Fuzzy Logic based Cricket Player Performance Evaluator

Gursharan Singh
IET Bhaddal, Ropar
Punjab, INDIA

Nitin Bhatia
DAV College, Jalandhar
Punjab, INDIA

Sawtantar Singh
Bhai Maha Singh College of Engg.
Mukatsar, Punjab, INDIA

ABSTRACT
Cricket is amongst the most popular sports. Performance of players directly affects their ranking internationally. We propose a fuzzy logic based technique to evaluate the performance of cricket players. Various input parameters are being considered which are scaled using linguistic variables and a very simple yet effective software tool is developed to compute the effect of input parameters on the ranking of the players.

Keywords
Fuzzy Logic, Mamdani, Cricket, Player, Performance Evaluator.

1. INTRODUCTION
Cricket is a bat and ball game played between two teams having eleven players each. Cricket is one of the most entertaining and favorite game for many people. Because of its popularity, and the fun and glamour involved in it, more and more people from all around the world are becoming interested in this game. This game is played in big oval shaped grass field, having a rectangular strip of 22 yards, called pitch, at the center of the ground. At the both ends of the pitch, three wooden sticks, called wickets, are placed. A white line is marked near these wickets. This white line is called crease. The match is divided into innings during which one team bats and the other team fields. The batting team has only two players, called batsmen, on the ground, whereas, the fielding team has all the eleven players on the ground per innings.

Different forms of cricket played at the international level are Test Match, One-Day International (ODI), and Twenty20 (T20). International Cricket Council (ICC) governs all these formats of international cricket and formulates the various rules and regulations. ICC is also responsible for the calculation of ranking of players, which depends on their performance. The ranking is calculated separately for test matches, ODIs and T20s, and also for batsman, bowler and all-rounder. But the rules for calculating the ranking are very vague and crisp, and therefore, the actual performance of player is not visible. Hence, in this research work, we will propose fuzzy based cricket player performance evaluator, that will evaluate the performance of a player using fuzzy logic.

Fuzzy logic was first introduced by Zadeh in his first paper on Fuzzy Sets in 1965. Fuzzy logic solves the problems with vague, imprecise and incomplete data and provides better and accurate results. Fuzzy logic is a rule based approach used for solving problems. J. M. Mendel defines fuzzy logic system as a non-linear mapping of an input data vector into a scalar output [1]. Fuzzy logic has many applications including aircraft control, weather forecasting, marketing, economics, politics, biology etc. Numbers of fuzzy logic based commercial products are available which helps to evaluate and control complex systems. It can be applied to number of fields for developing knowledge-based systems. Fuzzy logic is a decision support system and is becoming very popular day-by-day. It is a rule based technique and fuzzy rules are very easy to learn and use.

In this paper, the objective is to use the fuzzy logic tool to evaluate the performance of a cricket player. With the fuzzy logic, first of all we have to understand the system behavior by our knowledge. In second step, by using fuzzy rules, we have to design the control algorithm and at last debug the design.

2. RELATED WORK
Huge amount of literature is available on fuzzy logic and its applications. Fuzzy logic can handle problems with imprecise data and give more accurate results. Professor L. A. Zadeh introduced the concept of Fuzzy logic [2]. After that, researchers used this theory for developing new algorithms and decision analysis. The use of genetic algorithms for designing and implementation of fuzzy logic controllers was discussed [3]. There are many different formulations and interpretations of the theory of rough sets [4]. The relationship and differences between theories of fuzzy sets and rough sets with respect to two formulations of fuzzy sets and two views of rough sets are examined [5]. Different aspects of fuzzy logic and fuzzy sets are discussed by [6], which are necessary to synthesize a fuzzy logic system. Concepts and techniques used in fuzzy logic from modern perspective are examined that helps to learn fuzzy rule-based models for high dimensional problems [7].

Fuzzy Inference Systems (FIS) are models based on fuzzy logic. FIS does mapping from given input to an output using fuzzy logic. FIS have number of rules based on "if-then" conditions. These rules are easy to learn and use and can be modified according to the situation. FIS helps to make decisions. A. Abraham presented the different ways to learn fuzzy inference systems using neural network learning techniques [8]. M. Z. Shafiq et al. reported a comparative study of Fuzzy Inference Systems, Neural Networks and Adaptive Neuro Fuzzy Inference Systems for Portscan Detection [9]. A synthetic multi-criterion evaluation method based on the Mamdani type FIS is developed to assess compost maturity and stability [10]. A fuzzy logic based loan risk predictor was developed to aid financial organizations in making decisions [11]. Risks associated with software development projects and their impact on software quality is discussed [12].

Fuzzy inference systems can be used in several fields like decision analysis, expert systems, computer vision, robotics and pattern recognition. FIS can also be effectively used in sports like cricket and soccer etc. Using fuzzy logic, the design and implementation of real-time game design of Pac-Man is presented [13]. A batting training system is suggested using fuzzy set theory to aid West Indies Cricket [14]. A decision algorithm using the concept of fuzzy logic is proposed in determining strategic shots in a game of pool [15].

3. PROPOSED WORK

In this research work, we will use a fuzzy-logic inference system for evaluating the player's performance in Cricket. Fuzzy Inference Systems (FIS) use fuzzy sets and if-then rules relevant to fuzzy sets to make decisions about incomplete or vague information [16]. The two most commonly fuzzy inference systems are those described by Mamdani and Sugeno. In our work, Mamdani algorithm is used to determine the output. FIS system executes in three major steps: Fuzzification, Inference and Defuzzification [17]. In first level, the degree of membership for crisp input variables is determined. At second level, i.e. inference level, evaluation of fuzzy rules is done and output is produced for each rule. Finally, the resulting fuzzy output is converted back into physical values through a defuzzfication process [6]. In our proposed work, we consider a fuzzy system for evaluating the performance of cricket player with eight inputs and one output. We have made 96 rules for this fuzzy system. Each input has three membership functions except for *out* which has two membership functions. The output has five membership functions. We have used MATLAB GUI tool to develop the proposed evaluator.

3.1 Design Methodology

In our fuzzy system, we have taken eight parameters as linguistic variables that affect the ranking or performance of a cricket player. The parameters taken for the system are: *RunsScored*, *BallsFaced*, *StrikeRate*, *Out*, *Fours*, *Sixes*, *TeamStrength* and *TeamAgainstStrength*. We have taken *Ranking* as an output parameter. All these input variables affect the ranking of a player. Figure 1 shows the input variables and output variables.

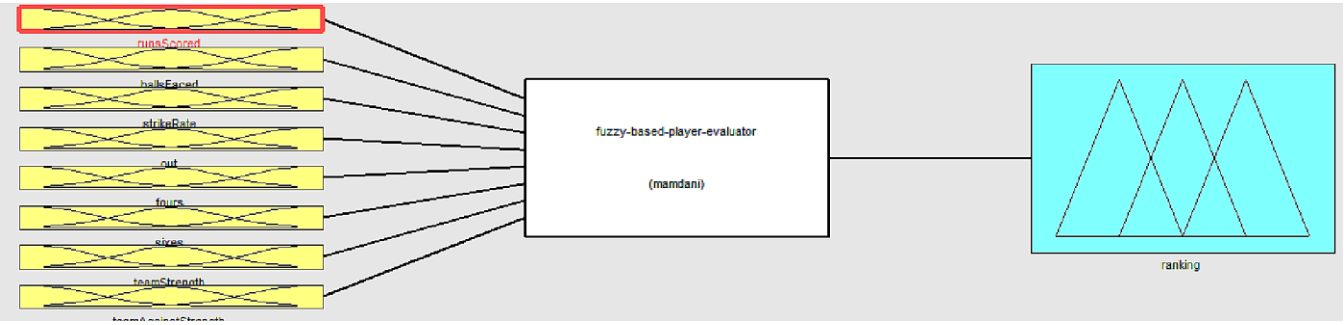


Fig. 1: Eight Inputs and One Output Parameter.

On the basis of the description of input and output variables, we have constructed 96 rules. Following is the description of some of the rules:

Rule 1: If (*runsScored* is *High*) and (*ballsFaced* is *Low*) and (*strikeRate* is *High*) and (*out* is *No*) and (*fours* is *High*) and (*sixes* is *Med*) and (*teamStrength* is *High*) and (*teamAgainstStregth* is *High*) then (*ranking* is *very High*) (0.75).

Rule 2: If (*runsScored* is *High*) and (*ballsFaced* is *Low*) and (*strikeRate* is *High*) and (*out* is *No*) and (*fours* is *High*) and (*sixes* is *Med*) and (*teamStrength* is *High*) and (*teamAgainstStregth* is *High*) then (*ranking* is *High*) (0.25).

Rule 3: If (*runsScored* is *High*) and (*ballsFaced* is *Med*) and (*strikeRate* is *High*) and (*out* is *No*) and (*fours* is *High*) and (*sixes* is *Low*) and (*teamStrength* is *High*) and (*teamAgainstStregth* is *High*) then (*ranking* is *Very High*) (0.75).

Rule 4: If (*runsScored* is *High*) and (*ballsFaced* is *Med*) and (*strikeRate* is *High*) and (*out* is *No*) and (*fours* is *High*) and (*sixes* is *Low*) and (*teamStrength* is *High*) and (*teamAgainstStregth* is *High*) then (*ranking* is *High*) (0.25).

……..

Rule 95: If (*runsScored* is *Low*) and (*ballsFaced* is *High*) and (*strikeRate* is *Low*) and (*out* is *Yes*) and (*fours* is *Low*) and (*sixes* is *Low*) and (*teamStrength* is *Low*) and (*teamAgainstStregth* is *Low*) then (*ranking* is Very Low) (0.75).

Rule 96: If (*runsScored* is *Low*) and (*ballsFaced* is *High*) and (*strikeRate* is *Low*) and (*out* is *Yes*) and (*fours* is *Low*) and (*sixes* is *Low*) and (*teamStrength* is *Low*) and (*teamAgainstStregth* is *Low*) then (*ranking* is *Low*) (0.25).

3.2 Input Membership Functions

There are eight input variables (*runsScored*, *ballsFaced*, *strikeRate*, *Out*, *fours*, *sixes*, *teamStrength* and *teamAgainstStrength*) taken in our fuzzy system. These variables use different membership functions.

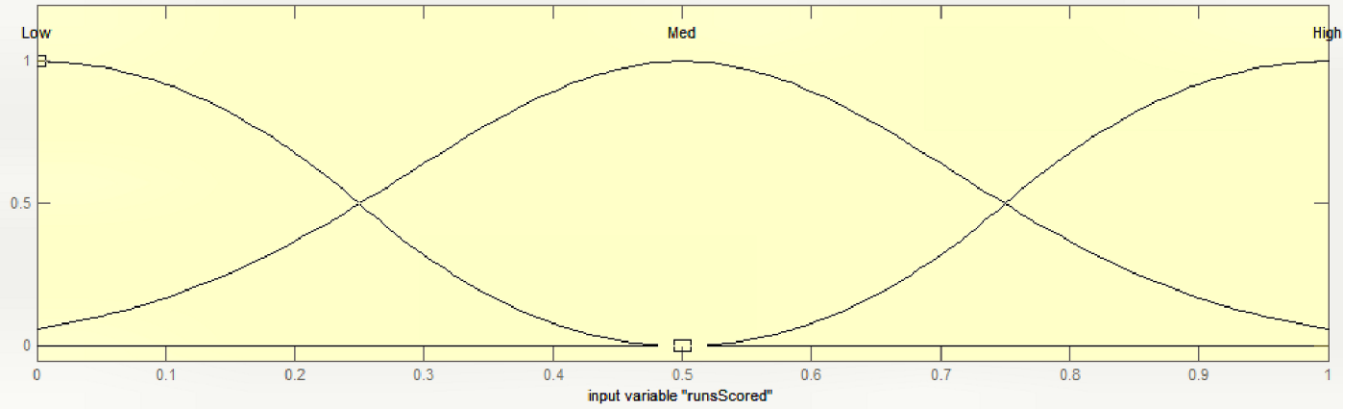


Fig. 2: Membership Functions for input Variable *runsScored*.

For instance, *runsScored* has three membership functions to represent *Low*, *Med* and *High* as shown in Figure 2. These functions are: **zmf** for *Low*, **guassmf** for *Med* and **smf** for *High*.

zmf: Z-shaped built-in membership function (zmf) is used to define the variable *Low*. The weight is calculated by the following formula:

$$f(x;0,0.5)=\begin{cases}1, x\le 0\\ 1-2\left(\frac{x-0}{0.5-0}\right)^2, 0\le x\le\frac{0+0.5}{2}\\ 2\left(\frac{x-0.5}{0.5-0}\right)^2, \frac{0+0.5}{2}\le x\le 0.5\\ 0, x\ge 0.5\end{cases}$$

gaussmf: Gaussian curve built-in membership function is used to define the variable *Med*. The weight is calculated by the following formula:

$$f\ x;0.2123,0.5\ = e^{\frac{-\ x-0.5\ ^2}{2\ 0.2123\ ^2}}$$

smf: S-shaped built-in membership function is defined for variable *High*. The weight is calculated by the following formula:

$$f(x;0.5,1)=\begin{cases}0, x\le 0.5\\ 2\left(\frac{x-0.5}{1-0.5}\right)^2, 0.5\le x\le\frac{0.5+1}{2}\\ 1-2\left(\frac{x-1}{1-0.5}\right)^2, \frac{0.5+1}{2}\le x\le 1\\ 1, x\ge 1\end{cases}$$

3.3 Output Membership Function

We have taken *ranking* as an output variable which has five levels: *Very Low*, *Low*, *Neutral*, *High* and *Very High* as shown in Figure 3. All these five levels are defined by the membership function **trimf**.

trimf: Triangular-shaped built-in membership function is defined for the variable *ranking*. The weight is calculated by the following formula:

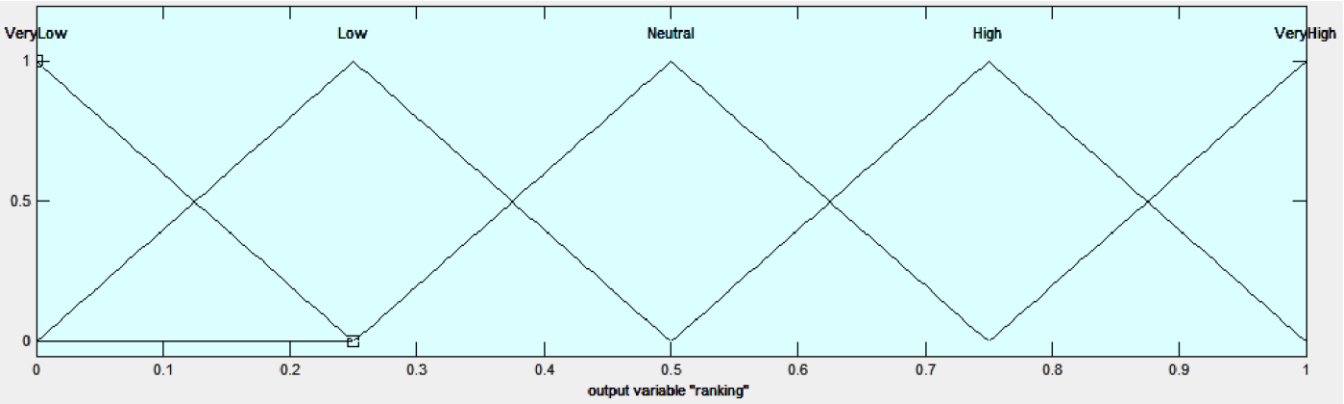


Fig. 3: Membership Functions for Output Variable *ranking*.

$$f(x;a,b,c)=\begin{cases}0, & x\le a\\ \dfrac{x-a}{b-a}, & a\le x\le b\\ \dfrac{c-x}{c-b}, & b\le x\le c\\ 0, & c\le x\end{cases}$$

Table 1 shows the values of a, b & c for all five variable.

Table 1: Values of a, b & c

Parameters	a	b	c
Very Low	-0.25	0	0.25
Low	0	0.25	0.5
Neutral	0.25	0.5	0.75
High	0.5	0.75	1
Very High	0.75	1	1.25

4. RESULT ANALYSIS

To calculate the performance of a cricket player by using the cricket player performance evaluator, we took four different hypothetical scenarios.

Scenario 1: A player belonging to a high rated team plays against a high rated team. He scores high amount of runs in low amount of balls. Hence, he has a high strike rate. He struck high number of fours and sixes, and remained not out in the match. All these parameters are entered into the performance evaluator developed in MATLAB, shown in Figure 4 (a). The output of this scenario shows that it affects his ranking by 64%, as shown in Figure 4 (b).

Scenario 2: The same performance, as mentioned in scenario 1, is made by a player belonging to a low strength team. The parameters entered are shown in Figure 5 (a).

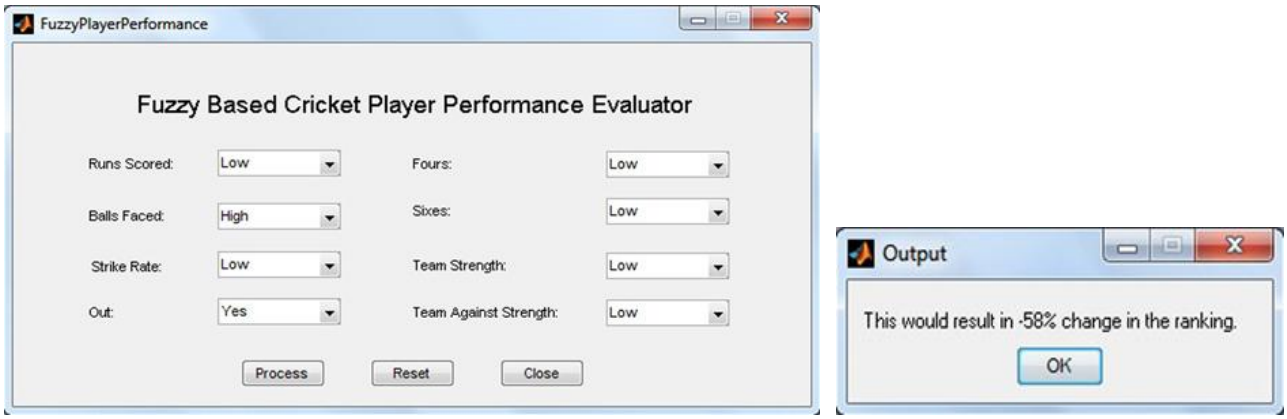
The output shows that it must impact his ranking by 84%, as shown in Figure 5 (b). The reason for such high rise in his ranking is that such a high class performance is given by a player belonging to a weak team, against a strong team.

(a) **(b)**

Fig. 4 (a): Parameters entered into Performance Evaluator based on Scenario 1. (b) Output of Scenario 1.

(a) **(b)**

Fig. 5 (a): Parameters entered into Performance Evaluator based on Scenario 2. (b) Output of Scenario 2.



(a) **(b)**

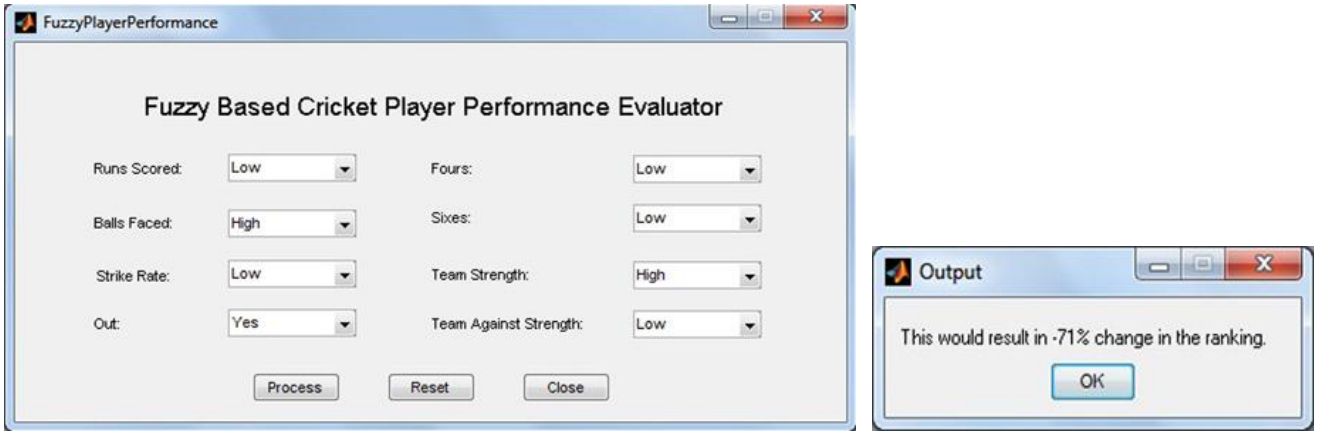
Fig. 6 (a): Parameters entered into Performance Evaluator based on Scenario 3. (b) Output of Scenario 3.

Scenario 3: A player belonging to a weak team plays against a weak team. He scores low amount of runs facing low balls, resulting in low strike rate. He also struck low number of fours and sixes before getting out. The parameters entered are shown in Figure 6 (a).

The output shows that his ranking must be affected by -58%, as shown in Figure 6 (b). The reason for downfall in the ranking is that a bad performance has been given by a player.

Scenario 4: The same performance, as in scenario 3, is given by a player of a strong team. The parameters entered are shown in Figure 7 (a).

The output shows that his bad performance must affect his ranking by -71%, as shown in Figure 7 (b). The reason for such a big downfall in the ranking is that a bad performance has been given by a player belonging to a strong team, against a weak team.



(a) **(b)**

Fig. 7 (a): Parameters entered into Performance Evaluator based on Scenario 4. (b) Output of Scenario 4.

5. CONCLUSION

This paper evaluates the performance of a cricket player in batting and the impact of his performance on the ICC ranking. To perform the evaluation, a Fuzzy Inference System is developed in MATLAB which takes into account all the parameters that must affect the ranking of a player. Each parameter is defined by membership functions. Then, 96 different rules are made based on "if-then" conditions. Finally, four different scenarios of batting performance are hypothetically assumed, which calculates the change of percentage in the ranking. We are currently not undertaking the relative performances of other players, playing in the same or other matches in parallel.

6. REFERENCES

[1] Mendel, J. M. 1995. Fuzzy logic systems for engineering: a tutorial. In Proceedings of the IEEE. Vol. 83. No. 3, March 1995.

[2] Zadeh, L. A. 1965. Fuzzy sets. Information and Control. 8, (1965) 338-353.

[3] Homaifar, A. and McCormick, E. 1995. Simultaneous design of membership functions and rule sets for fuzzy controllers using genetic algorithms. IEEE Trans. Fuzzy Systems. 3 (2), (May 1995).

[4] Yao, Y. Y. 1996. Two views of the theory of rough sets infinite universes. International Journal of Approximation Reasoning. 15, (1996) 291-317.

[5] Yao, Y. Y. 1998. A comparative study of fuzzy sets and rough sets. Information Sciences. 109 (1-4), (1998) 227-242.

[6] Hayward, G. and Davidson, V. 2003. Fuzzy logic applications. Analyst. 128, (2003) 1304–1306.

[7] Wang, W. and Bridges, S. M. 2000. Genetic algorithm optimization of membership functions for mining fuzzy association rules. In Proceedings of The International Joint Conference on Information Systems, Fuzzy Theory and Technology Conference, (March 2, 2000).

[8] Abraham, A. 2005. Adaptation of fuzzy inference system using neural learning. Fuzzy System Engineering: Theory and Practice. N. Nedjah, Ed. et al. Berlin, Germany: Springer-Verlag, 3, (2005) 53–83.

[9] Shafiq, M. Z., Farooq, M. and Khayam, S. A. 2008. A comparative study of fuzzy inference systems. Neural Networks and Adaptive Neuro Fuzzy Inference Systems for Portscan Detection. EvoCOMNET, LNCS, (2008).

[10] Zhiyi, F. 2004. A fuzzy inference system for synthetic evaluation of compost maturity and stability. Masters of Engineering thesis, University of Regina, Saskatchewan. (March 2004).

[11] Kumar, S., Bhatia, N. and Kapoor, N. 2011. Fuzzy logic based tool for loan risk prediction. In Proceedings of International Conference on Communication and Computing Technologies (ICCCT-2011), (Feb 25-26, 2011), 180-183.

[12] Kumar, S., Bhatia, N. and Kapoor, N. 2011. Software risk analysis using fuzzy logic. International Journal of Computer Information Systems, 2 (2), (2011), 7-12.

[13] Shaout, A., King, B. and Reisner, L. 2006. Real time game design of pac-man using fuzzy logic. The International Arab Journal of Information Technology. 3 (4), (October 2006).

[14] Curtis, K. M. 2010. Cricket batting technique analyser/trainer: a proposed solution using fuzzy set theory to assist West Indies cricket. In Proceedings of the 9th WSEAS international conference on Artificial intelligence, knowledge engineering and data base. (2010) 71-76.

[15] Chua, S. C., Tan, W. C., Wong, E. K. and Koo, V. C. 2002. Decision algorithm for pool using fuzzy system. Artificial Intelligence in Engineering & Technology, (2002) 370–375.

[16] Riley, J. 2005. Evolving fuzzy rules for goal-scoring behaviour in a robot soccer environment, PhD Thesis, RMIT University: Melbourne, Australia. (2005).

[17] Yanik, P., Ford, G. and McDaniel, W. 2010. An introduction and literature review of fuzzy logic applications for robot motion planning. In Proceedings of ASEE Southeast Section Conference. (2010).