RESEARCHERID
THOMSON REUTERS

[Kumar, 6(6): June 2019] ISSN 2348 – 8034
IDSTM-2019 Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

FUZZY RULE BASED AUTOMATIC BRAKING SYSTEM IN TRAIN USING VHDL

Naveen Kumar [1], Manmohan [2] & Lokesh Singhal[3]

[1]Asst. Proffessor in Mechanical Dept. in Ganga Technical Campus Soldha, Bahadurgarh
[2]M. Tech scholar,in Mechanical Dept. Ganga Techanical Campus Soldha, Bahadurgarh
[3]M.Tech scholar,in Mechanical Dept. Ganga Technical Campus Soldha,Bahadurgarh

ABSTRACT

This paper deals with a Fuzzy Logic Controller (FLC) for an automated train braking system. The response of the system are simulated by victimisation formal logic chest in VHDL. The intelligence for braking is provided by a formal logic controller. The fuzzy logic controller is simulated using VHDL. VHDL may be a general artificial language optimized for electronic circuit style. The projected formal logic controller helps in reduction of work force for the train operation. Here our interest is to prevent a railroad train that's approaching a station. We would like that the braking system is mechanically activated because the train nears its halt purpose. For the braking system to be activated, the brakes controller is supplied with two inputs: current speed of the train and the distance from the halt point on the station.

Keywords *-Train braking system, Fuzzy logic, VHDL.*

I. INTRODUCTION

It could be a undeniable fact is aware of that mathematical logic is a powerful downside determination methodology with wide selection of applications in industrial management, shopper physical science, management, professional system, and information technology [1]. It provides a straightforward thanks to draw definite conclusion from obscure, ambiguous or imprecise and incomplete info. It is a natural approach of creating a call and is extremely about to the approach soul suppose and create selections even underneath extremely unsure setting [2]. As we tend to proceed we tend to shall realize unless a system supported Classical logic that need a deep understanding of a system, actual mathematical equation and precise numerical values, fuzzy logic incorporates with new way of thinking. This alter native way allows modeling complex system using a higher level of abstraction originating from knowledge and experience of the expert s and thus circumventing the needs for rigorous mathematical treatment of systems that has dominated the scientific world nowadays. Fuzzy logic could be a natural approach of higher cognitive process because it permits to precise the requisite data needed for inward at a call with the subjective ideas such terribly hot, warm, little cool etc.[2]

II. WHAT IS FUZZY LOGIC?

In this context, Florida may be a problem-solving system methodology that lends itself to implementation in systems starting from easy, small, embedded micro-controllers to giant, networked, multichannel computer or workstation-based data acquisition and control systems. It may be enforced in hardware, software, or a mix of each. FL provides an easy thanks to gain a particular conclusion primarily based upon obscure, ambiguous, imprecise, noisy, or missing input data. FL's approach to regulate issues mimics however an individual would build selections, solely a lot of quicker [2]. Fuzzy logic starts with and builds on a collection of user-supplied human language rules [1]. The fuzzy systems convert these rules to their mathematical equivalents. This simplifies the duty of the system designer and therefore the pc, and leads to way more correct representations of the manner systems behave within the world. Additional edges of symbolic logic embrace its simplicity and its flexibility. Fuzzy logic will handle issues with inaccurate and incomplete knowledge, and it will model nonlinear functions of capricious complexity.

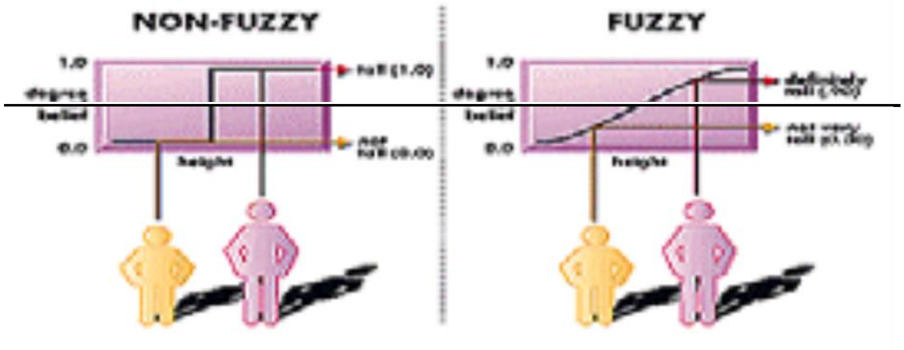

Fig. 1: shows fuzzy and non fuzzy sets

How does Fuzzy Logic works?

FL incorporates a straightforward, rule-based IF X AND Y THEN Z approach to a finding management downside instead of making an attempt to model a system mathematically. The FL model is empiricallybased, hoping on Associate in Nursing operator's expertise instead of their technical understanding of the system. For example, instead of coping with temperature management in terms like "SP =500F", "T <1000F", or "210C <TEMP <220C", terms like "IF (process is too cool) AND (process is getting colder) THEN (add heat to the process)" or "IF (process is too hot) AND (process is heating rapidly) THEN (cool the process quickly)" are used. These terms are imprecise and yet very descriptive of what must actually happen. Consider what you do in the shower if the temperature is too cold: you will make the water comfortable very quickly with little trouble. FL is capable of mimicking this type of behaviour but at very high rate.

Overview of Design

The first step in the design is to select the number of stations where the train stops. The distances between the stations are calculated and stored. The fuzzy logic controller is fed with the instantaneous values of speed and distance. The controller constantly compares the distance between the previous and the next station to distance traveled by the train towards the approaching station. For example, suppose we want to design a simple system to stop a sub way train that is approaching a station. We wish that the braking system is automatically activated as the train is near the halt point. For the braking system to be activated the brake controller is supplied with two inputs, current distance and speed of train from halt point from the station. Variable distance has been divided into four fuzzy sets. These are very close, close, far, very far. Same way base variable speed is divided into three fuzzy sets i.e. slow, medium, fast.

System Operating Rules

Fuzzy control rules are characterized by a collection of fuzzy IFTHEN rules in which the pre conditions and consequence involve linguistic variables a fuzzy rule have two components:

IF-part (also referred to as the antecedent) and THEN-part (also referred to as the consequent): FTHEN
The antecedent describes a condition, and the consequent describes a conclusion that can be drawn when the condition holds.

- If Distance is 'very close' and Speed is 'very slow' Then Brake is L.
- If Distance is 'very close' and Speed is 'slow' Then Brake is H.
- If Distance is 'very close' and Speed is 'fast' Then Brake is VH.
- If Distance is 'very close' and Speed is 'very fast' Then Brake is VH.
- If Distance is 'close' and Speed is 'very slow' Then Brake is L.
- If Distance is 'close' and Speed is 'slow' Then Brake is L.
- If Distance is 'close' and Speed is 'fast' Then Brake is H.
- If Distance is 'close' and Speed is 'very fast' Then Brake is VH.
- If Distance is 'far' and Speed is 'very slow' Then Brake is L.

- If Distance is 'far' and Speed is 'slow' Then Brake is VL.
- If Distance is 'far' and Speed is 'fast' Then Brake is L.
- If Distance is 'far' and Speed is 'very fast' Then Brake is H.
- If Distance is 'very far' and Speed is 'fast' Then Brake is L.
- If Distance is 'very far' and Speed is 'very slow' Then Brake is VL.
- If Distance is 'very far' and Speed is 'slow' Then Brake is VL.
- If Distance is 'very far' and Speed is 'very fast' Then Brake is L.

Linguistic Variables

In the last article the concept of linguistic variables was presented The fuzzy parameters of error (command-feedback) and errordot (rate-of-change-of-error) were modified by the adjectives "negative", "zero", and "positive". To image this, imagine the only sensible implementation, a 3-by-3 matrix. The columns represent "negative error", "zero error", and "positive error" inputs from left to right. The rows represent "negative", "zero",and "positive" "error-dot" input from high to bottom. This planar construct is called a rule matrix. It has 2 input conditions, "error" and "error-dot", and one output response conclusion (at the intersection of each row and column). In this case there square measure 9 doable logical product (AND) output response conclusions. The primary objective of this construct is to contrive the universe of doable inputs whereas keeping the system sufficiently in check.

1. Input degree of membership

- "error" = -1.0: "negative" = 0.5 and "zero" = 0.5
- "error-dot" = +2.5: "zero" = 0.5 and "positive" = 0.5

2. Antecedent & consequent blocks

(e = error, er = error-dot or error-rate)

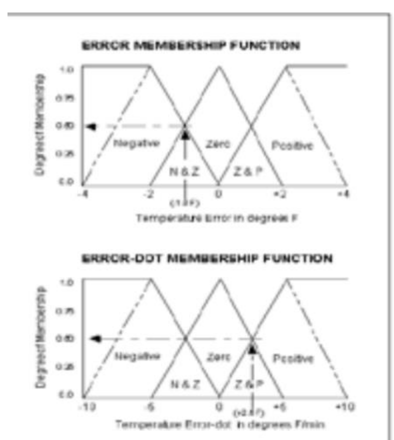

Fig. 2: shows error & error dot membership function

C. Membership Functions

A membership perform (MF) may be a curve that defines however every purpose within the input area is mapped to a membership price (or degree of membership) between zero and one [3]. The input area is typically said because the universe of discourse, a elaborate name for an easy thought. One of the foremost ordinarily used samples of a fuzzy set is that the set of tall folks.. If the set of tall folks is given the well-defined (crisp) boundary of a classical set, we'd say all folks taller than vi feet ar formally thought-about tall. But such a distinction is clearly absurd. It may be to think about the set of all real numbers larger than vi as a result of numbers belong on Associate in Nursing abstract plane, however once we need to speak regarding real people, it is unreasonable to call one person short and another one tall when they differ in height by the width of a hair. A Fuzzy control system is a MISO (multiple input single output) control system. In such case the fuzzy rule is modified as: If (a is B) * (c is D) * (e is F) . . . . . . THEN (x is Y)

Where * denotes AND/OR operation and a, c, e and x are variables and B, D, F and Y are fuzzy sets.
The variable distance has been divided into four fuzzy sets:
Very close --> zed function
Close --> triangular function
Far --> trapezoidal function
Very far --> sigma function
Same way base variable speed is divided into four fuzzy sets:
Very slow --> zed function
Slow --> triangular function
Fast --> trapezoidal function
Very fast --> sigma function
The first function that our fuzzy system (controller) is supposed to perform is that of fuzzification. For the defuzzification we have used the TSK algorithm.

D. The TAKAGI-SUGENO Fuzzy System
In the rule bases described hitherto with the IF-THEN rules of this chapter fuzzy sets both in the premises and in the conclusions are used. This kind of inference is called Mamdani Inference. modified inference scheme, developed by Takagi and Sugeno, represents the conclusions by functions. A rule of this form will be

IF x_1 **is** A_{r1} **AND** x_2 **is** A_{r2} **...AND** x_n **is** A_{rn} **THEN** $u = f_r(x_1, x_2, \ldots, x_n)$**.**

The structures of the premises are the same as for the Mamdani inference. However, in the conclusion all linguistic terms Br are substituted by the functions fr, and therefore it is not necessary to define a priori linguistic terms Br (u) for the conclusions. The function fr represents a direct mapping from the input space X1 x X2 x…….x Xn with the input values r1,r2,r3,…….,rn to the output space u.

The connective operation in a rule is in this case performed via the degree of relevance Hr of the premise of the rule Rr and the function fr in the conclusion. The final output is determined as a

$$u' = \frac{\sum_R H_r\, f_r(x_1, x_2, \ldots, x_n)}{\sum_R H_r}.$$

The effort of performing a defuzzification is saved, as the crisp value is directly determined by the inference operation and this makes this method attractive. The Takagi-Sugeno fuzzy system builds an overall combination of functions , which are valid in some range. If the membership functions of the fuzzy sets in the premises are overlapping, the transition between the functions is always continuous. For the special case of linear functions

$$f_r(x_1, x_2, \ldots, x_n) = \sum_{\nu=1}^{n} c_{r\nu}\, x_\nu$$

The coefficients crv can be determined by some identification procedure.

III. STEPS & ALGORITHM IN VHDL

A. Steps for VHDL programming [5]:

1. Function Binary to Integer.
2. Function Integer to Binary.
3. Define Z function logic.

4. Define S function logic.
5. Define Triangular function logic.
6. Define Trapezoidal function logic.
7. Define main module signals & logic.

B. Algorithms:

Table1 : shows various algorithms

Algorithm: For Z function

1. Input the parameters A & B membership grade of Z function.
2. Enter the value of x.
3. If x<A, then Q=1.
4. If x>B, then Q=0.
5. If A<x<B then Q= (B-x)/ (B-A)

Algorithm: For S function

1. Input the parameters A & B membership grade of S function.
2. Enter the value of x.
3. If x<A, then Q=0.
4. If x>B, then Q=1.
5. If A<x<B then Q= (x-B)/ (B-A).

Algorithm: For Triangular function

1. Input the parameters A & B membership grade of Triangular function.
2. Enter the value of x.
3. If x<A, then Q=0.
4. If A<x>B then Q=(x-A)/(B-A)
5. If B<x<C, then Q=(C-x)/(C-B).
6. If x>C then Q=0.

Algorithm: For Trapezoidal function

1. Input the parameters A & B membership grade of Trapezoidal function.
2. Enter the value of x.
3. If x<A, then Q=0.
4. If A<x<B then Q=(x-A)/(B-A)
5. If B<x<C, then Q=1
6. If C< x>D then Q= (D-x)/ (D-C).[5]

IV. Simulation Results

The brake is applied at a distance of halt position from the station.
The speed gradually decreases and exactly at the station train stops [6]. This can be verified from outputs given below:-

1. Z function:

2. S function:

3. Triangular function:

4. Trapezoidal function:

5. Main module output:

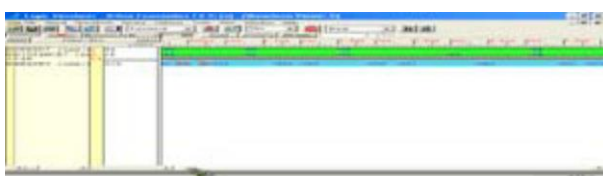

Fig. 3 : Simulation Results

IV. CONCLUSION

The use of symbolic logic controller offers a swish braking system. Developing and testing a prototype model of fuzzy logic controller can further prove the accuracy of the system for braking in subway trains. For a future development of this project, the Fuzzy Logic Controller designed can be enhanced by applying more rules. By then, it can produce better response. The response ought to be higher will|and may|and might} be applied to a true hardware model to watch the $64000 response and however can improve the system.

REFERENCES

1. *Ahmad M.Ibrahim "Applied fuzzy logic controllers". Prentice hall India.*
2. *John Yen, Reza Langari "Fuzzy Logic Intelligence Control and Information". Pearson Education Pvt Limited.*
3. *Timothy J.Ross "Fuzzy Logic with Engineering Applications". McGraw Hill International Editions.*
4. *J. Bhasker, "A VHDL Primer". Pearson Education, ThirdEdition, 1999.*
5. *Designing of VHDL circuits. [Online] Available: http://www.csee.umbc.edu/help/VHDL/design.html.*
6. *Overview of VLSI & VHDL circuits. [Online] Available:http:// students.washington.edu/kevinduh/VLSI/overview.html.*