International Journal of Information Technology and Knowledge Management
January-June 2008, Volume 1, No. 1, pp. 85-95

FUZZY LOGIC BASED SYSTEMS FOR PERFORMANCE ANALYSIS AND DECISION MAKING

Manoj Sharma & Rajeshwar Singh

Abstract

With incorrect decision, the efficiency and effectiveness of an organization may degrade therefore decision making for an employee continuance or removal from an organization is a critical issue. There is a need for certain algorithm, tools, techniques etc which can provide precise and accurate information for the performance analysis and decision making. This paper presents a method for performance analysis of faculty members which has given us more precised and accurate results. This analysis is divided into three parts i.e. input fuzzification, rule evaluation and defuzzification. All the steps have been tested on a number of faculty members and the experimental results have demonstrated a fast, robust, and reliable analysis simulation. The faculty performance analysis inputs are taken as "Feedback from students", "Self-development effort", "proficiency in teaching" and "management feedback". The output is obtained in term of "overall performance" of the faculty which is utilized as standard for decision making. The proposed performance analysis technique is simulated using fuzzyTECH 5.7 developed by Inform Software Corporation.

Keyword: Fuzzy Logic (FL), Crisp Value, Decision Making, Faculty Performance Analysis (FPA), Fuzzification and Defuzzification

1. Introduction

Fuzzy Logic control systems Fig. 1 have been reported in wide range of applications that include industrial processes, transportation system, robotics and consumer products.

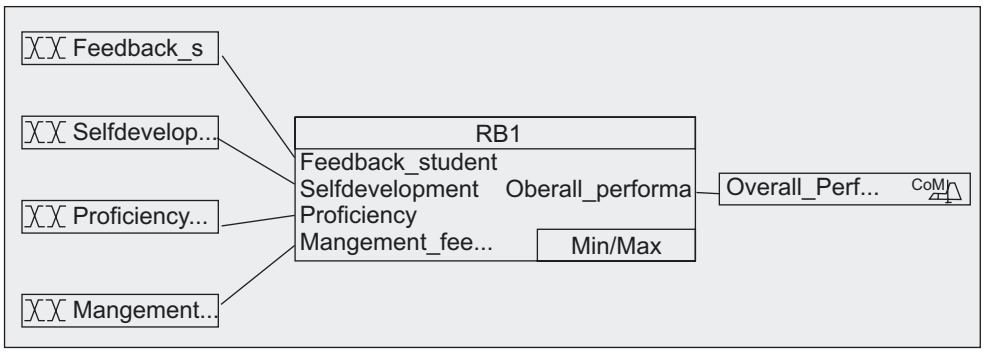

Figure 1: Structure of the Fuzzy Logic System

The concepts of fuzzy logic (FL) was conceived by Lotfi Zadeh, a professor at University of California at Berkley, and presented as a way of processing data by allowing partial set membership rather than crisp set membership or non membership [1].

Professor Zadeh reasoned that people do not require precise, numerical information input, and yet they are capable of highly adoptive control. Fuzzy logic is a problem solving control system methodology that lends itself to implementation in system ranging from simple, small, embedded microcontrollers to large network, multi channel PC or work station based data acquisition and control systems. Fuzzy Systems are used in various fields such as game design [2], scoring method [3], clinical practice guidelines [4], autonomous systems [5] and planning systems [6] and etc. It can be implemented by hardware, software or a combination of both. Fuzzy logic provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy or missing input information. There are a number of factors which affects the performance of a faculty member; however we have considered four important aspects. The fuzzy logic based faculty performance analysis and decision making system is devised on the basis these factors:

(a) Feedback from students.

(b) Self Development effort.

(c) Proficiency in teaching.

(d) Management Feedback.

Each factor is allotted with 20 marks and on the basis of it overall performance of a faculty member is analyzed using fuzzy logic software.

2. PROPOSED FUZZY MODEL

In order to design Fuzzy Logic (FL) system we must describe the operation of system linguistically [7]. Steps in designing FL system in this case are appended below:

(a) Identify the inputs and outputs using linguistic variables.

(b) Assign membership function to the variables (fuzzification).

In our case study we have four input parameters and one output parameter. Membership functions are selected from the list of factors affecting the overall performance of a faculty at teaching institutions.

(c) Build a rule base.

(d) Generate crisp control action (defuzzification).

2.1 Fuzzification

For this analysis we have taken four input parameters which are appended below:

Feedback from Student: This factor is dependent on various aspects, however in this performance analysis we have considered the following four aspects:

(a) Presentation/Communication Skill.

(b) Course content and coverage.

(c) Motivation Skill.

(d) Punctuality and regularity.

Each aspect is assigned with 5 marks with a total of 20 marks.

Self Development Effort: This factor is collection of the following aspects:

(a) Publications (Paper/articles/book/manual).

(b) Research and development/Industrial projects.

(c) Participation (Seminar/Conferences/Workshop etc).

(d) Research guidance to U.G/P.G/Ph.D.

Self Development Effort is having total marks of 20 with 5 marks for each aspect.

Proficiency in Teaching: This factor includes:

(a) Handouts and lecture notes.

(b) Use of teaching aids.

(c) Participation in lab development work.

(d) Effective teaching skill

Total 20 marks are assigned for this factor and each aspect is assigned with 5 marks.

Management Feedback: The decision making depends upon various factors. However, management perception plays a vital role in decision making. Hence it is opined to consider this factor and the following aspects are considered for performance analysis:

(a) Student's performance in university Exam.

(b) Award/Warning appreciation letter etc.

(c) Professional Body Membership.

(d) Availability after working hours.

Total 20 marks are assigned for this factor and each aspect is assigned with 5 marks.

The Input parameters are fuzzified using the pre-defined membership functions shown in Fig. 2, Fig. 3, Fig. 4 and Fig. 5. For four input parameters we have chosen four possibilities in each case.

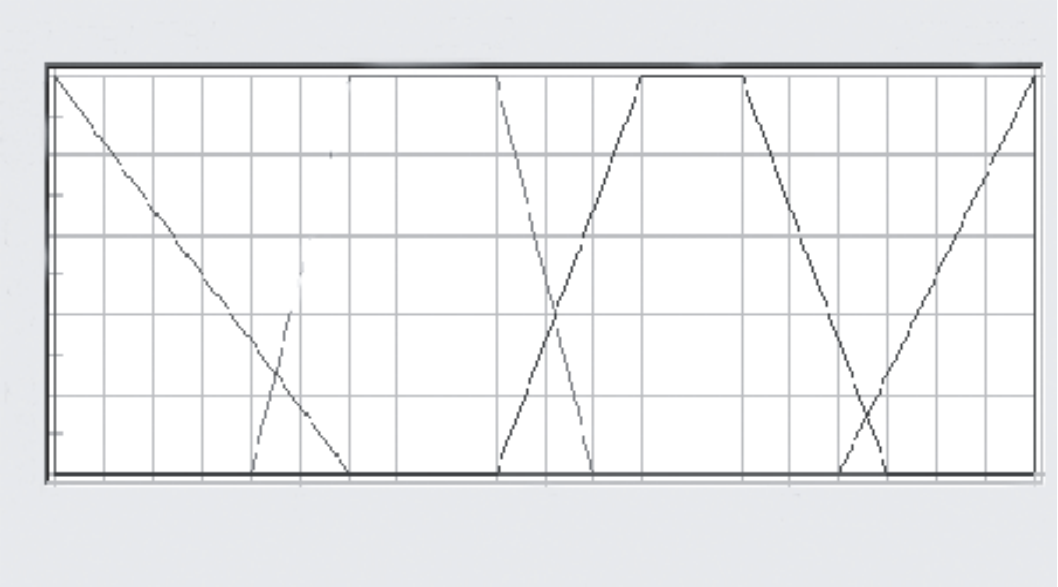

Figure 2: Membership Functions for Input Parameter "Feedback from Students"

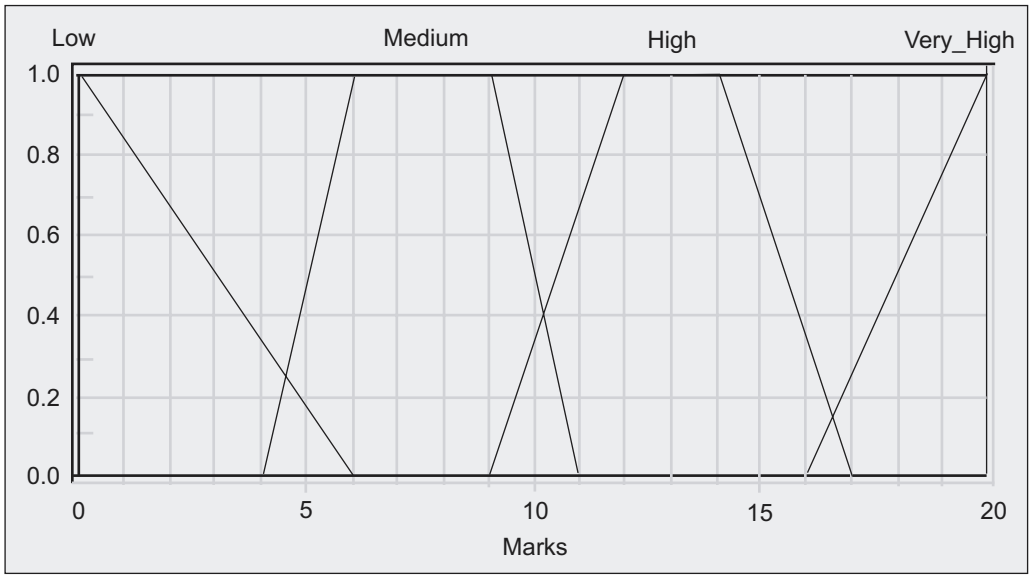

Figure 3: Membership Functions for Input Parameter "Proficiency in Teaching"

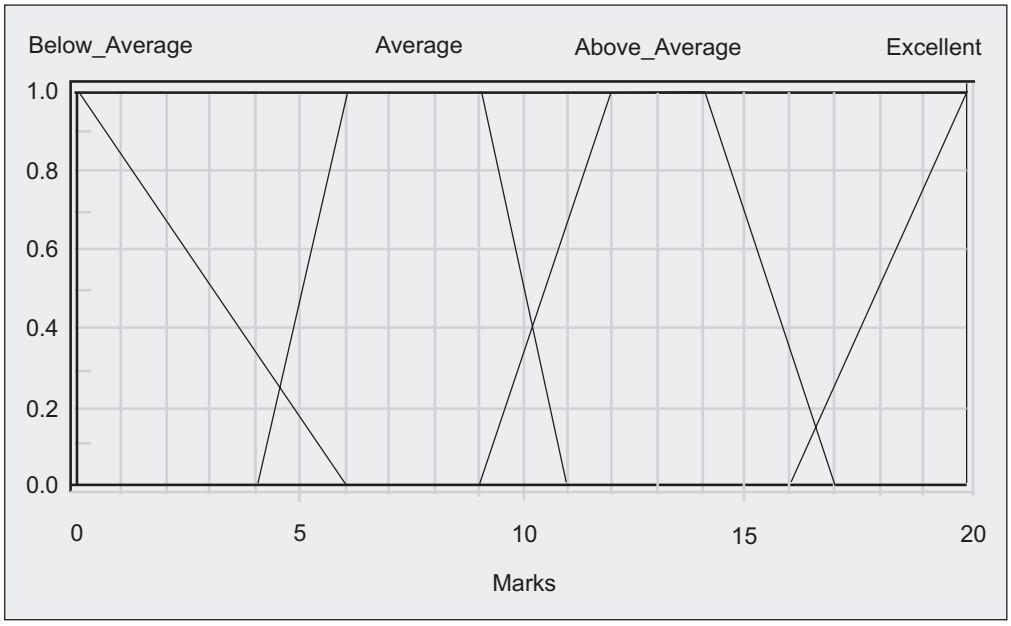

Figure 4: Membership Function for Input Parameter "Self Development Effort"

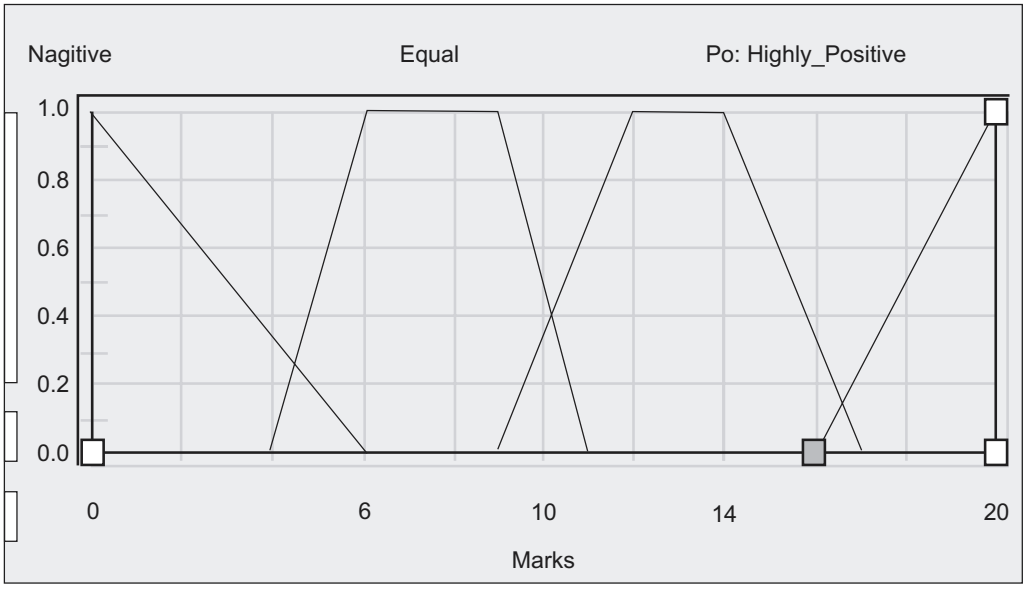

Figure 5: Membership Function for Input Parameter "Management Feedback"

Similarly the output parameter "overall performance" is also fuzzified as shown in Fig. 6.

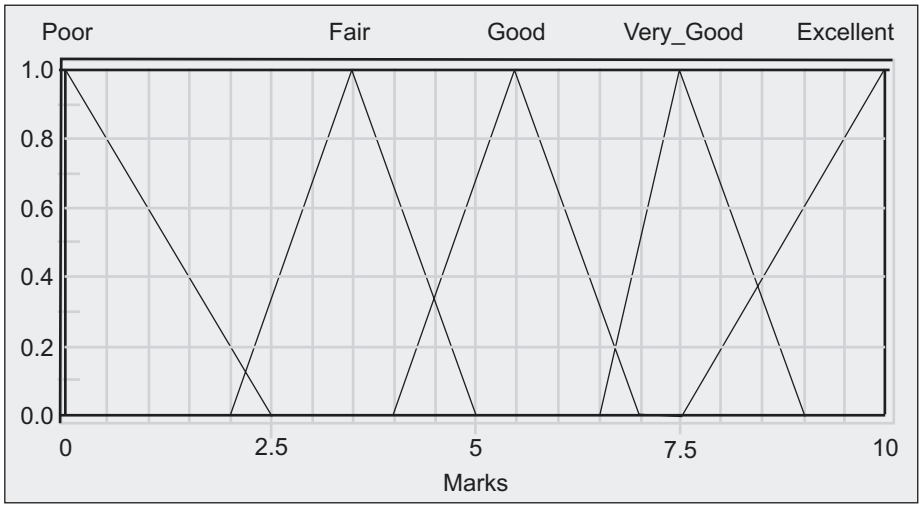

Figure 6: Membership Functions for Output Parameter "Overall Performance"

The output parameter is divided into five categories:

a. Poor
b. Fair
c. Good
d. Very Good
e. Excellent

2.2 Rule Evaluation

These fuzzified input values are used to evaluate rules for obtaining overall performance of faculty member. These rules are placed at Appendix to this paper. For the simulation we have fired 256 rules to find out the performance analysis of faculty members.

2.3 Defuzzification

In this step we calculate the crisp value of the fuzzy system. There are various methods for the method of calculation crisp values; here we have used the centre of maximum (CoM) defuzzification method [8], [9] for simulation of results. The input aggregation is minimum and the output aggregation used is maximum.

3. SIMULATION RESULTS & DISCUSSION

This analysis simulation was programmed using Inform Software Corporation's fuzzyTECH 5.7. Every input was divided into four sets. The simulation results use 256 rules which are placed at Appendix. The summary of results is shown in Table 1.

Table 1
Showing Result of 13 Faculty Members

Faculty Sl No	*Feedback from students*	*Management feedback*	*Proficiency in teaching*	*Self Dev. effort*	*Overall performance*
1	15	10	3	17	5.5
2	7	17	10	5	5.5
3	15	3	5	10	4.29
4	4	5	7	7	2.332
5	19	19	19	19	10
6	5	13	15	5	5
7	17	4	7	12	5.5
8	3	10	7	12	4.5
9	10	10	10	10	5.5414
10	19	2	6	3	3.3
11	7	12	15	18	7.5
12	0	3	7	18	3.3
13	6	5	7	5	2.624

Total 13 input patterns are taken as inputs for 13 faculty members and their corresponding output is evaluated using fuzzy logic system. For example if a faculty member is having a feedback from student is of 4, proficiency in teaching is 7 and self development effort is 7 and management feedback is 5, then the overall performance of faculty member using fuzzy logic is derived out to be 2.332. This gives an indication on scale of 10 that the faculty member is not having satisfactory performance and it helps in removal of faculty from that educational institute / organization. Similarly we have derived the result of 13 faculty members and as per the organizational standard requirement; decisions are taken on continuance or removal of faculty. The performance analysis result is placed at Table-1.

The table shows that the values obtained as overall performance is up to maximum 4 decimal points. This provides a highly précised control for performance analysis. All the factors are equally contributable to the overall performance of a faculty member. The required standard of the organization can be used for decision making on a scale of 10 and if overall performance of faculty is above the required standard then the faculty is to be retained otherwise he or she is to be removed from the organization in order to maintain the efficiency and effectiveness of the organization.

The Real sample was collected by method of direct data collection for 13 faculty members from an Engineering Institution and it was analyzed using fuzzy logic. The performance analysis of the faculty members using fuzzy logic is carried out and the overall performance is defined on the scale of 10.

The surface curve for the four input parameters and one output parameter are shown in Fig 7, 8, 9, 10, 11 and 12.

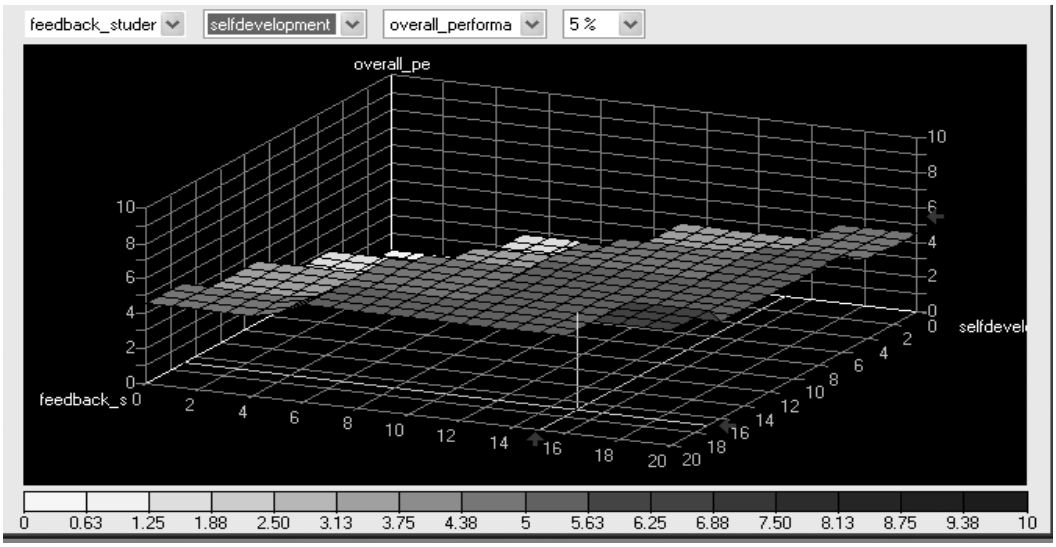

Figure 7: Surface Curve for Input Parameter "Feedback from Students", "Self Development Effort" and Output Parameter "Overall Performance"

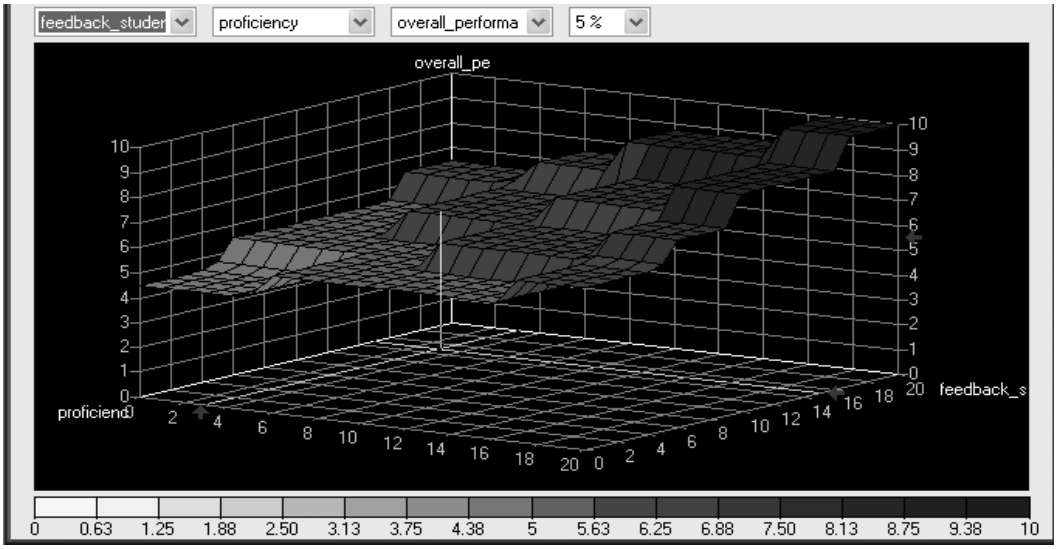

Figure 8: Surface Curve for Input Parameter "Feedback from Students", "Proficiency in Teaching" and Output Parameter "Overall Performance"

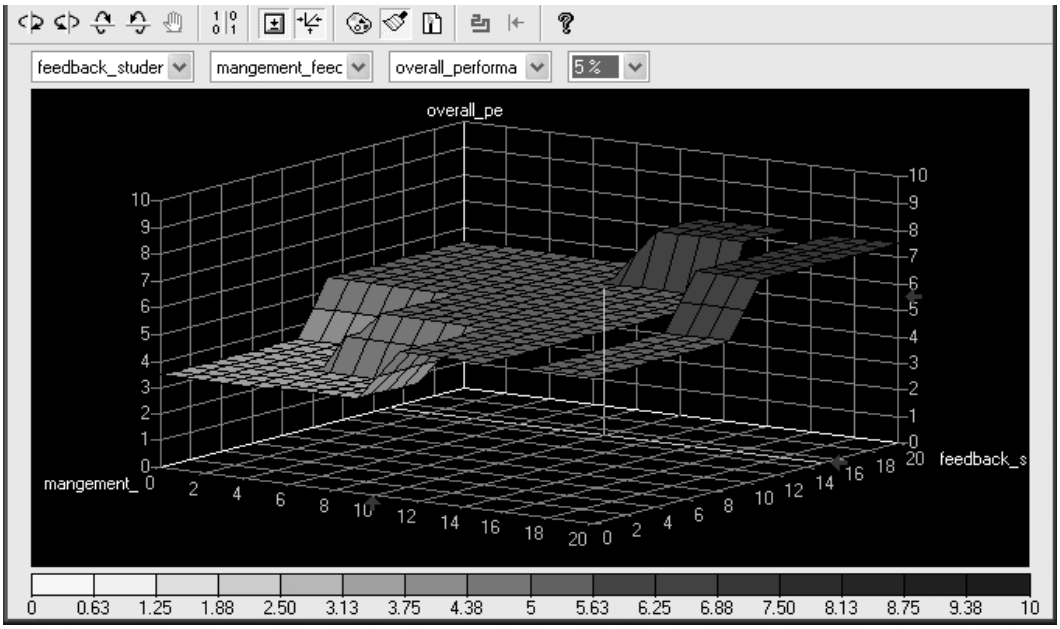

Figure 9: Surface Curve for Input Parameter "Feedback from Students", "Management Feedback" and Output Parameter "Overall Performance"

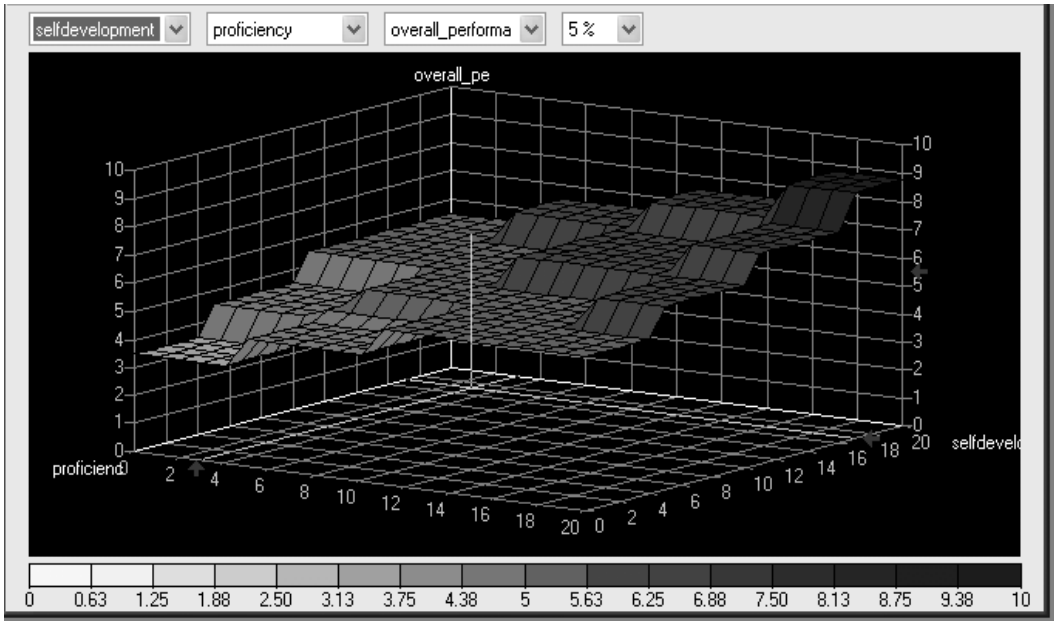

Figure 10: Surface Curve for Input Parameter "Self Development Effort", "Proficiency in Teaching" and Output Parameter "Overall Performance"

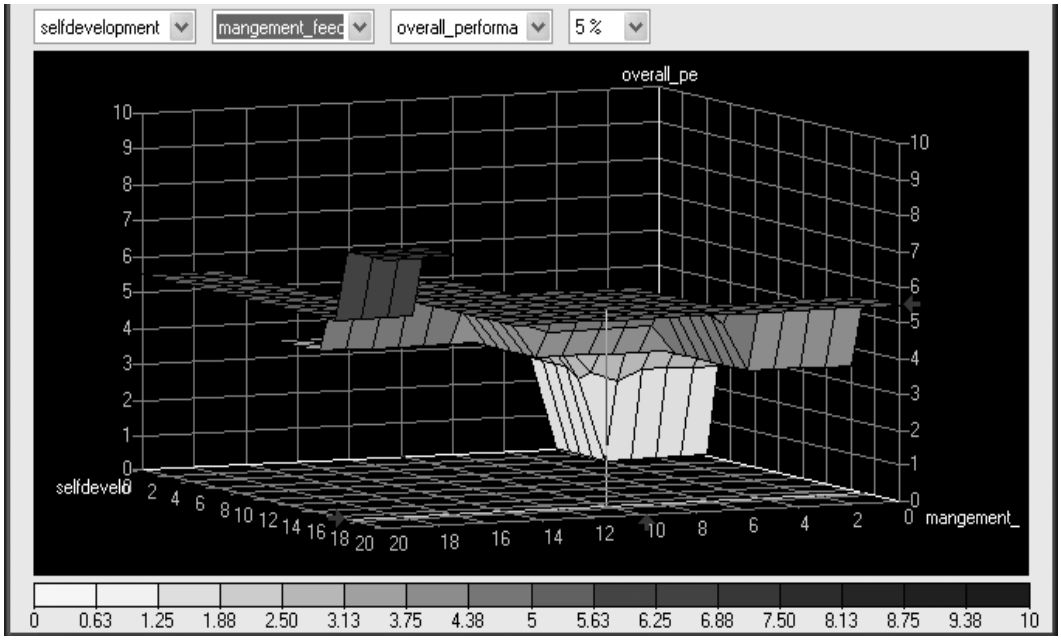

Figure 11: Surface Curve for Input Parameter "Self Development Effort", "Management Feedback" and Output Parameter "Overall Performance"

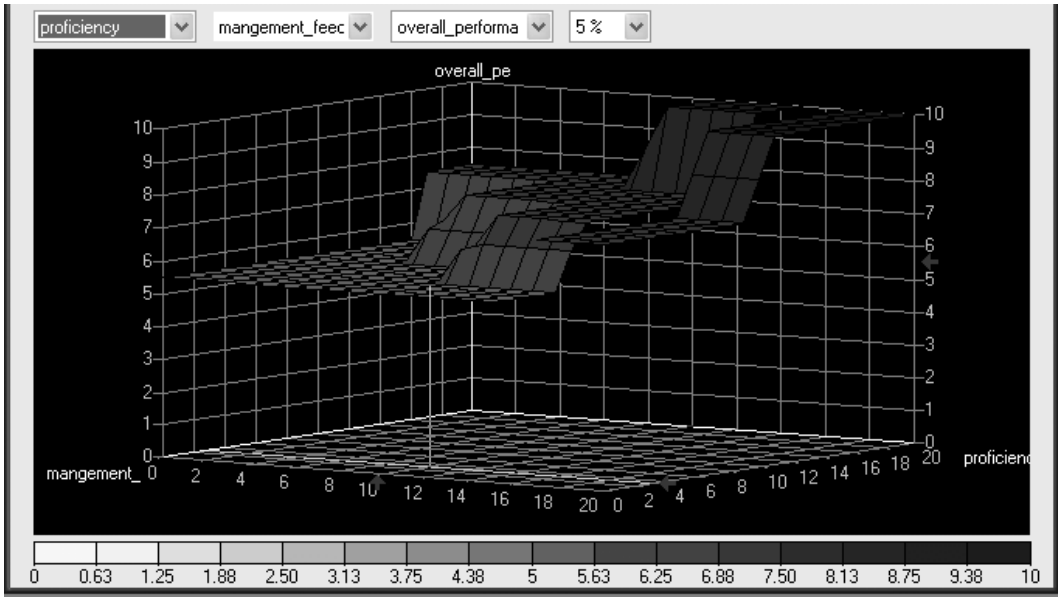

Figure 12: Surface Curve for Input Parameter "Proficiency in Teaching", "Management Feedback" and Output Parameter "Overall Performance"

CONCLUSION

Fuzzy logic is a problem solving control system methodology that lends itself to implementation in system ranging from simple, small, embedded microcontrollers to large network, multi channel PC or work station based data acquisition and control systems. In this paper, overall performance analysis of 13 faculty members of an Engineering Institution is taken as sample. The overall performances of the faculty members were analyzed and the result is utilized for decision making for continuance or removal of an employee from an organization. This can further be extended as per the requirement of the educational institute/organization. This method provides an easy and precise method for accurately defining and analyzing the overall performance of a faculty member. These methods can also be extended for the performance analysis of students in teaching institutions and also in industries for performance evaluation of employee at end of every year.

REFERENCES

[1] L. A. Zadeh, *"Fuzzy Sets", Information & Control*, **8**, (1965), 338-353.

[2] Yifa Li, Peter Musilek and Loren Wyard, (2004), "Fuzzy Logic in Agent-based Game Designing", University of Alberta, Canada.

[3] C. K. Kwong, W. H. Ip, and J. W. K. Chan, (2002), "Combining Scoring Method and Fuzzy Expert Systems Approach to Supplier Assessment: A Case Study, *Integrated Manufacturing Systems"*, **13**(7), 512-519(8), Emerald Group Publishing Limited.

[4] J. Warren, G. Beliakov, and B. van der Zwaag, (2000), "Fuzzy Logic in Clinical Practice Decision Support Systems," Presented at the *Proceedings of 33rd Hawaii International Conference on System Sciences*, Piscataway, NJ.

[5] Carlos Daniel Pimentel Flores, (2005), Miguel Angel Hernandez Gutierrez, Ruben Alejos Palomares, "Fuzzy Logic Approach to Autonomous Car Parking Using MATLAB", *15th International Conference on Electronics, Communications and Computers (CONIELECOMP'05)*, 335-340.

[6] Ian Miguela and Qiang Shenb, (2002), "Fuzzy rrDFCSP and Planning", Department of Computer Science, University of York, United Kingdom and School of Informatics, University of Edinburgh, United Kingdom.

[7] Ibrahim. Ahmad. M, (2004), "Introduction to Applied Fuzzy Electronics". PHI.

[8] T. J. Ross, (1997), Fuzzy Logic with Engg. Applications, MGH.

[9] Kwang H. Lee "First Course On Fuzzy Theory and Applications", Springer International Edition.

Manoj Sharma[1] & Rajeshwar Singh[2]
Electronics & Communication Engineering Department
BRCM College of Engg. & Tech., Bahal, Haryana
MD University, Rohtak, Haryana, INDIA
E-mails: neelmanoj@gmail.com[1]: rajeshwar.rajata@gmail.com[2]