How to Cite:
Patel, H., Patel, H. K., & Dinner, I. (2022). Fuzzy logic based elbow strength prediction for lateral epicondylitis. *International Journal of Health Sciences*, *6*(S3), 4307–4313. https://doi.org/10.53730/ijhs.v6nS3.6857

Fuzzy logic based elbow strength prediction for lateral epicondylitis

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***Abstract*---**We proposed and implemented a system based on fuzzy logic Toolbox. We designed such a system to measure the strength of the upper limb elbow of a tennis player. We have tried to predict the injuries and movements for the sports player, for that we used the Triangle and Trapezoidal membership function for better prediction of the elbow strength. We have selected two input parameters Elbow Flexion Angle and Torque in the system development using fuzzy logic toolbox in Matlab. We have considered these two inputs and based on that we have developed membership functions. After we get the elbow strength levels we will be able to predict the level of injuries. By measuring the elbow strength, comments can be made on the chances of player getting elbow related injuries.

***Keywords*---**fuzzy logic, strength prediction, epicondylitis.

Introduction

Fuzzy logic, among the various available Artificial Intelligence techniques, emerges as an advantageous technique in predicting future events. Subjective and Objective modeling are two types of fuzzy modeling. Objective type fuzzy modeling is used to build the prediction system. We proposed the Fuzzy logic to apply here in our applications in sports. So far Fuzzy logic have been applied from control Theory to Artificial Intelligence. As study shows that nearly half 41.8% of the tennis players suffers Lateral Epicondylitis (Tennis Elbow) in their career [1]. The present paper provides the methodology to predict the elbow strength of tennis players. For this Fuzzy logic based system is designed to measure the strength of elbow of tennis players using triangle membership functions and trapezoidal membership functions.

Methodology: A system is designed using the Fuzzy Logic Toolbox in MATLAB for predicting the elbow strength of players. As fuzzy logic is the extension of boolean logic, inputs and their relations are requires to predict the elbow strength. This system takes elbow flexion angle and torque at elbow as inputs. Fuzzy logic Rules which is relation between inputs and output are defined as shown in table 1 for predicting the output. Here, elbow flexion angle and elbow torque is experimental values[2]. system predicts elbow strength using triangle membership functions and trapezoidal membership functions.

Flow diagram

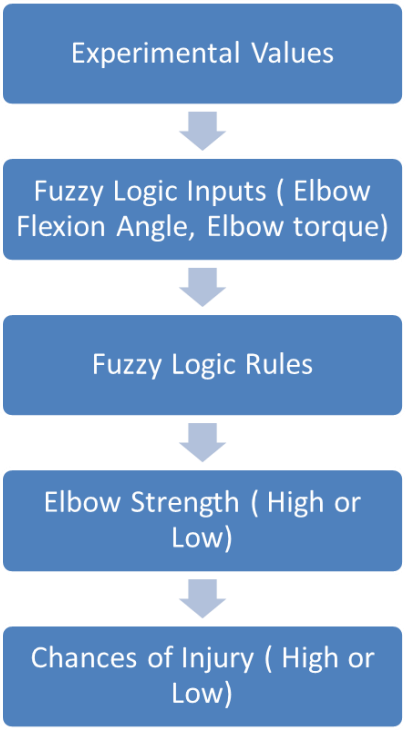

Fig 1. Flow diagram fuzzy rules

Fuzzy Logic Rules: Fuzzy Logic methodology is divided into the following sections:

- Description of input and output variables
- Defining membership functions for each input and output variables
- Defuzzification to obtain prediction;
- Define rules
- Predict the output.

There are total 7 rules in fuzzy logic system, which will predict the elbow strength depending on the elbow flexion angle and elbow torque. Rules are shown in table 1.

Table 1

Sr.No.	Elbow Flexion Angle	Elbow Torque	Elbow Strength
1	Low	-	Low
2	Good	Low	Low
3	Good	Average	High
4	Good	High	Low
5	High	Low	Low
6	High	Average	Average
7	High	High	Low

Membership functions

The purpose of defining Membership Function (MF) is to create relation for input and output. Among many MF available such as triangular, trapezoidal, etc. for this work, triangular and trapezoidal MF is used. Triangular MF offers advantages like high computational efficiency and larger implementation, while trapezoidal MF offers simplicity in analysis. hence both MF is used for this work.

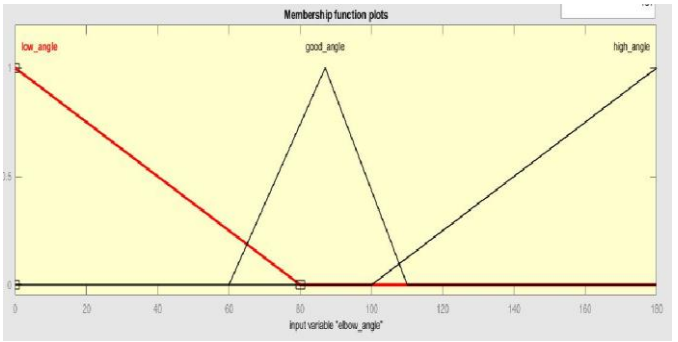

Fig 2. Triangle MF of Elbow Angle

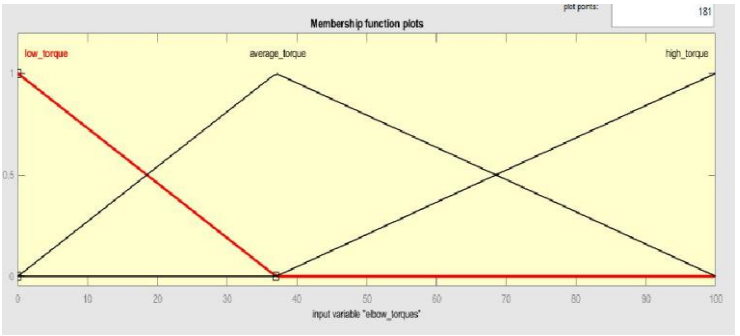

Fig 3. Triangle MF of Elbow Torque

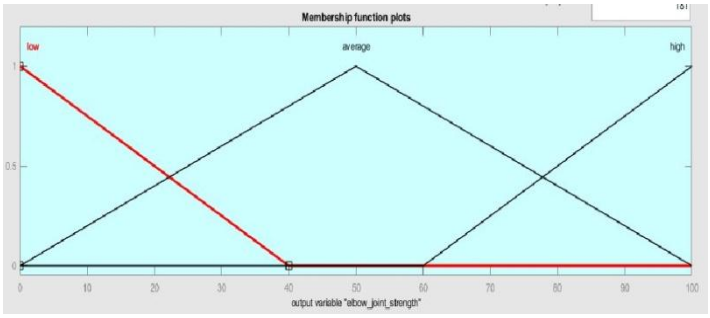

Fig 4. Triangle MF of Elbow joint Strength

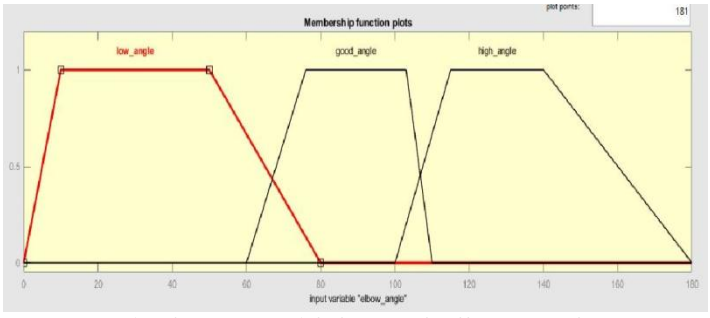

Fig 5. Trapezoidal MF of Elbow Angle

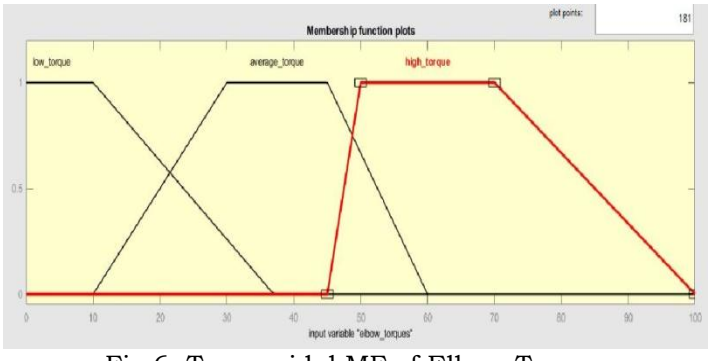

Fig 6. Trapezoidal MF of Elbow Torque

Results

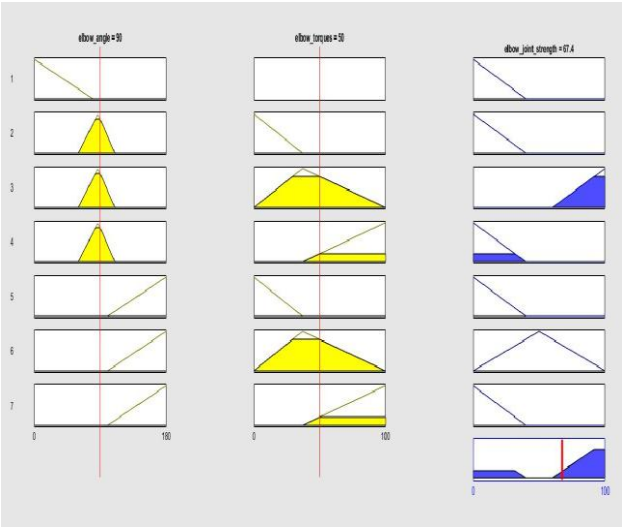

Fig 7. Result for Triangle MF

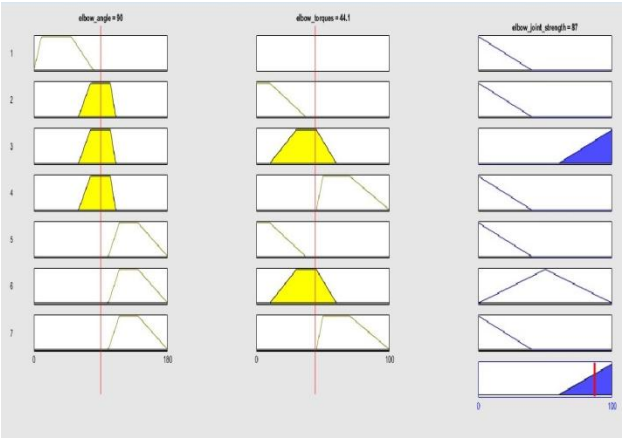

Fig 8. Results for Trapezoidal MF

Discussion

This system can only predict the strength of Elbow joint. The higher the strength the less chances of injury and the lower the elbow strength the more chances of elbow injury. For completely predict the injury neural network can be implemented with sufficient database using the player's intrinsic and extrinsic predicting factors.

Conclusion

In this work, fuzzy logic expert system is designed to predict the elbow strength playing sports. Taguchi design methodology is used to conduct the experiments taking torque, elbow strength and Angel as the process parameters. The results

shows that In both the MFs used, the maximum elbow strength is around 87% as there is only 2 inputs and there will be chances of error in measurement. this system fails to completely predict if player will suffer from tennis elbow. it can only predict which player has higher chances of having Lateral Epicondylitis.

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