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Application of Fuzzy Logic Control in Iron Box Temperature Regulation

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Abstract: This work investigates the use of fuzzy logic control in the context of temperature regulation in an iron box. Instead of the usual Boolean logic employed in computers, fuzzy logic is a computer-based approach of degree determination that gives the truth. Rather than adopting typical methods that put the problem into a black box model, this assists the problem solver in approaching the challenge in a way that they can explain and comprehend. The study explains how fuzzy logic can be used to manage an iron box's heating element based on input variables such as wrinkle severity and water level. To control the heat level of the iron, the system defines membership functions, rules, and other defuzzification mechanisms. This system's output can be used to effectively manage the heating element of the iron, providing a more intelligent and responsive operation. Through modelling and testing, we evaluate the effectiveness of our fuzzy logic control system in achieving accurate and dependable heating level outputs.
Keywords: FCM, Household Appliance, Rule Based Algo, Black Box, Membership Function

I. INTRODUCTION

Iron boxes are just one of the many domestic items that help us with our daily activities. The iron box is mostly used to iron clothes. The correct heating setting of the Iron box is required to achieve a decent, ironed cloth based on the severity of the wrinkles on the cloth and the amount of water present. In this circumstance, fuzzy logic control provides an opportunity to improve the precision and efficacy of heating level. This work investigates the use of fuzzy logic control systems to manage the heating level of an iron box and proposes a model for dependable and accurate results. There has recently been renewed interest in the application of fuzzy logic control in household appliances [1]. Household gadgets such as iron boxes, microwave ovens, and rice cookers have become more functional and user-friendly as sophisticated controls have been added. Because fuzzy logic is a control strategy that can manage imprecise and uncertain input data, it is well suited to dealing with the issues connected with such appliances.

A language control approach can be converted using the fuzzy logic controller (FLC)[2]. A survey of the FLC is offered, as well as a general technique for building an FLC and measuring its success. Special emphasis is placed on fuzzification and defuzzification procedures, the development of database and fuzzy control rules, the definition of fuzzy implication, and an examination of fuzzy reasoning mechanisms. Lofti A. Zadeh, a professor at the University of California, Berkeley, first suggested the concept of fuzzy logic [3] in 1965. Fuzzy logic is used to monitor nonlinear systems that pose mathematical hurdles. Non-probabilistic uncertainty is monitored using fuzzy logic and fuzzy set theory [4]. In paper [5] provides an overview of the principles of fuzzy sets, fuzzy rules, and fuzzy inference systems. Started with crisp or classical sets and their operations and worked our way up to fuzzy sets and their operations. Following set theory, classical set membership functions and fuzzy membership functions are thoroughly addressed. An air conditioner control example is used to explain fuzzy rules. The various defuzzification strategies and their processes are presented step by step using the same example.

II. PROPOSED DESIGN

The main objective of this design is to create a fuzzy logic control system for an iron box that regulates the heating level based on input variables, leading to more effective and user-friendly ironing. We came up with the mode based on the below approach.

A. Fuzzy Input Variable

For iron box based fussy system we are using 2 input variables which will be the severity of wrinkle on the cloth and the water level.

1) *Wrinkle Severity:* Represents the degree of wrinkles on the fabric, categorized into "poor," "average," and "good" with corresponding membership functions.
2) *Water Level:* Indicates the amount of water in the iron, categorized into "poor," "average," and "good" with appropriate membership functions.

B. Fuzzy Output Variable

The output variable is the heating level which is the idle temperature for ironing the cloth based on the wrinkle severity.

1) *Heat Level:* The output variable which is the outcome based on the input variable water level and Wrinkle Severity. The heating level is finally categorized as "low," "medium," and "high" categories.

C. Membership Functions

They are a fundamental concept in fuzzy logic, serving as a bridge between crisp input data and fuzzy sets, which are used to represent linguistic variables. Membership functions define the degree of membership or belongingness of an element to a particular fuzzy set. They play a critical role in fuzzy logic systems, helping to model and represent uncertainty and imprecision in real-world data. Types of Membership Functions

1) *Triangular Membership Function (Triangular MF):* This is one of the simplest and most used membership functions. It forms a triangle-shaped curve with a peak, characterized by three parameters: the left, right, and peak values. Triangular membership functions are suitable for representing variables with gradual transitions.
2) *Trapezoidal Membership Function (Trapezoidal MF):* Trapezoidal membership functions are similar to triangular ones but have parallel lines on the left and right sides instead of single points. They are particularly useful when the transition between linguistic terms is not symmetrical.
3) *Gaussian Membership Function (Gaussian MF):* Gaussian membership functions are bell-shaped curves, resembling the normal distribution. They are widely used when data is expected to cluster around a central value. Gaussian functions have parameters like the mean and standard deviation to control their shape.

D. Rules

A set of rules is established to dictate the relationship between the input variables (wrinkle severity and water level) and the output variable (heat level). These rules describe how the iron's heat should be adjusted based on the current conditions. example, Rule 1 says if the wrinkle severity is low and the water level is low then the heat level can also be maintained low. The defined set of rules help here to bring a fuzzy logic to maintain the appropriate heat level.

E. Control System

A control system is created, integrating the fuzzy variables, membership functions, and rules. This system is then simulated with specific input values, such as wrinkle severity and water level, to compute the output heat level.

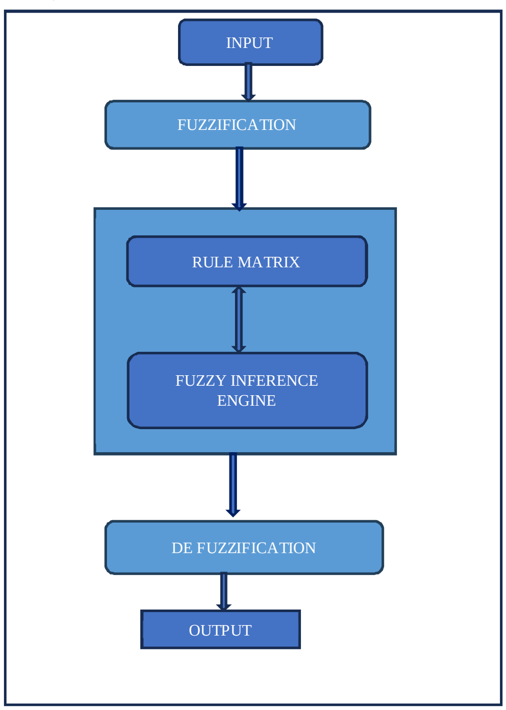

Fig 1. FLC base IRON BOX

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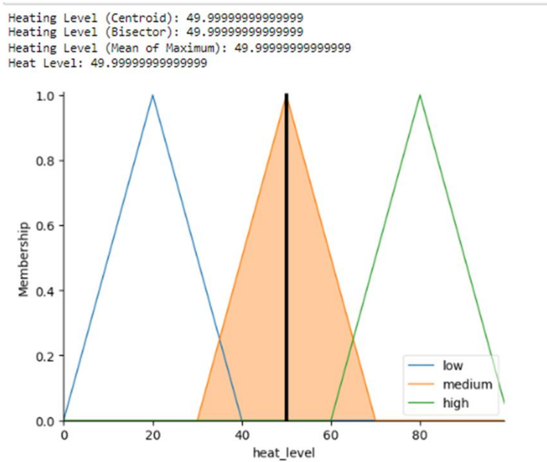
III. SIMULATION

We used the scikit-fuzzy Python module, a popular tool for modelling fuzzy logic, for the simulation. Different values of Water level and Wrinkle Severity are used to create almost all the applicable rules to get the desired output. Then the experiment was performed by giving various input to the system and the results was observed in the form of the Membership functions.

A. Triangular

The simulation was run on triangle membership function where wrinkle severity was 50 and water level was 50 as the inputs. Below figure shows the defuzzification output.

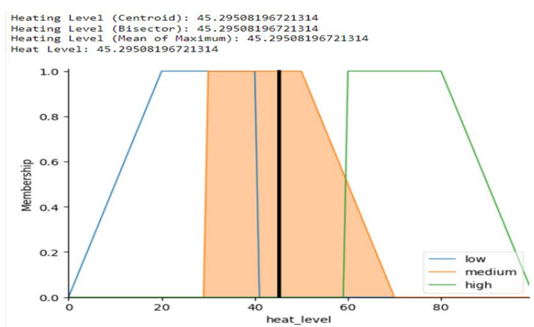
Defuzzification is done on Centroid, Bisector, Mean of Maximum and it gives heating level is 49.0 which is the defuzzification output.



B. Trapezoid

Similarly, when we take time equals to 5 and temperature equals to 8 as input. Below shows the defuzzification output.

Defuzzification is done on Centroid, Bisector, Mean of Maximum and it gives heating level is 49.2 which is the defuzzification output.



IV. RESULT

The simulation results revealed that the fuzzy logic control system successfully recognized the optimal heating setting based on the inputs of wrinkle severity and water level. The system displayed adaptability in responding to a variety of input situations, consistently achieving the desired heating level with minimal volatility. The results also revealed the system's resistance to the characteristic of fuzzy logic's imprecise input processing.

V. CONCLUSION

To summarize, the use of fuzzy logic control in an iron box provides a viable way for achieving accurate and consistent heating level results. By considering the input variables, the proposed model efficiently manages the heating level. The results of the simulation demonstrate how successful the fuzzy logic control system is in real-world settings. When we utilize the triangle member function, the heating level is higher than when we use the trapezoidal. This model could be improved more in the future by considering new input elements.

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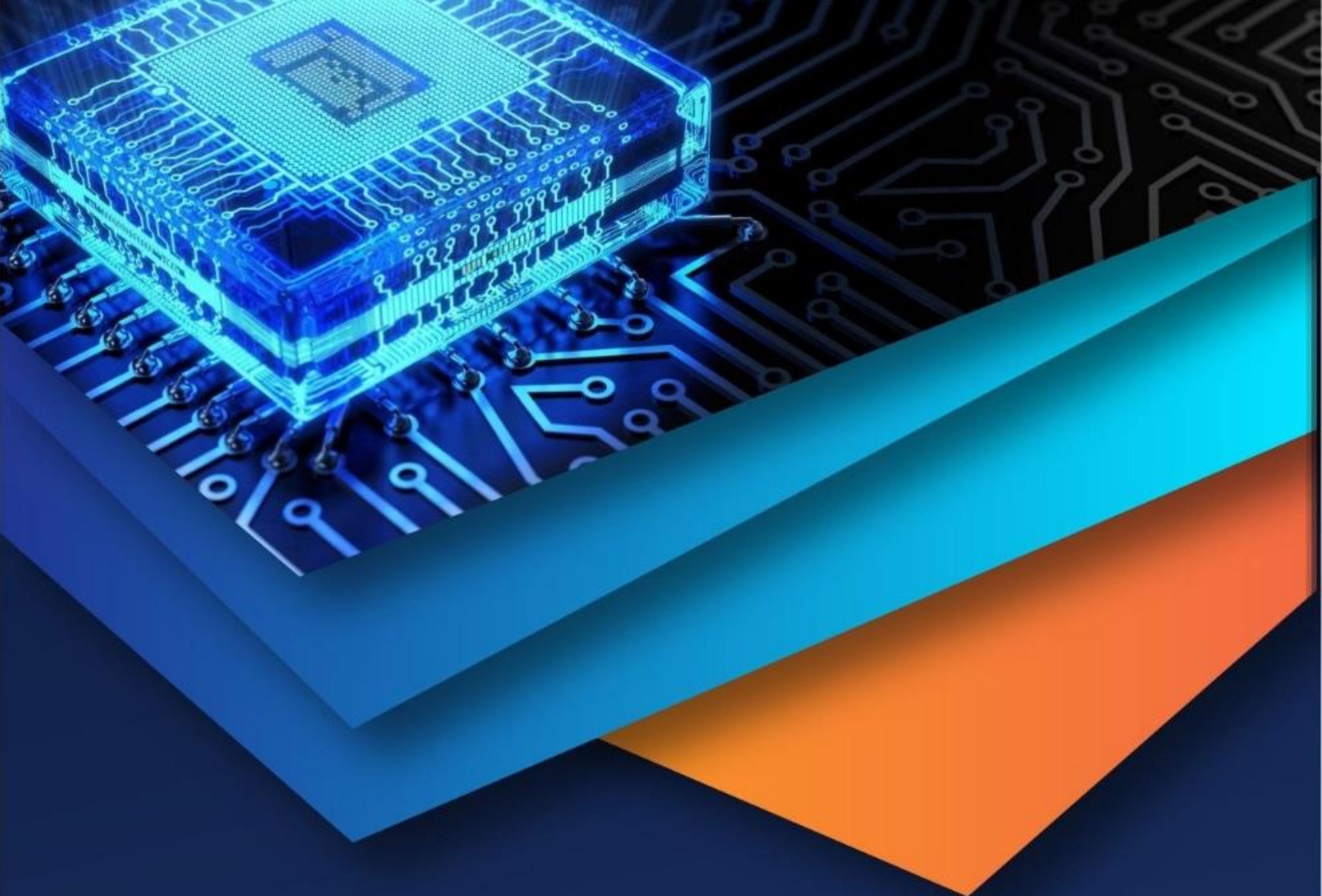

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