Automatic Braking System in Train using Fuzzy Logic

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Abstract

This paper focuses a new way of approach to find the solution for the artificial intelligent braking system in train using the fuzzy logic controller. Here we are designing the fuzzy logic controller using fuzzy logic tool box in mat lab software. The main function of the fuzzy logic controller used here is to automatically stop the train in each station without any manual procedure of stopping the train. Generally the Indian railways use two drivers to operate a train. In this paper the usage of fuzzy logic controller reduces the number of drivers to one. The fuzzy logic controller in train gets activated about 500m from the station so that the train stops at the station smoothly and automatically. The fuzzy controller takes the decision with reference to the speed and distance of the train.
Keyword- Fuzzy Logic, Automatic Braking System

I. INTRODUCTION

Day to day new advancements is taking place in railways. The new way of approach is to reduce the man power and to automate the system. We can use the advanced control equipment's in order to automate the system effectively. Generally the design of automatic braking system becomes more complex but it can be made easier and flexible by using fuzzy logic controller. In order to get the dynamic output we should connect the target to the fuzzy controller. The input of the fuzzy controller is chosen as distance and speed. The output of the fuzzy controller is breaking power. Based on rules of logic obtained from train drivers we Have framed 4x4 (16 rules) for fuzzy logic controller. In our design we use the triangular and trapezoidal member functions. The results from mat lab simulation clearly show that braking power is smooth and the train stops completely when the distance becomes zero.

II. OVERVIEW OF DESIGN

The design starts with the selection of number of stations where the train should stop. The distance between the stations is calculated. The fuzzy logic controller for braking system in train gets activated about 500m from the station. The controller gets its input as speed and distance instantaneously. The numerical values are converted into fuzzy sets by fuzzification technique.
Example:
For Speed = 70 kmph, distance=200m
The fuzzy set is,
Speed → {very fast, 1}
Distance → {far, 0.8}

After the fuzzification the corresponding rules are fired. Here, for the above example, the following rule is fired. If distance is (FAR) and speed is (VERY FAST) then braking power is (HEAVY). Then the fuzzy sets are converted into numerical values by the defuzzification technique. This numerical value which is the output of the fuzzy logic controller is used to Control the braking system of the train.

III. DESIGN PROCEDURE

Inputs - Speed and Distance
Output-Braking power (or % of braking).

A. Membership Functions

(Triangular and Trapezoidal)

Regarding Speed	Distance
1) Very slow	1) Very close
2) Slow	2) Close
3) Fast	3) Far
4) Very fast	4) Very far

B. Rules Formation

1) If distance is (VERY-CLOSE) and speed is (VERY SLOW) then braking is (LIGHT)
2) If distance is (VERY-CLOSE) and speed is (SLOW) then braking is (HEAVY)
3) If distance is (VERY-CLOSE) and speed is (FAST) then braking is (VERY HEAVY)
4) If distance is (VERY-CLOSE) and speed is (VERY FAST) then braking is (LIGHT)
5) If distance is (CLOSE) and speed is (VERY SLOW) then braking is (LIGHT)
6) If distance is (CLOSE) and speed is (SLOW) then braking is (LIGHT)
7) If distance is (CLOSE) and speed is (FAST) then braking is (HEAVY)
8) If distance is (CLOSE) and speed is (VERY FAST) then braking is (VERY HEAVY)
9) If distance is (FAR) and speed is (VERY SLOW) then braking is (LIGHT)
10) If distance is (FAR) and speed is (SLOW) then braking is (VERY LIGHT)
11) If distance is (FAR) and speed is (FAST) then braking is (LIGHT)
12) If distance is (FAR) and speed is (VERY FAST) then braking is (HEAVY)
13) If distance is (VERY FAR) and speed is (VERY SLOW) then braking is (VERY LIGHT)
14) If distance is (VERY FAR) and speed is (SLOW) then braking is (VERY LIGHT)
15) If distance is (VERY FAR) and speed is (FAST) then braking is (LIGHT)
16) If distance is (VERY FAR) and speed is (VERY FAST) then braking is (LIGHT)

IV. MEMBERSHIP FUNCTION OF DISTANCE

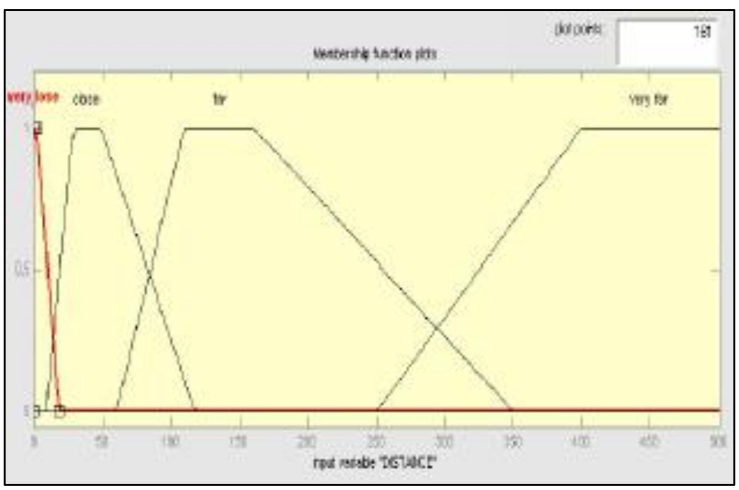

Fig. 1: Membership Function of Distance

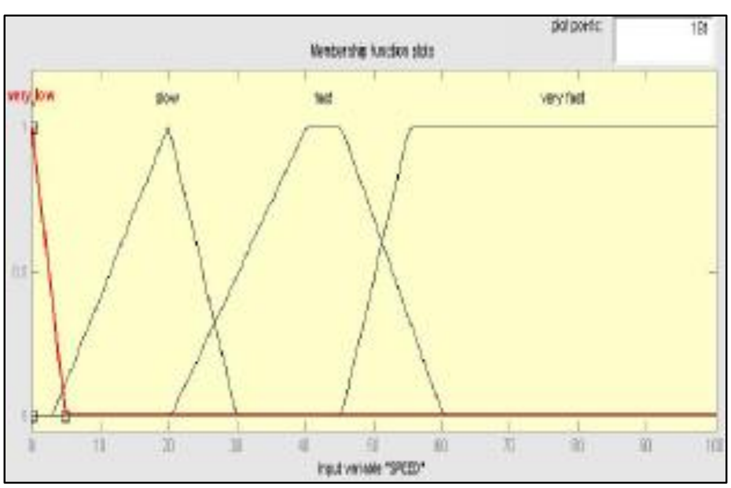

Fig. 2: Membership Function of Speed

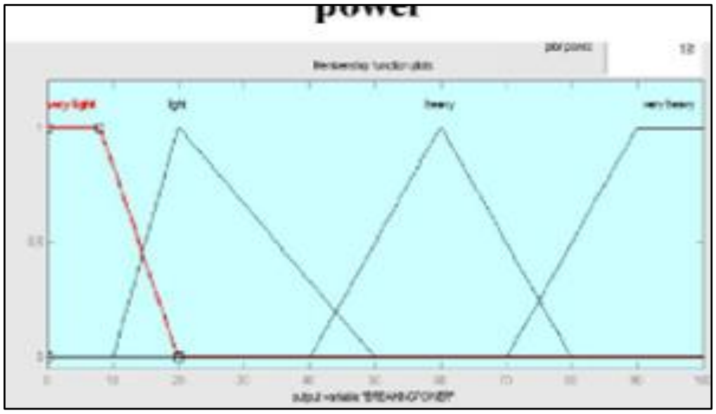

Fig. 3: Membership function of braking power

We designed this fuzzy logic controller in matlab. First the input and output membership functions are designed and rules are formed. This is done in FIS editor (fuzzy logic toolbox).

V. CRISP INPUT AND OUTPUT MAP

This is three dimensional surface plot of our design. In this plot X and Y axis are inputs and Z axis is output. Once the design is completed this 3D plot is automatically generated in fuzzy logic toolbox. The formula used for crisp action is given by

$$\textbf{CRISP ACTION} = \frac{\sum \textbf{(Rule strength). (Action)}}{\sum \textbf{(Rule strength)}}$$

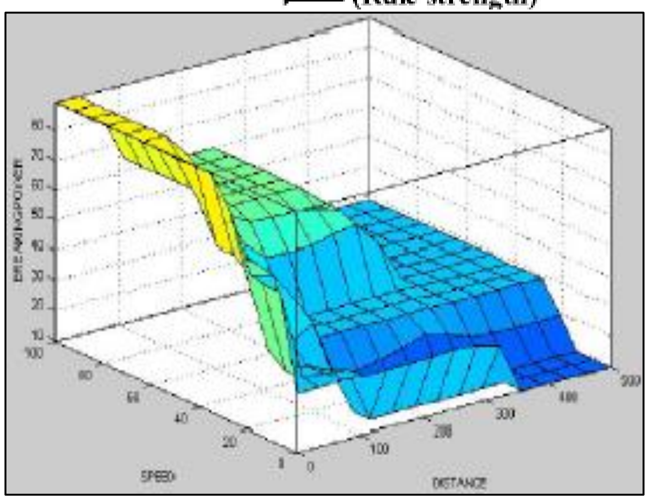

Fig. 4: Input and Output Map

VI. SIMULATION CIRCUIT OF FUZZY LOGIC CONTROLLER

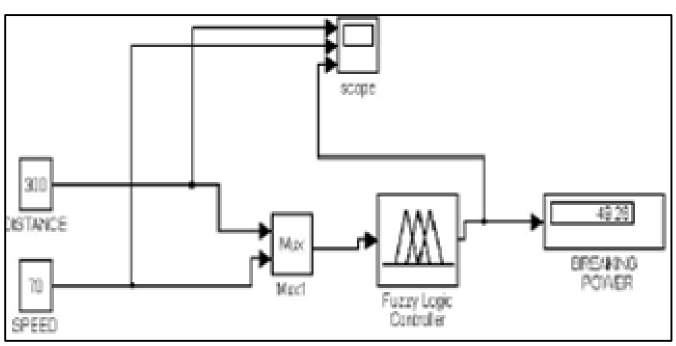

Fig. 5: Matlab Simulation Fuzzy Logic Controller

This is our simulation circuit which will show the amount of braking power required to stop the train at the station for the given inputs (Distance, Speed).But from this simulation circuit we don't know whether the train is stopped or not in the station so we are designed another simulation circuit in order to prove the train stops at the station.

VII. FUZZY LOGIC CONTROLLER

In this simulation circuit the speed of the motor is one input of the fuzzy logic controller, another input is distance. Distance is calculated from the speed. The fuzzy logic controller output is given to the motor.
This is the test circuit of the fuzzy logic controller. So the motor should stop when the distance becomes zero.

VIII. CONCLUSION

The use of fuzzy logic controller thus gives a smooth braking system. The accuracy of the system obtained for braking System in subway trains will be much higher by the use of fuzzy logic controller.

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