patterns through the pattern generalization component for protein-protein interactions (PPIs). PTQL queries are then formed by the query generator to perform extraction from the parse tree database.

Conclusion

Information Extraction has been an active research area over the years. The main focus has been on improving the accuracy of the extraction systems, and IE has been seen as an one-time execution process. Such paradigm is inadequate for real-world applications when IE is seen as long running processes. We describe how our proposed extraction framework differs from traditional IE systems, rule-based IE systems and IE systems based on machine learning. While new documents can be added to our text collection, the content of the existing documents are assumed not to be changed, which is the case for Medline abstracts. Our focus is on managing the processed data so that in the event of the deployment of an improved component or a new extraction goal, the affected subset of the text corpus can be easily identified.

The filtering process utilizes the efficiency of IR engines so that a complete scan of the parse tree database is not needed without sacrificing any sentences that should have been used for extraction. Furthermore, our approach

ISSN 2304-7712

provides automated query generation components so that casual users do not have to learn the query language in order to perform extraction. To demonstrate the feasibility of our incremental extraction approach, we performed experiments to highlight two important aspects of an information extraction system: efficiency and quality of extraction result

References

1. A. Doan, L. Gravano, R. Ramakrishnan, and S. Vaithyanathan, Introduction to Special Issue on Managing Information Extraction," ACM SIGMOD Record, vol. 37, no. 4, p. 5, 2008.

2. E. Agichtein and L. Gravano, "Snowball: Extracting Relations from Large Plain-Text collections," Proc. Fifth ACM Conf. Digital Libraries, pp. 85-94, 2000.

3. A. Doan, J Naughton, R. Ramakrishnan, A. Baid, X. Chai, Chen, P. DE Rose, B. Gao, C Gokhale, J.Huang,W. Shen, and B.-Q. Vuong, "Information Extraction Challenges in Managing Unstructured Data," ACM SIGMOD Record, vol. 37, no.4, pp. 14-20, 2008.

4. R. Krishnamurthy, Li, S. Raghavan, S. Vaithyanathan, and H. Zhu, "SystemT: A System for Declarative Information Extraction," ACM SIGMOD Record, vol. 37, no. 4, pp. 7-13, 2009.

5. P.G. Ipeirotis, E. Agichtein, P. Jain, and L. Gravano, "Towards a Query Optimizer for Text-Centric Tasks," ACM Trans. Database Systems, vol. 32, no. 4, p. 21, 2007.

6. P.G. Ipeirotis, E. Agichtein, P. Jain, and L. Gravano, "Towards a Query Optimizer for Text-Centric Tasks," ACM Trans. Database Systems, vol. 32, no. 4, p. 21, 2007.

ISSN 2304-7712

Multiple Choice Particle Swarm Optimization Algorithm For Solving Optimal Reactive Power Dispatch Problem

K. Lenin[1],

[1]Research Scholar, Jawaharlal Nehru Technological University Kukatpally,Hyderabad 500 085, India.

gklenin@gmail.com

Dr.B.Ravindranath Reddy[2],

[2]Deputy Executive Engineer, Jawaharlal Nehru Technological University Kukatpally,Hyderabad 500 085, India.

www.jntu.ac.in

Dr.M.Surya Kalavathi[3]

[3]Professor of Electrical and Electronics Engineering,Jawaharlal Nehru Technological University Kukatpally, Hyderabad 500 085, India.

www.jntu.ac.in

Abstract

This paper presents an algorithm for solving the multi-objective reactive power dispatch problem in power system. Modal analysis of the system is used for static voltage stability assessment. Loss minimization and maximization of voltage stability margin are taken as the objectives. Generator terminal voltages, reactive power generation of the capacitor banks and tap changing transformer setting are taken as the optimization variables. Evolutionary algorithm and Swarm Intelligence algorithm (EA, SI), a part of Bio inspired optimization algorithm, have been widely used to solve numerous optimization problem in various science and engineering domains. Particle swarm optimization (PSO) is a population-based swarm intelligence algorithm that shares many similarities with evolutionary computation techniques. However, the PSO is driven by the simulation of a social psychological metaphor motivated by collective behaviours of bird and other social organisms instead of the survival of the fittest individual. A new promising strategy for the PSO (Particle swarm optimization) algorithm is proposed and described in this paper. This new strategy presents alternative way of assigning new velocity to each individual in particle swarm (population). This new multiple choice particle swarm optimization (MC-PSO) algorithm is used to solve an optimal reactive power dispatch problem. In order to evaluate the proposed algorithm, it has been tested on IEEE 30 bus system and compared to other algorithms reported those before in literature. Results show that (MC-PSO) is more efficient than others for solution of single-objective ORPD problem.

Keywords: *Quantum behaved PSO, Optimization, Swarm Intelligence, optimal reactive power, Transmission loss.*

ISSN 2304-7712

• 1. INTRODUCTION

Optimal reactive power dispatch problem is one of the difficult optimization problems in power systems. The sources of the reactive power are the generators, synchronous condensers, capacitors, static compensators and tap changing transformers. The problem that has to be solved in a reactive power optimization is to determine the required reactive generation at various locations so as to optimize the objective function. Here the reactive power dispatch problem involves best utilization of the existing generator bus voltage magnitudes, transformer tap setting and the output of reactive power sources so as to minimize the loss and to enhance the voltage stability of the system. It involves a non linear optimization problem. Various mathematical techniques have been adopted to solve this optimal reactive power dispatch problem. These include the gradient method [1, 2], Newton method [3] and linear programming [4-7].The gradient and Newton methods suffer from the difficulty in handling inequality constraints. To apply linear programming, the input- output function is to be expressed as a set of linear functions which may lead to loss of accuracy.

Recently Global Optimization techniques such as genetic algorithms have been proposed to solve the reactive power flow problem [8.9]. In recent years, the problem of voltage stability and voltage collapse has become a major concern in power system planning and operation. To enhance the voltage stability, voltage magnitudes alone will not be a reliable indicator of how far an operating point is from the collapse point [10]. The reactive power support and voltage problems are intrinsically related. Hence, this paper formulates the reactive power dispatch as a multi-objective optimization problem with loss minimization and maximization of static voltage stability margin (SVSM) as the objectives. Voltage stability evaluation using modal analysis [10] is used as the indicator of voltage stability. Optimization started to play a crucial part for almost every engineering and informatics tasks during recent years. Optimization problems often represent very complex tasks and non-heuristic methods are very limited in finding of the proper solutions. As the complexity of optimization problems increases, the non-heuristic methods may not be able to solve them even in very distant future, whereas the new heuristic methods can solve such tasks. Among these so called “soft computing” methods belong to evolutionary algorithms, which are inspired by evolution theory and natural behaviour, and have helped to achieve very impressive results in solving various problems. The performance of (MC-PSO) has been evaluated in standard IEEE 30 bus test system and the results analysis shows that our proposed approach outperforms all approaches investigated in this paper. The performance of (MC-PSO) has been evaluated in standard IEEE 30 bus test system and the results analysis shows that our proposed approach outperforms all approaches investigated in this paper.

2. Voltage Stability Evaluation

2.1Modal analysis for voltage stability evaluation

Modal analysis is one of the methods for voltage stability enhancement in power systems. In this method, voltage stability analysis is done by computing Eigen values and right and left Eigen vectors of a jacobian matrix. It identifies the critical areas of voltage stability and provides information about the best actions to be taken for the improvement of system stability enhancements. The linearized steady state system power flow equations are given by.

$$\begin{bmatrix}\Delta P\\ \Delta Q\end{bmatrix} = \begin{bmatrix} J_{p\theta} & J_{pv}\\ J_{q\theta} & J_{QV}\end{bmatrix} \qquad (1)$$

Where

ΔP = Incremental change in bus real power.

ΔQ = Incremental change in bus reactive

ISSN 2304-7712

Power injection

$\Delta\theta$ = incremental change in bus voltage angle.

ΔV = Incremental change in bus voltage Magnitude

$J_{p\theta}$, J_{PV} , $J_{Q\theta}$, J_{QV} jacobian matrix are the sub-matrixes of the System voltage stability is affected by both P and Q. However at each operating point we keep P constant and evaluate voltage stability by considering incremental relationship between Q and V.

To reduce (1), let $\Delta P = 0$, then.

$$\Delta Q = \left[J_{QV} - J_{Q\theta} J_{P\theta^{-1}} J_{PV}\right]\Delta V = J_R \Delta V \quad (2)$$

$$\Delta V = J^{-1} - \Delta Q \quad (3)$$

Where

$$J_R = \left(J_{QV} - J_{Q\theta} J_{P\theta^{-1}} JPV\right) \quad (4)$$

J_R is called the reduced Jacobian matrix of the system.

Modes of Voltage instability:

Voltage Stability characteristics of the system can be identified by computing the eigen values and eigen vectors

Let

$$J_R = \xi \wedge \eta \quad (5)$$

Where,

ξ = right eigenvector matrix of J_R

η = left eigenvector matrix of J_R

$\wedge$ = diagonal eigenvalue matrix of J_R and

$$J_{R^{-1}} = \xi \wedge^{-1} \eta \quad (6)$$

From (3) and (6), we have

$$\Delta V = \xi \wedge^{-1} \eta \Delta Q \quad (7)$$

or

$$\Delta V = \sum_I \frac{\xi_i \eta_i}{\lambda_i} \Delta Q \quad (8)$$

Where ξ_i is the i_{th} column right eigenvector and η the i_{th} row left eigenvector of J_R.

λ_i is the i_{th} eigen value of J_R.

The i_{th} modal reactive power variation is,

$$\Delta Q_{mi} = K_i \xi_i \quad (9)$$

Where,

$$K_i = \sum_j \xi_{ij^2} - 1 \quad (10)$$

Where

ξ_{ji} is the j_{th} element of ξ_i

The corresponding ith modal voltage variation is

$$\Delta V_{mi} = [1/\lambda_i] \Delta Q_{mi} \quad (11)$$

It is seen that, when the reactive power variation is along the direction of ξ_i the corresponding voltage variation is also along the same direction and magnitude is amplified by a factor which is equal to the magnitude of the inverse of the ith eigenvalue. In this sense, the magnitude of each eigenvalue λ_i determines the weakness of the corresponding

ISSN 2304-7712

modal voltage. The smaller the magnitude of λ_i, the weaker will be the corresponding modal voltage. If $|\lambda_i| = 0$ the i_{th} modal voltage will collapse because any change in that modal reactive power will cause infinite modal voltage variation.

In (8), let $\Delta Q = e_k$ where e_k has all its elements zero except the k_{th} one being 1. Then,

$$\Delta V = \sum_i \frac{\eta_{1k}\, \xi_1}{\lambda_1} \quad (12)$$

η_{1k} k th element of η_1

V –Q sensitivity at bus k

$$\frac{\partial V_K}{\partial Q_K} = \sum_i \frac{\eta_{1k}\, \xi_1}{\lambda_1} = \sum_i \frac{P_{ki}}{\lambda_1} \quad (13)$$

3.Problem Formulation

The objectives of the reactive power dispatch problem considered here is to minimize the system real power loss and maximize the static voltage stability margins (SVSM). This objective is achieved by proper adjustment of reactive power variables like generator voltage magnitude (g_i) V, reactive power generation of capacitor bank (Q_{ci}), and transformer tap setting (tk).Power flow equations are the equality constraints of the problems, while the inequality constraints include the limits on real and reactive power generation, bus voltage magnitudes, transformer tap positions and line flows.

3.1. Minimization of Real Power Loss

It is aimed in this objective that minimizing of the real power loss (Ploss) in transmission lines of a power system. This is mathematically stated as follows.

$$P_{loss} = \sum_{\substack{k=1 \\ k=(i,j)}}^{n} g_{k(V_i^2 + V_j^2 - 2V_i V_j \cos\theta_{ij})} \quad (14)$$

Where n is the number of transmission lines, gk is the conductance of branch k, Vi and Vj are voltage magnitude at bus i and bus j, and θij is the voltage angle difference between bus i and bus j.

3.2.Minimization of Voltage Deviation

It is aimed in this objective that minimizing of the Deviations in voltage magnitudes (VD) at load buses. This is mathematically stated as follows.

$$\text{Minimize VD} = \sum_{k=1}^{nl} |V_k - 1.0| \quad (15)$$

Where nl is the number of load busses and Vk is the voltage magnitude at bus k.

3.3.System Constraints

In the minimization process of objective functions, some problem constraints which one is equality and others are inequality had to be met. Objective functions are subjected to these constraints shown below.
Load flow equality constraints:

$$P_{Gi} - P_{Di} - V_i \sum_{j=1}^{nb} V_j \begin{bmatrix} G_{ij} & \cos\theta_{ij} \\ +B_{ij} & \sin\theta_{ij} \end{bmatrix} = 0, i = 1,2 \ldots., nb \quad (16)$$

$$Q_{Gi} - Q_{Di} - V_i \sum_{j=1}^{nb} V_j \begin{bmatrix} G_{ij} & \cos\theta_{ij} \\ +B_{ij} & \sin\theta_{ij} \end{bmatrix} = 0, i = 1,2 \ldots., nb \quad (17)$$

where, nb is the number of buses, P_G and Q_G are the real and reactive power of the generator, P_D and Q_D are the real and reactive load of the generator, and G_{ij} and B_{ij} are the mutual conductance and susceptance between bus i and bus j.Generator bus voltage (V_{Gi}) inequality constraint:

$$V_{Gi}^{min} \leq V_{Gi} \leq V_{Gi}^{max}, i \in ng \quad (18)$$

ISSN 2304-7712

Load bus voltage (V_{Li}) inequality constraint:

$$V_{Li}^{min} \leq V_{Li} \leq V_{Li}^{max}, i \in nl \quad (19)$$

Switchable reactive power compensations (Q_{Ci}) inequality constraint:

$$Q_{Ci}^{min} \leq Q_{Ci} \leq Q_{Ci}^{max}, i \in nc \quad (20)$$

Reactive power generation (Q_{Gi}) inequality constraint:

$$Q_{Gi}^{min} \leq Q_{Gi} \leq Q_{Gi}^{max}, i \in ng \quad (21)$$

Transformers tap setting (T_i) inequality constraint:

$$T_i^{min} \leq T_i \leq T_i^{max}, i \in nt \quad (22)$$

Transmission line flow (S_{Li}) inequality constraint:

$$S_{Li}^{min} \leq S_{Li}^{max}, i \in nl \quad (23)$$

Where, nc, ng and nt are numbers of the switchable reactive power sources, generators and transformers.

4. PSO Algorithm

Particle swarm optimization algorithm is the evolutionary optimization algorithm based on the natural behaviour of bird and fish swarms and was firstly introduced by R. Eberhart and J. Kennedy in 1995 (Kennedy, Eberhart 1995, Eberhart, Kennedy 2001). The field of swarm intelligence is an emerging research area that presents features of self-organization and cooperation principles among group members bio-inspired on social insect societies [11–13]. Swarm intelligence is inspired by nature, based on the fact that the live animals of a group contribute with their individual experiences to the group, rendering it stronger to face other groups.

The particle swarm optimization (PSO) originally developed by Kennedy and Eberhart in 1995 [11,12] is a population based swarm algorithm. Similarly to genetic algorithms [13], an evolutionary algorithm approach, PSO is an optimization tool based on a population, where each member is seen as a particle, and each particle is a potential solution to the problem under analysis. Each particle in PSO has a randomized velocity associated to it, which moves through the space of the problem. However, unlike genetic algorithms, PSO does not have operators, such as crossover and mutation. PSO does not implement the survival of the fittest individuals; rather, it implements the simulation of social behaviour. As the optimization continues, the value of w is decreasing, thus the velocity of each particle is decreasing, since w is the number < 1 and it multiplies previous velocity of particle in the process of new velocity value calculation. Inertia weight modification PSO strategy has two control parameters wstart and wend.

New w for each generation is then given by Eq. 24, where i stand for current generation number and n for total number of generations.

$$w = w_{start} - \frac{((w_{start} - w_{end}) \cdot i)}{n} \quad (24)$$

$$v(t+1) = w.v(t) + c_1 \cdot Rand \cdot \left(pBest - x(t)\right) + c_2 \cdot Rand \cdot \left(gbest - x(t)\right) \quad (25)$$

Where:
v(t+1) – New velocity of particle.

v(t) – Current velocity of particle.

c1, c2 – Priority factors.

pBest – Best solution found by particle.

ISSN 2304-7712

gBest – Best solution found in population.

x(t) – Current position of particle.

Rand – Random number, interval <0,1>

New position of particle is then given by Eq. 26, where

x(t+1) represents the new position:

$$x(t+1) = x(t) + v(t+1) \quad (26)$$

5.MultipleChoiceParticleSwarm Optimization Algorithm (MC-PSO)

A new strategy, which is proposed in this research, alters the original way (Eq. 25) of calculating the particle velocity for the next generation. At first, three numbers b1, b2 and b3 are defined at the start of algorithm. These numbers represent limit values for different rules, so they should follow the pattern: b1 < b2 < b3. In this study following values were used: b1 = 0.3, b2 = 0.5, b3 = 0.8.

Afterwards during the calculation of new velocity of each particle a random number r is generated from the interval <0, 1>. Finally the new velocity is calculated based on following four rules: If r ≤ b1 a new velocity of particle is given by Eq. 27 :

$$v(t+1) = 0 \quad (27)$$

If b1 < r ≤ b2 a new velocity of particle is given by Eq. 28 :

$$v(t+1) = w.v(t) + c \cdot \text{Rand} \cdot \left(x_r(t) - x(t)\right) \quad (28)$$

Where xr(t) is the position of randomly chosen particle. If b2 < r ≤ b3 a new velocity of particle is given by Eq.29 :

$$v(t+1) = w.v(t) + c \cdot \text{Rand} \cdot \left(\text{pbest} - x(t)\right) \quad (29)$$

If b3 < r a new velocity of particle is given by Eq. 30 :

$$v(t+1) = w.v(t) + c \cdot \text{Rand} \cdot \left(\text{gbest} - x(t)\right) \quad (30)$$

The priority factors c1 and c2 from original equation (Eq. 25) are replaced within this novel approach with a new parameter c. In this novel strategy parameter c defines not the priority (which is naturally given by b1, b2 and b3 setting) but the overstep value. In other words how far past the target (pBest, gBest or random particle) can the active particle go. Within this initial research, parameter c was set to 2.

6. Simulation Results

The validity of the proposed Algorithm technique is demonstrated on IEEE-30 bus system. The IEEE-30 bus system has 6 generator buses, 24 load buses and 41 transmission lines of which four branches are (6-9), (6-10) , (4-12) and (28-27) - are with the tap setting transformers. The real power settings are taken from [1]. The lower voltage magnitude limits at all buses are 0.95 p.u. and the upper limits are 1.1 for all the PV buses and 1.05 p.u. for all the PQ buses and the reference bus.

Table 1. Voltage Stability under Contingency State

Sl.No	Contigency	ORPD Setting	Vscrpd Setting
1	28-27	0.1400	0.1422
2	4-12	0.1658	0.1662

ISSN 2304-7712

3	1-3	0.1784	0.1754
4	2-4	0.2012	0.2032

Table 2. Limit Violation Checking Of State Variables

State variables	limits		ORPD	VSCRPD
	Lower	upper		
Q1	-20	152	1.3422	-1.3269
Q2	-20	61	8.9900	9.8232
Q5	-15	49.92	25.920	26.001
Q8	-10	63.52	38.8200	40.802
Q11	-15	42	2.9300	5.002
Q13	-15	48	8.1025	6.033
V3	0.95	1.05	1.0372	1.0392
V4	0.95	1.05	1.0307	1.0328
V6	0.95	1.05	1.0282	1.0298
V7	0.95	1.05	1.0101	1.0152
V9	0.95	1.05	1.0462	1.0412
V10	0.95	1.05	1.0482	1.0498
V12	0.95	1.05	1.0400	1.0466
V14	0.95	1.05	1.0474	1.0443
V15	0.95	1.05	1.0457	1.0413
V16	0.95	1.05	1.0426	1.0405
V17	0.95	1.05	1.0382	1.0396
V18	0.95	1.05	1.0392	1.0400
V19	0.95	1.05	1.0381	1.0394
V20	0.95	1.05	1.0112	1.0194
V21	0.95	1.05	1.0435	1.0243
V22	0.95	1.05	1.0448	1.0396
V23	0.95	1.05	1.0472	1.0372
V24	0.95	1.05	1.0484	1.0372
V25	0.95	1.05	1.0142	1.0192
V26	0.95	1.05	1.0494	1.0422
V27	0.95	1.05	1.0472	1.0452
V28	0.95	1.05	1.0243	1.0283
V29	0.95	1.05	1.0439	1.0419
V30	0.95	1.05	1.0418	1.0397

Table 3. Comparison of Real Power Loss

Method	Minimum loss
Evolutionary programming[14]	5.0159
Genetic algorithm[15]	4.665
Real coded GA with Lindex as SVSM[16]	4.568
Real coded genetic algorithm[17]	4.5015
Proposed MC-PSO method	4.2301

7. Conclusion

In this paper a novel approach MC-PSO algorithm used to solve optimal reactive power dispatch problem, considering various generator constraints, has been successfully applied.The performance of the proposed algorithm demonstrated through its voltage stability assessment by modal analysis is effective at various instants following system contingencies. Also this method has a good performance for voltage stability Enhancement of large, complex power system networks. The effectiveness of the

ISSN 2304-7712

proposed method is demonstrated on IEEE 30-bus system.

References

[1] *O.Alsac,and B. Scott, "Optimal load flow with steady state security",IEEE Transaction. PAS -1973, pp. 745-751.*

[2] *Lee K Y ,Paru Y M , Oritz J L –A united approach to optimal real and reactive power dispatch , IEEE Transactions on power Apparatus and systems 1985: PAS-104 : 1147-1153*

[3] *A.Monticelli , M .V.F Pereira ,and S. Granville , "Security constrained optimal power flow with post contingency corrective rescheduling" , IEEE Transactions on Power Systems :PWRS-2, No. 1, pp.175-182.,1987.*

[4] *Deeb N ,Shahidehpur S.M ,Linear reactive power optimization in a large power network using the decomposition approach. IEEE Transactions on power system 1990: 5(2) : 428-435*

[5] *E. Hobson ,'Network consrained reactive power control using linear programming, ' IEEE Transactions on power systems PAS -99 (4) ,pp 868-877, 1980*

[6] *K.Y Lee ,Y.M Park , and J.L Oritz, "Fuel –cost optimization for both real and reactive power dispatches" , IEE Proc; 131C,(3), pp.85-93.*

[7] *M.K. Mangoli, and K.Y. Lee, "Optimal real and reactive power control using linear programming" , Electr.Power Syst.Res, Vol.26, pp.1-10,1993.*

[8] *S.R.Paranjothi ,and K.Anburaja, "Optimal power flow using refined genetic algorithm", Electr.Power Compon.Syst , Vol. 30, 1055-1063,2002.*

[9] *D. Devaraj, and B. Yeganarayana, "Genetic algorithm based optimal power flow for security enhancement", IEE proc-Generation.Transmission and. Distribution; 152, 6 November 2005.*

[10] *C.A. Canizares , A.C.Z.de Souza and V.H. Quintana , " Comparison of performance indices for detection of proximity to voltage collapse ,'' vol. 11. no.3 , pp.1441-1450, Aug 1996 .*

[11] *Kennedy JF, Eberhart RC. Particle swarm optimization. In: Proceedings of IEEE international conference on neural networks, Perth, Australia, 1995. p. 1942–48.*

ISSN 2304-7712

[12] Eberhart RC, Kennedy JF. A new optimizer using particle swarm theory. In: Proceedings of international symposium on micro machine and human science, Japan, 1995. p. 39–43.

[13] Goldberg DE. Genetic algorithms in search, optimization, and machine learning. Reading (MA, USA): Addison Wesley; 1989.

[14] Wu Q H, Ma J T. Power system optimal reactive power dispatch using evolutionary programming. IEEE Transactions on power systems 1995; 10(3): 1243-1248 .

[15] S.Durairaj, D.Devaraj, P.S.Kannan ,' Genetic algorithm applications to optimal reactive power dispatch with voltage stability enhancement' , IE(I) Journal-EL Vol 87,September 2006.

[16] D.Devaraj ,' Improved genetic algorithm for multi – objective reactive power dispatch problem' European Transactions on electrical power 2007 ; 17: 569-581.

[17] P. Aruna Jeyanthy and Dr. D. Devaraj "Optimal Reactive Power Dispatch for Voltage Stability Enhancement Using Real Coded Genetic Algorithm" International Journal of Computer and Electrical Engineering, Vol. 2, No. 4, August, 2010 1793-8163.

ISSN 2304-7712

K. Lenin has received his B.E., Degree, electrical and electronics engineering in 1999 from university of madras, Chennai, India and M.E., Degree in power systems in 2000 from Annamalai University, TamilNadu, India. Presently pursuing Ph.D., degree at JNTU, Hyderabad,India.

Bhumanapally. RavindhranathReddy, Born on 3rd September,1969. Got his B.Tech in Electrical & Electronics Engineering from the J.N.T.U. College of Engg., Anantapur in the year 1991. Completed his M.Tech in Energy Systems in IPGSR of J.N.T.University Hyderabad in the year 1997. Obtained his doctoral degree from JNTUA,Anantapur University in the field of Electrical Power Systems. Published 12 Research Papers and presently guiding 6 Ph.D. Scholars. He was specialized in Power Systems, High Voltage Engineering and Control Systems. His research interests include Simulation studies on Transients of different power system equipment.

M. Surya Kalavathi has received her B.Tech. Electrical and Electronics Engineering from SVU, Andhra Pradesh, India and M.Tech, power system operation and control from SVU, Andhra Pradesh, India. she received her Phd. Degree from JNTU, hyderabad and Post doc. From CMU – USA. Currently she is Professor and Head of the electrical and electronics engineering department in JNTU, Hyderabad, India and she has Published 16 Research Papers and presently guiding 5 Ph.D. Scholars. She has specialised in Power Systems, High Voltage Engineering and Control Systems. Her research interests include Simulation studies on Transients of different power system equipment. She has 18 years of experience. She has invited for various lectures in institutes.

ISSN 2304-7712

Dynamic Performance of HVDC Link based 3-level VSC Supplying a Passive Load

Djehaf M,

Zidi S-A, Djilani Kobibi Y

Intelligent Control and Electrical Power System Laboratory
Djillali Liabes University of Sidi Bel-Abbes, Algeria
med_djehaf@yahoo.com, sbzidi@yahoo.fr, youcef_kobibi@yahoo.fr

Abstract — This paper investigates the steady-state and transient performance of high-voltage DC (HVDC) transmission systems connected to passive network. The VSC HVDC tie employing PWM may well represent the ultimate FACTS device. Besides controlling the through power flow, it can supply reactive power and provide independent dynamic control at its two terminals. The control systems for rectifier and inverter are discussed in DC (HVDC) transmission systems based on three-level voltage source converters. The study involves analysis of active-reactive power capabilities (P-Q envelope) including active power flow and provision of voltage support to AC networks. The transient performance is explored by examining the VSC_HVDC response to external AC faults. Finally, the models and results are presented and tested by simulations using Matlab Simulink and its toolbox SimPowerSystems.

Keywords- HVDC, Voltage source converter (VSC), IGBT, SPWM, Control design, passive load

Introduction

With the scale of the new energy utilization enlarging, and the power requirements of offshore drilling platforms, isolated island, and other passive load, the traditional ac/dc transmission technology becomes diseconomical and environmental pollution.

VSC-HVDC system is a new generation of HVDC technology based on pulse width modulation and voltage source converter (VSC), the modern high-power power electronic technology applied in the power system. Comparing with traditional HVDC based on phase control converter (PCC), control method of VSC-HVDC system is flexible, and has no failure of commutation, small harmonic content, without capacity requirements about terminal power system, the reactive power of system could be controlled. The economic capacity of VSC-HVDC system extends from several megawatts to hundreds of megawatts [1]. There are seven VSCHVDC system put into operation abroad[8-10].

ISSN 2304-7712

The introduction of pulse width modulated voltage source converter technology into high-voltage DC (HVDC) transmission systems has increased their viability in many applications in terms of cost and performance [5]. The main benefits of VSC-HVDC over the classic LCC-HVDC are [4]- [12]:

• Converter inherent reactive power capability (resulting in smaller converter size and reduced filtering requirements.

• Independent control of active and reactive power (allowing the converters to provide damping, frequency and voltage support to AC networks without compromising system performance).

• Black start capability (extending the use of HVDC systems for connection of weak AC networks with no generation).

• Power reversal is achieved instantaneously and without the need to reverse the DC link voltage polarity. This allows the use of inexpensive cable and transformers with lower insulation requirements, as they are not required to withstand high voltage stresses during power reversal.

• Fault ride-through capability, improves transient stability of the ac networks.

The objective of this paper is to study the operational performance of VSC_HVDC supplying power to passive network and its control strategies. The vector control method is studied using 3-level VSC connected to an active AC system at the first end & passive load at the second end of the HVDC link. Finally, simulations and results are presented by means of Matlab Toolbox Simpower System. This simulation presents the controller performance in the operation range against some steps change in the load and shows the control of active and reactive power. Following that typical operating contingency scenarios are simulated in order to evaluate transient performance. The simulation results confirm that the control strategy has fast response and strong stability.

VSC-HVDC TRANSMISSION MODEL

Basic principle

The HVDC system is modeled as a conventional bi-polar transmission system. Two series connected DC capacitors of same size are employed across the DC transmission line with grounded midpoint for VSC operation, to reduce the ripples in DC voltage. A smoothing reactor is also connected in series with transmission line for reducing the ripple in DC current. During failure or scheduled maintenance of one pole of transmission line, a reduced amount of power can still be transmitted by other pole.

Fundamental Of Vsc-Hvdc Transmission

The fundamentals of VSC transmission operation may be explained by considering the terminal as a voltage source connected to the AC transmission network via a three-phase reactor. Changing the fundamental frequency voltage phase angle across the series reactor controls the power; whereas, changing the fundamental frequency

ISSN 2304-7712

voltage magnitude across the series reactor controls the reactive power. The main circuit structure of VSC - HVDC transmission system supplying power to passive network is shown in Figure 1 [4-6] [13].

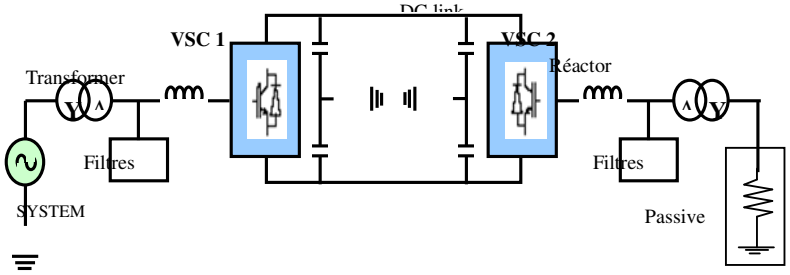


Fig 1: Basic VSC-HVD transmission Supplying a Passive Load

Fig. 2 shows a phasor diagram for the VSC converter connected to an AC network via a transformer inductance. The fundamental voltage on the valve side of the converter transformer, i.e. $U_{V(1)}$, is proportional to the DC voltage has been expressed in equation (1):

$$U_{V(1)} = k_u \cdot U_d \qquad (1)$$

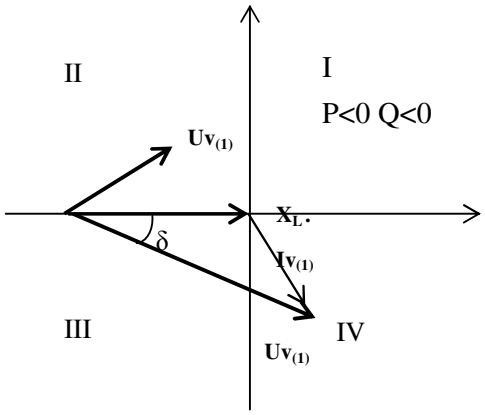


Fig 2: Phasor diagram of VSC and direction of power

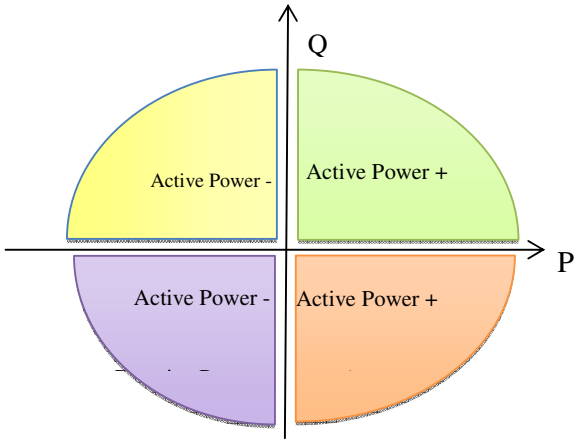
The quantity k_u can be controlled by applying additional number of commutation per cycle, i.e. applying pulse with modulation (PWM). Using the definition of the apparent power and neglecting the resistance of the transformer results in the following equations for the active and reactive power:

$$P = U_d \cdot I_d = \frac{U_L \cdot U_{V(1)}}{X_L} \sin \delta \qquad (2)$$

$$Q = \frac{U_L \cdot (U_L - U_{V(1)} \cdot \cos \delta)}{X_L} \quad (3)$$

The active power and reactive power exchanged by VSC-HVDC and AC system can be adjusted promptly by change the magnitude and angle of the output AC voltage of the VSC-HVDC. This characteristic of VSC-HVDC makes itself more flexible than other FACTS technology, such as SVC, STATCOM, also than traditional HVDC. By means of Phase Width Modulation (PWM) technology, especially Sinusoidal PWM (SPWM), two degrees of freedom, i.e. phase and amplitude can be acquired. Phase and Amplitude Control (PAC) technology is developed for VSC-HVDC applications [6,7]. The VSC can easily interchange active and reactive power with an AC network as well as a synchronous machine.

But the extent of the active power and reactive power which can be adjusted in VSC-HVDC is subject to the rate power limit and the operation condition of the time. The adjusting ability of the active power and that of the reactive power influence each other dynamically. So it is necessarily to analyze the ability in real time. Figure 3 shows a typical P-Q diagram for a VSC based transmission system expressed in per unit [1][3].



Green = active power delivery and reactive power delivery

Orange = active power delivery and reactive power receipt

Fig 3: P-Q characteristics of a VSC-HVDC system

$$P^2 + \left(Q - \frac{U_L^2}{X_L}\right)^2 = \left(\frac{U_L \cdot U_{V(1)}}{X_L}\right)^2 \quad (4)$$

If the output voltage of the converter $U_{V(1)}$ is reduced, e.i by using PWM, supply of any active and reactive power within the circle is possible.

Control strategy

Generallythe control strategy of a two terminal VSC-HVDC transmission line is to keep one terminal DC voltage constant as operation point, and adjust the other terminal DC current or active power order. The AC voltage or the reactive power of the two terminals can be controlled.

Fig. 4 shows an overview diagram of the VSC control system and its interface with the main circuit [6] [11]. The converter 1 and converter 2 controller designs are identical. The two controllers are independent with no communication between them. Each converter has two degrees of freedom. In our case, these are used to control:

I. P and Q in station 1 (rectifier)

II. U_d and Q in station 2 (inverter).

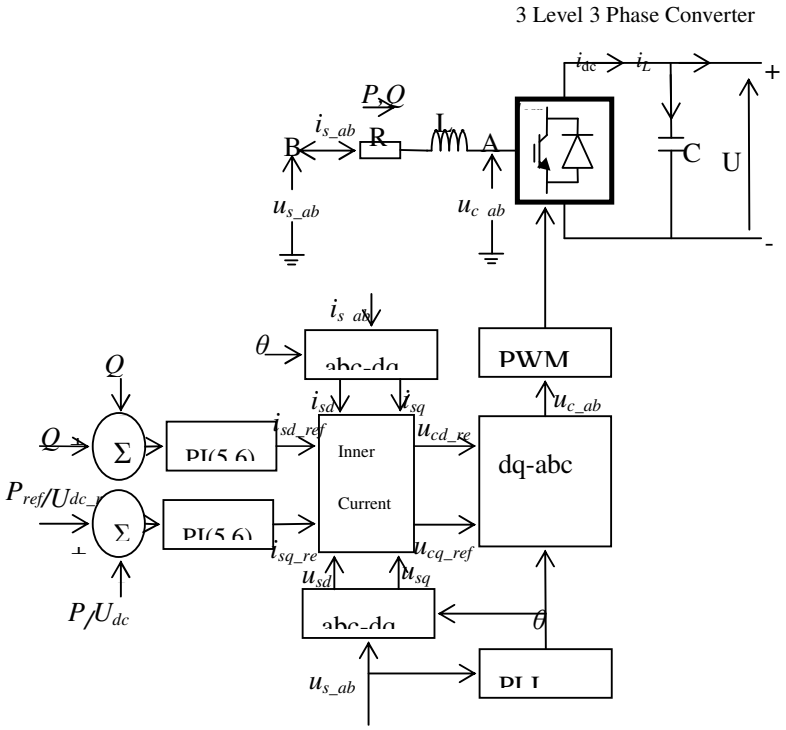


Fig 4: Overview diagram of the VSC control system

A. Phase locked loop

The phase locked loop (PLL) shown in fig.5 is used to synchronize the converter control with the line voltage and also to compute the transformation angle used in the d-q transformation. The PLL block measures the system frequency and provides the phase synchronous angle Θ for the d-q transformations block. In steady state, sin (Θ) is in phase with the fundamental (positive sequence) of the α component and phase A of the point of common coupling voltage (Uabc).

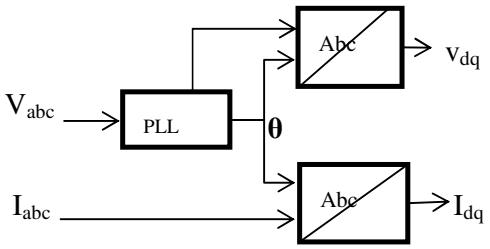


Fig 5: Phase locked loop block

B. Outer active and reactive power and voltage loop

The active power or the DC voltage is controlled by the control of δ and the reactive power is controlled by the control of the modulation index (*m*). The instantaneous real and imaginary power of the inverter on the valve side can be expressed in terms of the *dq*component of the current and the voltage on the valve sideas follows:

$$p = \frac{3}{2} \cdot \mathrm{Re}(\bar{u}_f^{dq} \cdot \bar{i}_v^{*dq}) = \frac{3}{2} \cdot (u_{fd} \cdot i_{vd} + u_{fq} \cdot i_{vq}) \quad (5)$$

$$q = \frac{3}{2} \cdot \mathrm{Im}(\bar{u}_f^{dq} \cdot \bar{i}_v^{*dq}) = \frac{3}{2} \cdot (-u_{fd} \cdot i_{vq} + u_{fq} \cdot i_{vd}) \quad (6)$$

If the reference of the *dq*-frame is selected such that the quadrature component of the voltage is being very small and negligible ($u_{Lq} \approx 0$) then the equations (5) and (6) indicate that the active and the reactive power are proportional to the *d* and *q* component of the current respectively. Accordingly, it is possible to control the active power (or the DC voltage or the DC current) and the reactive power (or the AC bus voltage) by control of the current components i_{vd} and i_{vq} respectively. The active and reactive power and voltage loop contains the outer loop regulators that calculate the reference value of the converter current vector (I^*_{dq}) which is the input to the inner current loop [2].

C. Inner current loop

The AC Current Control block tracks the current reference vector ("d" and "q" components) with a feed forward scheme to achieve a fast control of the current at load changes and disturbances (e.g., so short-circuit faults do not exceed the references) [3] [5] [6]. In essence, it consist of knowing the U_dq vector voltages and computing what the converter voltages have to be, by adding the voltage drops due to the currents across the impedance between the U and the PWM-VSC voltages. The state equations representing the dynamics of the VSC currents are used (an approximation is made by neglecting the AC filters). The "d" and "q" components are decoupled to obtain two independent first-order plant models. A proportional integral (PI) feedback of the converter current is used to reduce the error to zero in steady state. The output of the AC Current Control block is the unlimited reference voltage vector

Vref_dq_tmp.

D. DC voltage balance control

The difference between the DC side voltages (positive and negative) are controlled to keep the DC side of the three level bridge balanced (i.e., equal pole voltages) in steady-state. Small deviations between the pole voltages may occur at changes of active/reactive converter current or due to nonlinearity on lack of precision in the execution of the pulse width modulated bridge voltage. Furthermore, deviations between the pole voltages may be due to inherent unbalance in the circuit components impedance.

MODEL PERFORMANCE ANALYSIS

The dynamic performance of the transmission system is verified by simulating the:

A. VSC_HVDC response to external AC fault at the rectifier side (source).

B. VSC_HVDC response to external AC faults at the inverter side (load) & the dc line.

1. Case 1

A single phase to ground fault was first applied at t = 2.8s during 0.1s (5 cycles) at station 1(figure 6) AC bus in order to investigate the behaviour of VSC-HVDC during unbalanced faults. Fig.7 presents the simulations results. From the simulation, it can be noted that before a single phase to ground fault at station 1, the active power flow is kept constant, transmitted from converter 1 to converter 2. These fault cause transients on the active and reactive power. However, the DC voltage and the active & reactive powers P2 and Q2 at VSC 2 don't change.

2. Case 2

A single phase to ground fault was first applied at t = 1.2s during 0.1s (5 cycles) at station 2(figure 7) AC bus in order to investigate the behaviour of VSC-HVDC during unbalanced faults. A second perturbation follows. A fault to ground is applied at the dc line (figure 7) at t = 2.1 s and is cleared at 5 cycles after the fault, i.e., at t = 2.2 s. Fig.7 presents the simulations results.

ISSN 2304-7712

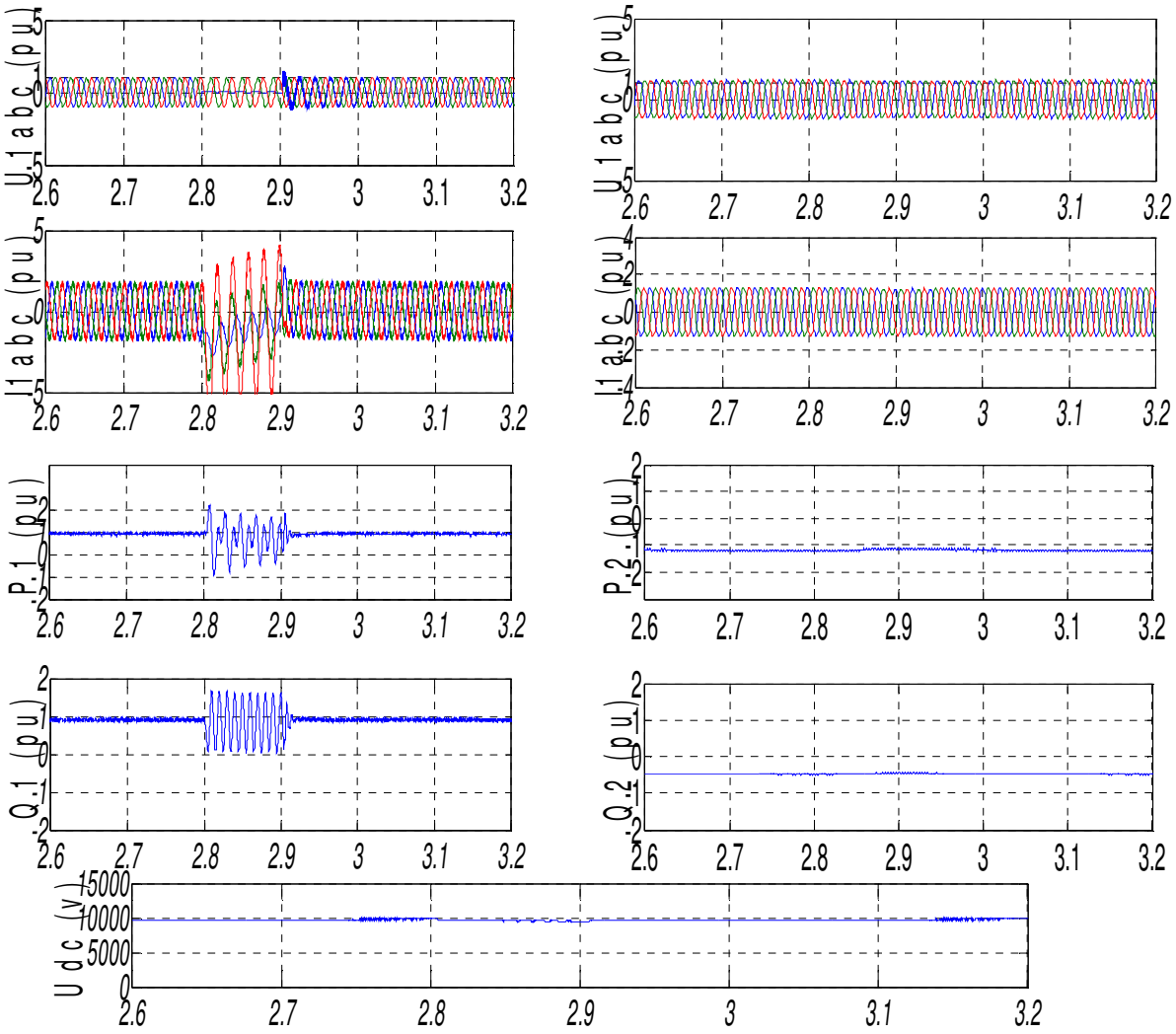


Fig 6: AC side perturbations at the rectifier side (source)

From the simulation, it can be noted that before a single phase to ground fault at station 2, the active power flow is kept constant, transmitted from converter 1 to converter 2, and is kept constant during the fault.

The DC voltage drops and it contains an oscillation during the fault. Consequently the transferred DC power contains also the oscillation. During the station 1 side fault the transmitted power can be kept constant except a small oscillation during the fault. All oscillations in voltages and currents at both systems, means that the phase voltages and currents at both systems are unbalanced. Note that during the three-phase fault, the transmitted DC power is almost zero. At this moment the two VSC stations can be considered as independent STATCOM. The system recovers well after the fault within 50 ms.

During the severe single phase to ground fault at station 2 at t = 2.1s, the DC voltage is decreased to 0.7 pu during the fault and recovers fast and successfully to 1.0 pu voltage after clearing the fault. The transmitted power flow is reduced to low value during the fault and recovers after the fault.

ISSN 2304-7712

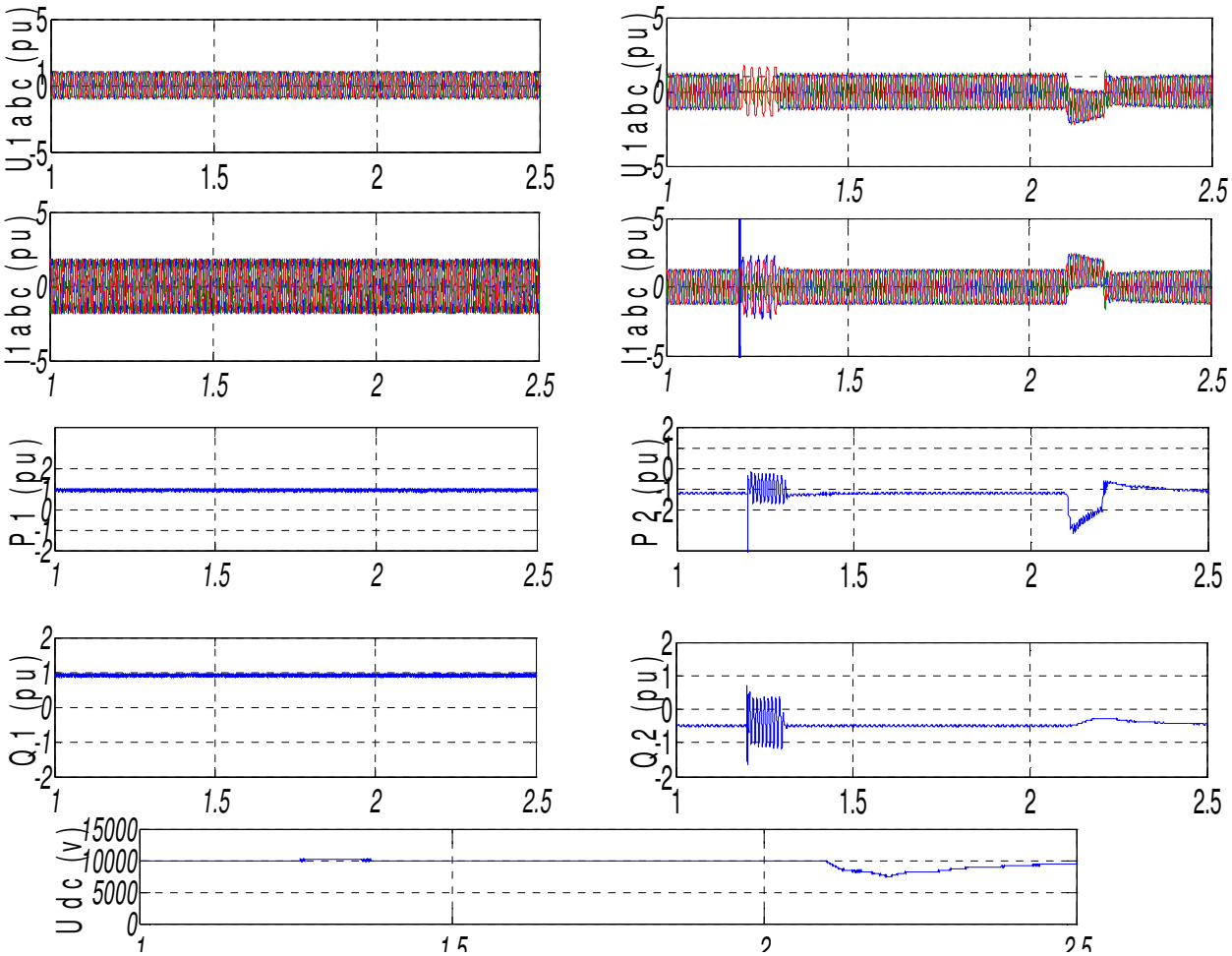


Fig 7: AC side perturbations at the rectifier side (load) & DC line

It takes about 50 ms to recover the steady state before the next perturbation initiation. The DC voltage, which can be controlled to 1.0 pu during the fault, has some oscillations at the beginning of the fault and at clearing the fault.

Conclusion

In this paper, we have presented the steady-state and dynamic performances of VSC_HVDC transmission system supplying power to passive network during unbalanced faults. In all cases the proposed control strategy has been shown to provide fast and satisfactory dynamic responses of the proposed system. From the simulation, it can be obtained that the VSC-HVDC can fulfill fast and flexible power transfers. It can be obtained also that during a single-phase fault the transmitted power can be kept constant except a small oscillation during the fault.

The system advantages of deploying a VSC HVDC transmission system Tie with standby dynamic voltage control during network contingencies with it VSC-HVDC technology can make passive network voltage more stably,

ISSN 2304-7712

and have the same affection as the STATCOM, in a certain extent; it improves the system voltage stable.

Nomenclature

U_L = the sinusoidal AC voltage in the AC network

U_f = AC voltage in the AC network at the filter-bus

$U_{V(1)}$ = the fundamental line to line voltage (valve side)

X_L = the leakage reactance of the transformer

δ = phase shift between U_L and $U_{V(1)}$

I_V = source current

L, R = phase reactor inductance and resistance

C = DC side capacitance

ω = source voltage angular frequency

P, Q = AC active, reactive power inputs

U_d, I_d, P_d = DC side voltage, current, power

α, β = stationary α -β axis

d, q = synchronous$d$ -q axis

p, n = positive, negative components

$_*$,ref = reference value for controller

IV. APPENDIX

Station 1(Rectifier side)	110kV(80°), 2000 MVA, SCR = 10, L_1 = 31.02 mH, R = 0.003 Ω , L_2 = 33.6 mH. f = 50 Hz
Station 2(Passiveload)	10kV(80°),P= 20 MW, Q_L= 12.5 MVAR , f = 50Hz
Transformer	Yg/Δ, 110kV/10kV, 200 MVA, 15%
Main DC capacitor	70 μF
DC Cables	50 Km×2 (R=0.015 Ω /km, L = 0.792 mH/km, C = 14.4 μF/km
Switching frequency	1350 Hz

References

[1] Ruihua, Song, Chao, Zheng, Ruomei, Li, Xiaoxin, Zhou" VSCs based HVDC and its control strategy", IEEE/PES Transmission and Distribution Conference & Exhibition: Asia and Pacific Dalian, China, 2005.

ISSN 2304-7712

[2] D. Madhan Mohan, Bhim Singh and B. K. Panigrahi" A New Control Strategy for Active and Reactive Power Control of Three-Level VSC Based HVDC System", Annual IEEE India Conference (INDICON), 2010.

[3] G.P. Adam, O. Anaya-Lara and G. Burt" Steady-state and Transient Performance of DC Transmission Systems Based on HVDC Technology" , AC and DC Power Transmission,. ACDC. 9th IET International Conference ,2010.

[4] Gengyin Li, Ming Yin, Ming Zhou, Chengyong Zhao,"Modeling of VSC-HVDC and Control Strategies for Supplying both Active and Passive Systems", IEEE Power Engineering Society General Meeting, 2006.

[5] ChathuraJeevanthaPatabandiMaddumage" Co-Simulation of Back-to-Back VSC Transmission System", A Master thesis submitted to the Faculty of Graduate Studies at the University of Manitoba, 2011.

[6] Weimers, L. "HVDC Light: A New Technology for a Better Environment" IEEE Power Engineering Review, Vol 18, Issue 8, Aug. 1998. pp: 19 – 20.

[7] Schettler, F.; Huang, H.; Christl, N. "HVDC transmission systems using voltage sourced converters design and applications" IEEE Power Engineering Society Summer Meeting. Vol 2, 2000 pp: 715 – 720.

[8] Asplund, G. **"**Application of HVDC Light to power system enhancement"IEEE Power Engineering Society Winter Meeting. Vol 4, 2000 Page(s):2498 – 2503

[9] Weimers, L. **"**New markets need new technology" International Conference on Power System Technology, PowerCon 2000. Vol 2, 2000 pp: 873 – 877.

[10] Smith D, "Cross Sound HVDC Link Extends IGBT Power", Modern Power Systems – Transmission & Distribution, October 2000. pp: 31-36.

[11] Lindberg, A.; Larsson, T. "PWM and Control of Three Level Voltage Source Converters in an Hvdc Back-to-back Station" Sixth International Conference on AC and DC Power Transmission, 29 Apr-3 May 1996. pp: 297 – 302

[12] Lie Xu; Andersen B.R.; Cartwright P. "Control of VSC transmission systems under unbalanced network conditions" Transmission and Distribution Conference and Exposition, 2003 IEEE PES Vol 2, Issue , 7-12 Sept. 2003 pp: 626 – 632

[13] Liang Hai-feng, Li Geng-yin, Li Guang-kai, Zhang Kai, Zhou Ming simulation study of VSC-HVDC system connected to passive network, Power system technology, vol. 29, pp. 45-50, April 2005.

ISSN 2304-7712

Modelling a UPFC for the Study of Power System Steady state and Transient Characteristics

Djilani Kobibi Y.I,
Hadjeri Samir,
Djehaf Mohamed

Intelligent Control and Electrical Power System Laboratory

Djillali Liabes University of Sidi Bel-Abbes, Algeria

youcef_kobibi@yahoo.fr, shadjeri2@yahoo.fr, med_djehaf@yahoo.com

Abstract—The maintenance and reliability of the power system has become a major aspect of study. The encouragement to the construction of HV lines, the amount of power transmission/km on HV line and the amount of power transaction as seen from economic side is much responsible for concern towards congestion in power system. The solution is the use of FACTS devices especially the use of UPFC. In this paper the study of UPFC with its various modes of operation is understood. Second, the operation of control system used in its converters is also studied. Finally Using the UPFC simulation model established in SIMULINK, a dynamic simulation tool in MATLAB, take a simple power system with UPFC as an example. The simulation test has been conducted on a simple system composed of synchronous generator and infinite capacity bus, the steady state and transient characteristics of UPFC in this system are researched.

Index Terms— FACTS, Power flow control, UPFC, Newton- Raphson, dynamic characteristics.

- **Introduction**

With the major restructuring of the electricity industry, especially the newly development of electrical network towards "smart strong grid", power transmission systems are being required to increase available transfer capability and to become a higher controllability, reliability and stability. [1]

ONE of the most promising network controllers for the bulk power system is the family of power electronics-based controllers, known as "flexible AC transmission systems" (FACTS) devices. FACTS devices work by modifying power flow in individual lines of the power grid, maintaining voltage stability, and damping oscillations. The rapid development of the power electronics industry has made FACTS devices increasingly attractive for utility deployment due to their flexibility and ability to effectively control power system dynamics.

The unified power flow controller, or UPFC, is the most versatile of the FACTS devices. The primary function of the UPFC is to control the transmission line power flow; the secondary functions of the UPFC can be voltage control, transient stability improvement, and oscillation damping.[2]

ISSN 2304-7712

With such a comprehensive control capability, the UPFC make it possible to provide real-time control of power flows within a power system to meet some predefined operating target or optimal operation performance.

Provided no operating limits are violated, the UPFC regulates all three variables simultaneously or any combination of them. From the operational point of view, the UPFC may act as a shunt VAR compensator or as a thyristor controlled series compensator or as a phase-shifter controller. The versatility afforded by the UPFC makes it a prime contender to provide many of the control functions required to solve a wide range of dynamic and steady-state problems encountered in electrical power networks [3]

However, with the adoption of UPFCs in power systems will face new challenges in modeling and solution techniques. So it is imperative to make further in-depth study on model of UPFC during steady and dynamic states. [2]

Transient stability of electric power systems considers the problem of loss of synchronism among synchronous generators caused by unwanted large disturbances. Therefore use of a suitable control strategy for these conditions is of particular importance.

This paper presents the improvement of the steady state and the transient stability of power systems using the most flexible FACTS device, i.e., UPFC.

- Unified Power Flow Controller

- *Characteristics of UPFC*

Line outage, congestion, cascading line tripping, power system stability loss are the major issues where capability and utilization of FACTS are noticed. Representative of the last generation of FACTS devices is the Unified Power Flow Controller (UPFC). The UPFC is a device which can control simultaneously all three parameters of line power flow (line impedance, voltage and phase angle). Such "new" FACTS device combines together the features of two "old" FACTS devices: the Static Synchronous Compensator (STATCOM) and the Static Synchronous Series Compensator (SSSC). In practice, these two devices are two Voltage Source Converters (VSC's) connected respectively in shunt with the transmission line through a shunt transformer and in series with the transmission line through a series transformer, connected to each other by a common dc link including a storage capacitor. The shunt inverter is used for voltage regulation at the point of connection injecting an opportune reactive power flow into the line and to balance the real power flow exchanged between the series converter and the transmission line. The series converter can be used to control the real and reactive line power flow inserting an opportune voltage with controllable magnitude and phase in series with the transmission line. Thereby, the UPFC can fulfill functions of reactive shunt compensation, active and reactive series compensation and phase shifting. Besides, the UPFC allows a secondary but important function such as stability control to suppress power system oscillations improving the transient stability of power system. As the need for flexible and fast power flow controllers, such as the UPFC, is expected to grow in the future due to the changes in the electricity markets, there is a corresponding need for reliable and realistic models of these controllers to investigate the impact of them on the performance of the power system. [11]

- *Operation of UPFC*

The basic operation principle diagram of the UPFC is shown in Fig. 1. which is already described in open literature [4]-[5].

ISSN 2304-7712

The basic components of the UPFC are two voltage source converters (VSCs) sharing a common dc storage capacitor [6], and connected to the power system through coupling transformers. One VSI is connected to in shunt to the transmission system via a shunt transformer, while the other one is connected in series through a series transformer.

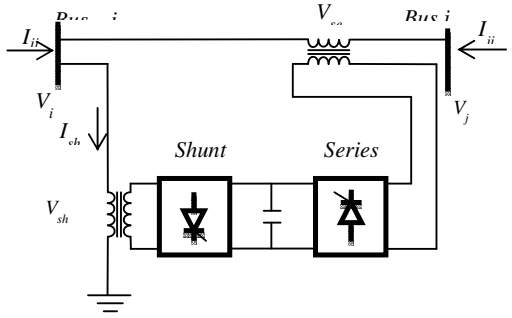


Fig. 1. UPFC model

The series converter is controlled to inject a symmetrical three phase voltage system (Vse), of controllable magnitude and phase angle in series with the line to control active and reactive power flows on the transmission line. So, this converter will exchange active and reactive power with the line. The reactive power is electronically provided by the series converter, and the active power is transmitted to the DC terminals. The shunt converter is operated in such a way as to demand this DC terminal power (positive or negative) from the line keeping the voltage across the storage capacitor V_{dc} constant. So, the net real power absorbed from the line by the UPFC is equal only to the losses of the converters and their transformers. The remaining capacity of the shunt converter can be used to exchange reactive power with the line so to provide a voltage regulation at the connection point. The two VSC's can work independently of each other by separating the dc side. So in that case, the shunt converter is operating as a STATCOM (Static Synchronous Compensators) that generates or absorbs reactive power to regulate the voltage magnitude at the connection point. Instead, the series converter is operating as SSSC (Static Synchronous series compensators) that generates or absorbs reactive power to regulate the current flow, and hence the power flows on the transmission line.

- *Operating Modes of UPFC*

The UPFC has many possible operating modes. In particular, the shunt inverter is operating in such a way to inject a controllable current, into the transmission line. This current consists of two components with respect to the line voltage: the real or direct component, which is in phase or in opposite phase with the line voltage, and the reactive or quadrature component, which is in quadrature. The direct component is automatically determined by the requirement to balance the real power of the series inverter. The quadrature component, instead, can be independently set to any desired reference level (inductive or capacitive) within the capability of the inverter, to absorb or generate respectively reactive power from the line. The shunt inverter can be controlled in two different modes:

- *VAR Control Mode:* The reference input is an inductive or capacitive VAR request. The shunt inverter control translates the Var reference into a corresponding shunt current request and adjusts gating of the inverter to establish the desired current. For this mode of control a feedback signal representing the dc bus voltage, V_{dc}, is also required.

- *Automatic Voltage Control Mode:* The shunt inverter reactive current is automatically regulated to maintain the transmission line voltage at the point of connection to a reference value. For this mode of control, voltage feedback signals are obtained from the sending end bus feeding the shunt coupling transformer. The series inverter controls the magnitude and angle of the voltage injected in series with the line to influence the power flow on the line. The actual value of the injected voltage can be obtained in several ways.
- *Direct Voltage Injection Mode:* The reference inputs are directly the magnitude and phase angle of the series voltage.
- *Phase Angle Shifter Emulation mode:* The reference input is phase displacement between the sending end voltage and the receiving end voltage.
- *Line Impedance Emulation mode:* The reference input is an impedance value to insert in series with the line impedance
- *Automatic Power Flow Control Mode:* The reference inputs are values of P and Q to maintain on the transmission line despite system changes.

- UPFC CONTROL SYSTEM

In order to understand the UPFC Control System the phasor diagram in the figure 2and Figure3 given below is system.

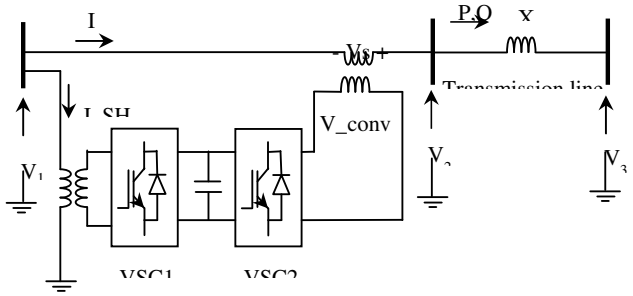


Fig.2 Single-line Diagram of a UPFC

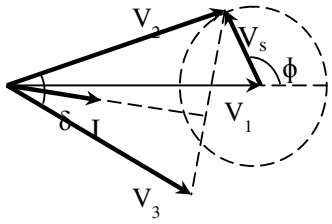


Fig.3 Phasor Diagram of Voltages and Currents[10]

$$P = \frac{V_2 * V_3 * sin\delta}{X} \quad (1)$$

$$Q = \frac{V_2(V_2 - V_3 \cos\delta)}{X} \quad (2)$$

This FACTS topology provides much more flexibility than the SSSC for controlling the line active and reactive power because active power can now be transferred from the shunt converter to the series converter, through the DC bus. Contrary to the SSSC where the injected voltage V_s is constrained to stay in quadrature with line current I, the injected voltage V_s can now

have any angle with respect to line current. If the magnitude of injected voltage V_s is kept constant and if its phase angle with respect to V_1 is varied from 0 to 360 degrees, the locus described by the end of vector V_2 ($V_2=V_1+V_s$) is a circle as shown on the phasor diagram. As is varying, the phase shift δ between voltages V_2 and V_3 at the two line ends also varies. It follows that both the active power P and the reactive power Q transmitted at one line end can be controlled.

The shunt converter operates as a STATCOM. In summary, the shunt converter controls the AC voltage at its terminals and the voltage of the DC bus. It uses a dual voltage regulation loop: an inner current control loop and an outer loop regulating AC and DC voltages.

Control of the series branch is different from the SSSC. In a SSSC the two degrees of freedom of the series converter are used to control the DC voltage and the reactive power. In case of a UPFC the two degrees of freedom are used to control the active power and the reactive power. A simplified block diagram of the series converter is shown below Figure 4.

The series converter can operate either in power flow control (automatic mode) or in manual voltage injection mode. In power control mode, the measured active power and reactive power are compared with reference values to produce P and Q errors. The P error and the Q error are used by two PI regulators to compute respectively the V_q and V_d components of voltage to be synthesized by the VSC. (V_q in quadrature with V_1controls active power and V_d in phase with V_1 controls reactive power).

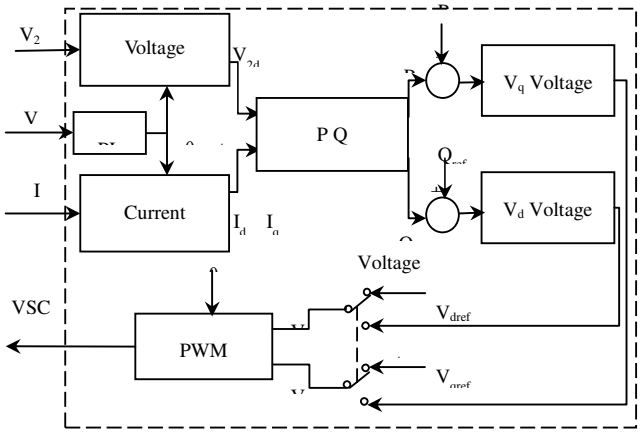


Fig. 4 Simplified Block of the Series Converter Control System[11]

In manual voltage injection mode, regulators are not used. The reference values of injected voltage V_{dref} and V_{qref} are used to synthesize the converter voltage. [9]

- The effect of UPFC on power system

UPFC can achieve the target of control the active and reactive power on transmission line, and the active power PSE exchanged between the series part of UPFC and system must be provide by the parallel part of UPFC which can absorb power from the transmission line.

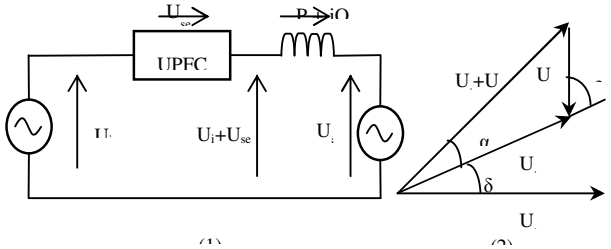


Fig. 5. two-machine system with UPFC (1) equivalent circuit (2) vector relations

From the Fig.5.1, we can see that: the ending power of the line can be expressed as:

(3)

Suppose if the UPFC is installed at the end of transmission line, according to the vector relations, we can get the active and reactive power equations as follows:

$$P = \frac{U_i U_j}{X}\sin\delta + \frac{U_{se} U_j}{X}\sin(\delta + \rho) \quad (4)$$

$$Q = \frac{U_i U_j}{X}(\cos\delta - 1) + \frac{U_{se} U_j}{X}\cos(\delta + \rho) \quad (5)$$

It can be seen from the above equation that when ρ = 90°-δ, transmission line which the UPFC is installed can obtain the greatest power, that is to say, at this point Use has the greatest impact on power flow of the line. make a appropriate transformation of equation (4) and (5),we can obtain the reactive power and active power equation as follows:

$$\left(P - \frac{U_i U_j}{X}\sin\delta\right)^2 + \left[Q - \frac{U_i U_j}{X}(\cos\delta - 1)\right]^2 = \left(\frac{U_{se} U_j}{X}\right)^2 \quad (6)$$

take different values of δ, the reactive power and active power curve that on the terminal of the transmission line is shown in Fig.6

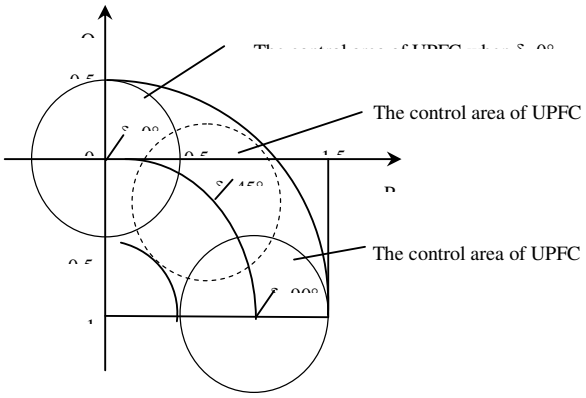


Fig.6. Reactive power and active power curve when δ is different

From the above we can see that UPFC devices can expands the operating range of the transmission system greatly. especially when δ = 90°, transmission system has reached the limit point of stable operation if there is no compensation of UPFC

devices, Operation range of the system is far beyond the original range, and the system can still running stability after the UPFC device inputted in the system. It is important to optimal operation for the system, improve the stability limit of the system and improve system stability margin if appropriate number of UPFC devices are installed in a system.[7]

- System investigated

MATLAB/SIMULINK is multifunctional software for power system simulation, especially for dedicated power electronic system. Compared with PSCAD/EMTDC, It can produce almost identical and consistent results during steady-state and transients situations [8].

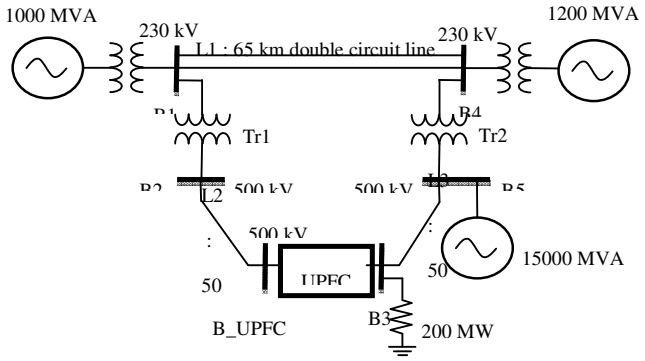


Figure. 7 UPFC installed in a Multimachine system

A UPFC is used to control the power flow in a 500 kV /230 kV transmission system. The system, connected in a loop configuration, consists essentially of five buses (B1 to B5) interconnected through three transmission lines (L1, L2, L3) and two 500 kV/230 kV transformer banks Tr1 and Tr2. Two power plants located on the 230 kV system generate a total of 1500 MW which is transmitted to a 500 kV, 15000 MVA equivalent and to a 200 MW load connected at bus B3. Each plant model includes a speed regulator, an excitation system as well as a power system stabilizer (PSS).

SIMULATION RESULTS :

The UPFC located at the right end of line L2 is used to control the active and reactive powers at the 500 kV bus B3, as well as the voltage at bus B_UPFC. The UPFC consists of two 100 MVA, IGBT-based, converters (one shunt converter and one series converter interconnected through a DC bus). We are considering a contingency case where only two transformers out of three are available (Tr2= 2*400 MVA = 800 MVA).

Case 1: Initially the Bypass breaker is closed and the resulting natural power flow at bus B3 is 587 MW and -27 Mvar. The Pref block is programmed with an initial active power of 5.87 pu corresponding to the natural power flow. Then, at t=3s, Pref is increased by 1 pu (100 MW), from 5.87 pu to 6.87 pu, while Qref is kept constant at -0.27 pu. Then at t=7s Qref change from -0.27 to -0.17 pu, Waveforms are reproduced in figure 8.

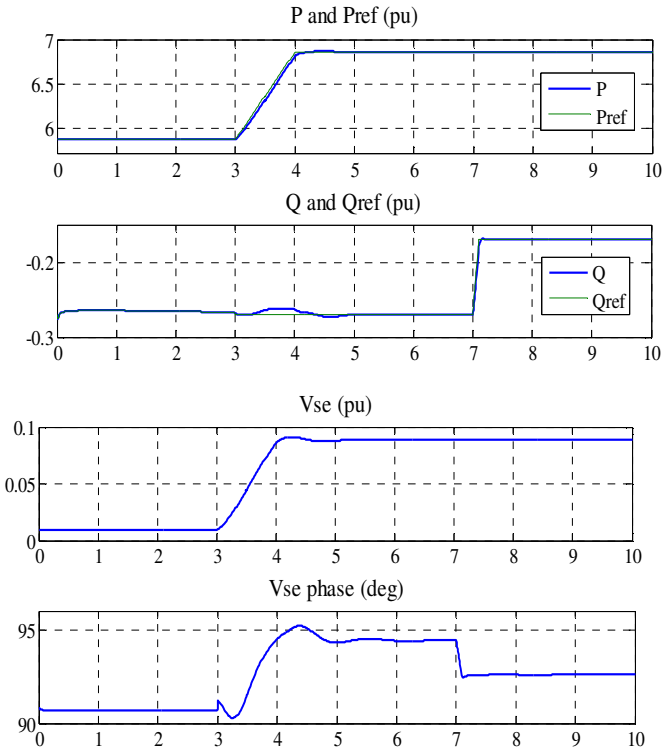


Fig. 8 UPFC dynamic response to a change in reference power

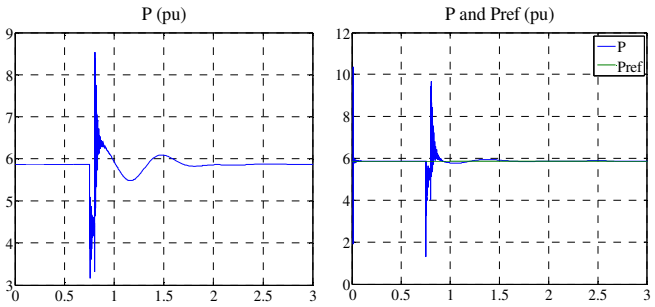
As shown in Figure 8, The load flow when the UPFC is bypassed shows that most of the power generated by plant #2 is transmitted through the 800 MVA transformer bank (899 MW out of 1000 MW) and that 96 MW is circulating in the loop. Transformer Tr2 is therefore overloaded by 99 MVA.0

UPFC can relieve this power congestion. By increasing the power rate of 1 pu, at t=3s without noticeable transient on the reactive power , it takes one second for the power to increase to 687 MW. This 100 MW increase of active power at bus B3 is achieved by injecting a series voltage of 0.089 pu with an angle of 94 degrees. This results in an approximate 100 MW decrease in the active power flowing through Tr2 (from 899 MW to 796 MW), which now carries an acceptable load, and allow a better use of underloaded lines.

At t=7s, Qref change from -0.27 to -0.17, it takes 0.17s, without noticeable transient on the active power , this variation in the reactive power is achieved by keeping the injected voltage at 0.089pu with an angle of 92 degrees.

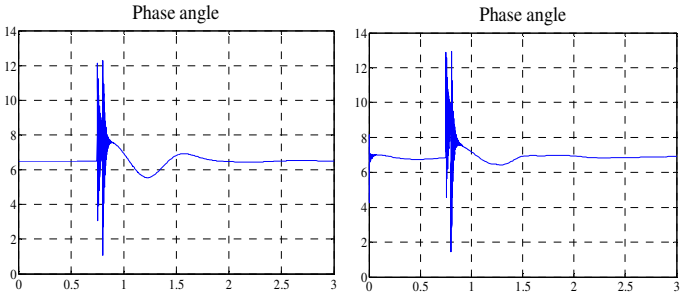
Case 2: Suppose that single phase to ground short circuit fault occurs on the line L3. doing transient simulation on this system, and the simulation time is 3s, during 0.75s to 0.8s, single phase to ground short circuit fault occurs on L3, at 0.8s the fault is removed, then maintain the single-loop operation. Pre-fault system is in normal operation, and the reference as follows: Pref=6.87pu，Qref=-0.27pu，Vref=1.0pu.

ISSN 2304-7712



(a) (b)

Fig.9 active power of the transmission line when UPFC (a) out of service and (b)on service



(a) (b)

Fig.10 the phasor angle when UPFC (a) out of service and (b) on service

Instantaneous short-circuit fault will cause the system power angle oscillation, then causing oscillation on power flow of the line, considering two cases that the UPFC device not installed in and joined in the system, due to the power control of UPFC, system working in single circuit when the fault is removed, active power of single-circuit lines can still tracing the reference value, while the active power is lower than reference value when UPFC is out of working, Fig.9 also descript that the dynamic feature of system is better than the status of UPFC out of service. The system power can restore stability after 0.15s running when the fault removed, active and reactive power of the system still shocking seriously in a long time after the fault removed when UPFC does not work. And at this time the oscillation range of power is greater than the case of UPFC working. So that they all directed that UPFC has a very good improvement on system transient stability, it can enhance the power flow of transmission line and improve the stability of system power.

When the system disturbed, the voltage of access point drops sharply, Fig.11 reveals that, when UPFC is on service, the amplitude of the voltage can give back to the potential faster than UPFC out of services. That is to say, at this time the parallel side of UPFC working as a compensator to maintain the system voltage constant and improve system's stability.

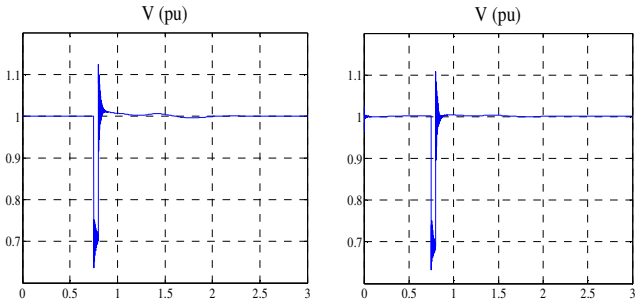


Fig.11 input voltage when UPFC on service and out of service

CONCLUSION :

Modeling the system and studying the results have given an indication that UPFC are very useful when it comes to organize and maintain power system.

UPFC device in the dynamic simulation system, can adjust the distribution the system power flow among the transmission line quickly and smoothly, and have no significant impact to other operating parameters of the system. At the same time, the UPFC can improve system's stability, to keep down the shaking of the line power angle and inhibit the line power flow line oscillation.

REFERENCES

[1] Qiang Tong, Qiang Jiang," A Novel Method of Power Flow Analysis with UPFC Considering Limit Violations of Variable", Projects Sichuan Education Department-Funded, IEEE 2011

[2] Keyou Wang, Mariesa L. Crow, Bruce McMillin and Stan Atcitty," A Novel Real-Time Approach to Unified Power Flow Controller Validation," IEEE TRANSACTIONS ON POWER SYSTEMS, VOL. 25, NO. 4, NOVEMBER 2010

[3] C.R. Fuerte-Esquivel, E.Acha, "Unified power flow controller: a critical comparison of Newton-Raphson UPFC algorithms in power flow studies", IEE Proc.-Gener. Transm. Distrib., Vol. 144, No. 5, September 1997

[4] Song Y.H., Johns A.T: "Flexible AC Transmission Systems (FACTS)", The Institute of Electrical Engineers(IEE) Press, London, U. K, 1999.

[5] Rietman T.R., Edris A.A., Schauder C.D, Torgerson D.R., Williams S.L., "The Unified Power Flow Controller: A New Approach to Power Transmission Control" IEEE Trans on Power Delivery, Vol. IO, No.2, pp.1085-1093, April 1995.

[6] L. Xu and V.G. Agelidis, "Flying Capacitor Multilevel PWM Converter Based UPFC', IEE Proc. Of Electronic Power Application, Vol. 149, No. 4, July 2003.

[7] Yao Shu-jun,Song Xiao-yan, Wang Yan, Yan Yu-xin, Yan Zhi," Research on dynamic characteristics of Unified Power Flow Controller (UPFC)", IEEE 2011

[8] M. O. Faruque, Y. Zhang, and V. Dinavahi, "Detailed modeling of CIGRE HVDC benchmark system using PSCAD/EMTDC and PSB/SIMULINK," IEEE Trans. Power Delivery, vol. 21, pp. 378-387, Jan. 2006.

[9] Vibhor Gupta," Study and Effects of UPFC and its Control System for Power Flow Control and Voltage Injection in a Power System" International Journal of Engineering Science and Technology Vol. 2(7), 2010

[10] Phasor Model of UPFC control, MATLAB v 7.6, 'help'- UPFC for power flow control

[11] Control Block of UPFC - M. Toufan, U.D. Annakkage, "Simulation of The Unified Power Flow Controller Performance Using PSCAD/EMTDC," Electrical Power System Research Vol. 46, 1998, pp 67-75

ISSN 2304-7712