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IMPLEMENTATION OF SMOOTH TRANSITION WALL FOLLOWER USING FUZZY LOGIC

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Abstract : **This paper proposes the wall follower using fuzzy logic. Here fuzzy Logic used is Sugeno modelling. The advantage of Sugeno is that it provides sharp response near boundaries with less time. In this work, the development of an autonomous wall following robot is presented. The wall following controller is a two input, two output system. The inputs are the speeds of the two rear wheels. For the embedded fuzzy logic controller, the behaviour must be approximately encoded for the target processor, and then downloaded to the system for execution. The largest system is a small software for execution. The detection of a wall by the sensors activates the controller which simply attempts to align the robot with the wall at a specified reference distance. The proposed model performance is compared with Mamdani approach. All simulations are done in MATLAB.**

Keywords – wall follower, fuzzy logic, robotics, Mamdani technique etc.

I. INTRODUCTION

Mobile robots are the mechanical devices generally have the ability to perform various tasks in real environment like wall following, path tracking, navigation and many other. Mobile roots have the ability that it moves in a environment with certain degree of autonomy. Autonomous navigation deals with the external sensors that is useful for capture the information from the environment. There are various sensors used most common are the distance sensors like laser, ultrasonic etc. Theses sensors are used for detecting obstacles and for measuring the distance to walls that are close to the robot path. [1]

Advance autonomous robot can also be used in indoor as well as outdoor environment have equipped the ability to move through corridors, to intimate the walls, to turn corners and to enter the rooms where there is a open space. Navigation of mobile robots covers a large area of applications and large number of technologies. It proceeds on some techniques used in ancient time as well as many other advance technology used now a days of the space science and engineering. The desired robotic wall – following behaviour is specified by a scalar fitness function describing the performance of the controller. Each controller is tested for a training set of environments which differ in the geometry and dimension of walls and obstacles.

The robot is started in every environment at various initial positions and headings. A single run either ends when the robot collides with a wall of if a maximal number of control steps Nmax is exceeded. In a gross abuse of ethological terminology, the robot experiences pain when it collides with an abject and receives pleasure of going straight. A collision terminates a run and hinders the robot from experiencing further pleasure. Or in other words, pain manifests itself through the denial of future pleasure. [2]

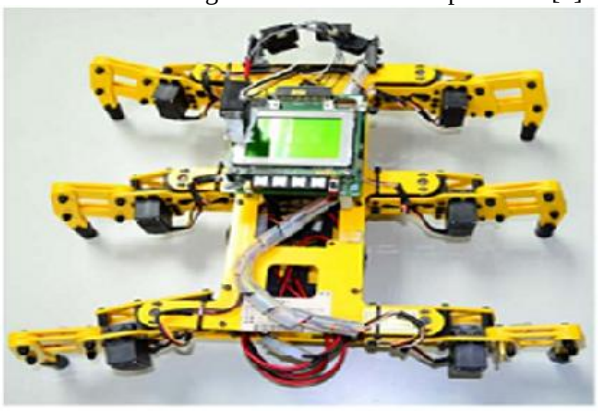

Figure 1: View of hexapod robot[2]

A robot that gyrates on the spot without moving forward avoids pain. In order to elude the revolution of this trivial, but inadequate control strategy, the fitness function includes a pleasure component that at each control step reward the robot for going straight. For many real world problems, in particular robot behaviour design, a mathematical precise and complete solution is not only evitable, but also often infeasible. [3]

Fuzzy systems exploit this tolerance for impression by aggregating similar states into coarse granules. The remaining design task is to find the correct set of fuzzy if then rules, rather than learning a general analytic function from sensory perceptions to control actions. Furthermore, a granular representation avoids the tendency of evolutionary algorithms to generate brittle solutions that are over-adapted to peculiar features of the problem. In addition to the fuzzy database, the human expert can use his domain knowledge about the robot's mission and environment to find an initial set of fuzzy rules. Usually, this initial rule-set does not constitute a complete solution but merely a small collection of primitive features supposedly beneficial to achieve the

desired behaviour. The corridors vary in their dimensions and geometry, so that a controller needs to generalize over different environments. Adaptation to a particular prototypical environment bears the risk of brittleness and failure in novel situations.
Turns in confined space require precise and smooth manoeuvring because of the wide swing described by the robot's tail. Noisy and incomplete sensor data can mislead the robot about its actual situation. [4]

The paper is organized as follows. In Section II, it describes MR images. In Section III, it describes the proposed steps used in processing technique. The results are given in Section IV. Finally, conclusion is explained in Section VI.

II. FUZZY LOGIC

Fuzzy Logic is a mathematical concept to intimate the human method of thinking and learning. First person to publish the idea of fuzzy logic was Lotfi Asker Zadeh in 1965. In 1972 Professor Toshire Terano organized the worlds first working group on fuzzy systems and F.L. Smidth & Co. In 1980 was first to market fuzzy expert systems. Due the wide range of applications fuzzy has been accepted as a most outstanding technology. One of the ultimate applications of fuzzy logic was subway system in sendai city of Japan. The result indicates that fuzzy logic control was much better than traditional one. Fuzzy logic deals with the concept of more than one value i.e. many valued. The term "FUZZY" deals with the concept that logic involved cannot showed "Completely true" or "completely false" value the logic handle the values between them i.e. partially true, Fuzzy deals with reasoning instead of fixed and exact value. [5]

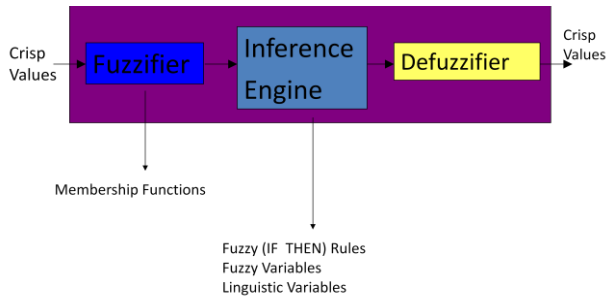

Figure 2: Fuzzy system[5]

Fuzzifier performs the various task like measurements of the input variables, scale mapping and fuzzification Thus fuzzifier transformed the measured signals into fuzzyone. This can performed by using membership functions. Membership functions consists of value between 0&1. If any quantity belongs to the fuzzy set than its value between 01.1 if any quantity that doen't belongs to fuzzy set than its value is 0. In inference engine if-then rules are evaluate and the output is inguistic value. It performs the task of defuzzification. IT gives a non-fuzzy crisp value. [6]

Fuzzy Inference System

Thee are two inference system for fuzzy i.e. MAMDANI & SUGENO These two techniques are used in fuzzy logic but both are different from each other. The main difference between them is method of generation of crisp output from the fuzzy inputs. In Mamdani FIS uses the method of defuzzification of the fuzzy output whereas Sugeno FIS uses weighted average to give the crisp output. In comparison with the both Mamdami and Sugeno the processing time of Sugeno is much better than Mamdami because in this weighted average is used in replacement of time consuming defuzzification.

Linguistic Variables And Fuzzy If-Then Rules :

In 1973, Professor Lotfi Zadeh initiate the idea of linguistic of 'fuzzy" variables. He think them as a linguistic things or linguistic words, instead of numbers. He consider sensor input is noun like temperature, pressure, displacement, flow etc. Since error is just. The fuzzy variables themselves are adjectives that alter the variable like large positive error, small positive error, zero error etc. Thus a a minimum, one could simply have positive, zero and negative variables for each of the parameters. In additional to these ranges there are very large and very small range which can also be added but they are not essential in a basic system. If once the linguistic variables and value are defines, the rules of the fuzzy inference system can be produced. These rules helps to map the fuzzy input to fuzzy outputs. This mapping can implemented with the help of compositional rule of inference. This rule is not a big thing it is just a very familiar for if-then conditional form, A fuzzy if then rule is also known as fuzzy rule there is a assumption in the form.

If x is A then y is B [7]

III. WALL FOLLOWER USING FUZZY LOGIC

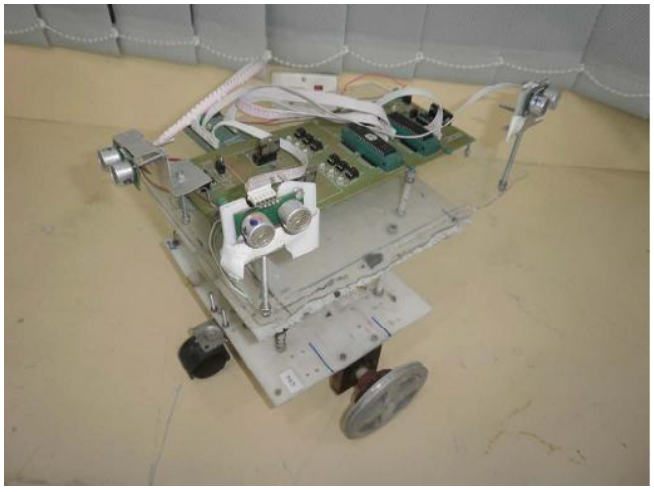

Figure 3: Wall Follower Robot[7]

The consumption and design of fuzzy controller for the wall-following behaviour does not pose an extremely difficult engineering problem. Nevertheless, the particular realization of the robot causes additional challenges. The perception vector provides only limited information on the environment, for instance if does not discriminate sufficiently between right-angle turns and dead-ends or does

not indicate if a major obstacle in a corridor s vary in their dimensions and geometry, so that a controller needs to generalize over different environments. Adaptation to a particular prototypical environment bears the risk of brittleness and failure in novel situations. Turns in confined space require precise and smooth manoeuvring because of the wide swing described by the robot's tail. Noisy and incomplete sensor data can mislead the robot about its actual situation. [8]

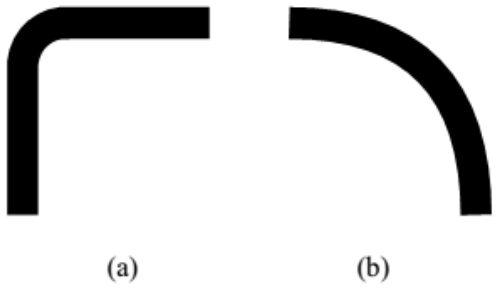

Figure 4 : Straight & Curved Trajectory [9]

Although a relatively new concept, fuzzy logic is being used in many engineering applicants because it is considered by the designers to be the simplest solution available for the specific problem. What gives fuzzy logic advantages over more traditional solutions is that it allows computers to reason more like humans, responding effectively to complex inputs to deal with notions such as 'too hot', too cold' or 'just right'. Furthermore, fuzzy logic is well suited to low-cost implantations based on cheap sensors, low-resolution analog-to-digital converters, and 4-bit sensors, low resolution analog-to-digital converters, and 4-bot or 8-bit converter or 8-bit one-chip microcontroller chips. Such systems can be easily upgraded by adding new rules to improve performance of add new features. In many cases, fuzzy control can be used to improve existing traditional controller systems by adding an extra layer of intelligence to the current control method.[10]

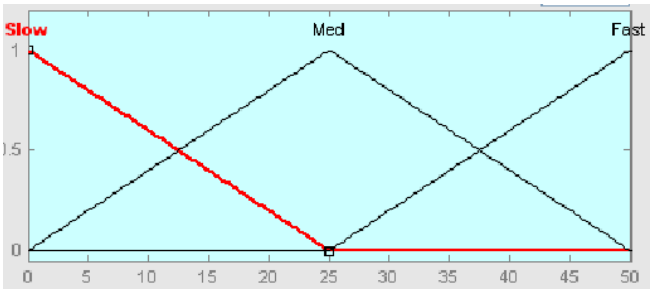

Figure 5: Fuzzy membership Functions[11]

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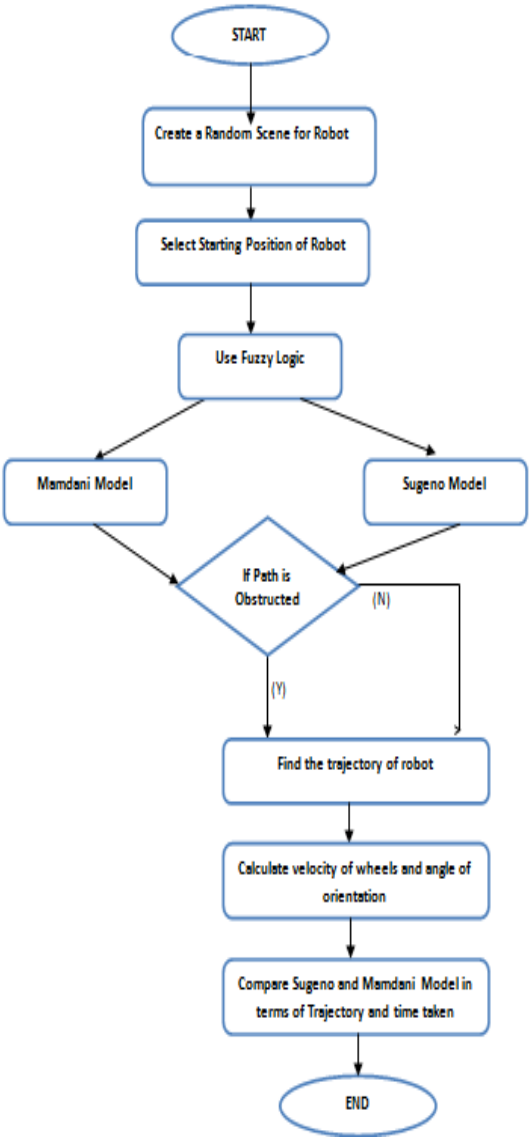
If x is A then y is B

Steps of Proposed System :



IV RESULTS

The first step is to select a random scene for robot i.e. to select a path where robot moves. Next step is to select a starting point of robot. There are two types of fuzzy logic ie. Mamdani and Sugeno, these two logics than apply There are different parameters which are used to distinguish between the Mamdani model from the sugeno one. Firstly find the trajectory of robot, than calculate the velocity of wheels i.e. left wheel velocity and right wheel velocity. Next parameter is angle of orientation. Last step is to compare the parameters of Mamdami and Sugeno and find the better one. This process can also be perform for different scenes.

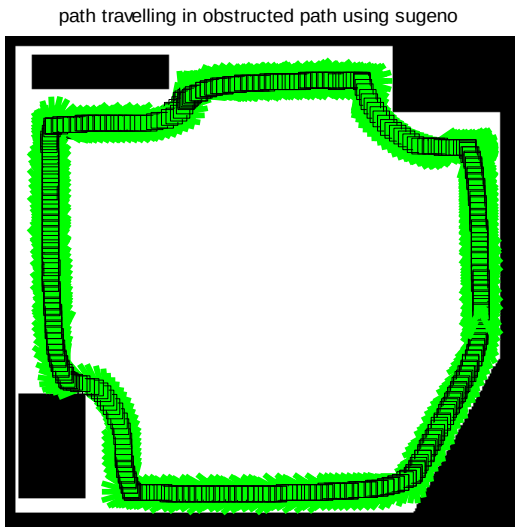


Figure : Wall Robot in Obstructed Path by Proposed Approach

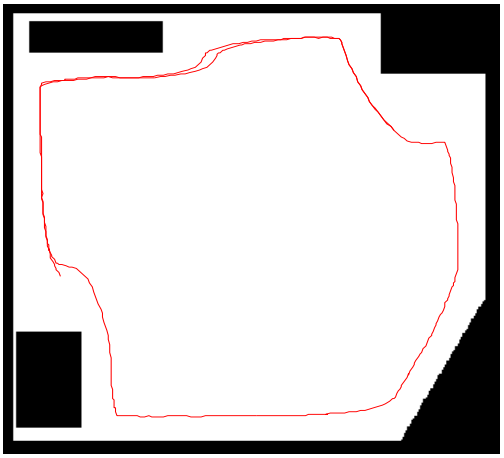


Figure : Wall Robot by Mamdani Approach

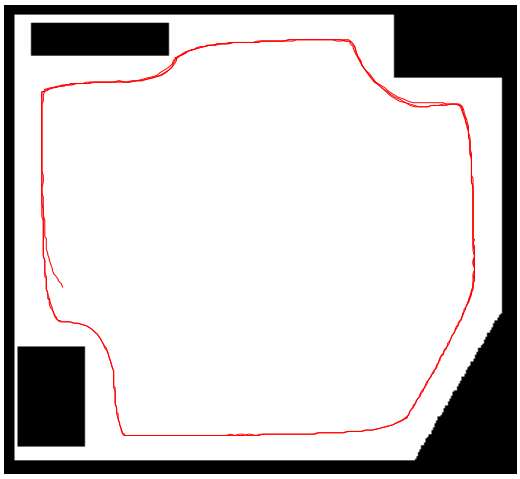
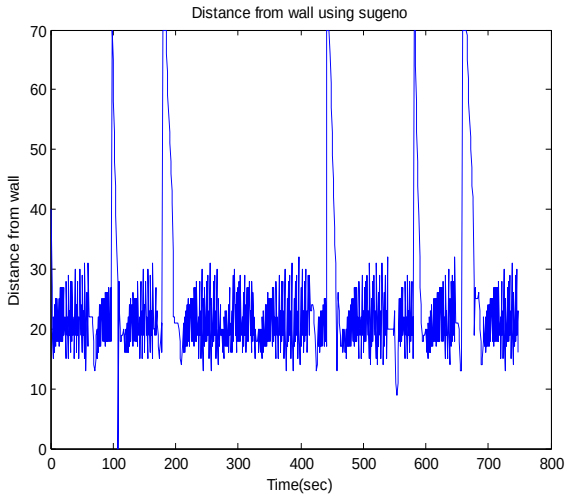


Figure : Wall Robot by Proposed Approach



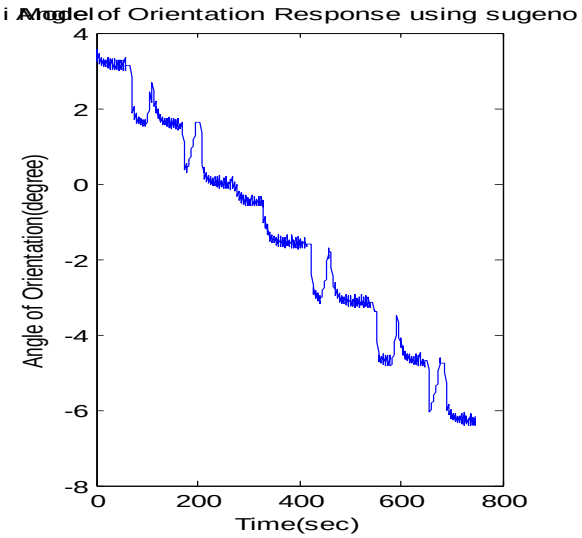


Table 1: Performance Comparison

Parameter	Mamdani Model	Proposed Model

Time (sec)	42	40

V CONCLUSIONS

In this work it presented the wall follower robot using fuzzy logic. Here two fuzzy logics are used one is mamdani and another one is sugeno model. In this work there is a comparison between two modelling techniques and find which gives the better results. There are some parameters i.e time, distance from the wall ,angle of orientation used for comparison. Mamdani method shows less flexibility. Sugeno method follow the wall in better way .In case of obstructed path Sugeno method give more optimum results. Weighted average (Sugeno method) exhibits best results among all the methods.

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