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Attitude Control of Robotic System According to Fuzzy Logic

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Abstract— At Present world, the working intention, capability, and priority of a robot have been changed on demand. Robotics requires a working skill of electronics, mechanics, and software. When Software and machines come together there is must need of logic. Without logical conception, the robotic system couldn't be work properly. When we think about the controlling system of robot then it's a matter of complexity that which method or logic should establish. If errorless attitude needed then Fuzzy Logic is essential. It's like an umbrella term for any robotic system that does something smart. This solution will help to solve the problem on decision making that why fuzzy logic is an essential technique for controlling the attitude of robotic system.

Keywords— Robotics, Fuzzy Logic, Artificial Neural Network (ANN), Attitude Control, PID controller, Controlling system, Robotic Engineering, Sensing.

I. INTRODUCTION

Time changes and the demand of the robotic system increases a lot. There are mainly two types of robot, Industrial and Mobile Robots. The industrial robot is automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications. Mobile robots usually move around in their environment they are not fixed to one physical location. These can be AMR (AMR - autonomous mobile robot) in this way they are capable of navigating the accurate things and control the uncontrolled devices without the need for physical or electro-mechanical guidance devices. All of this Robot dependent on the program and a set of machines. Both types of robot needed three essential characteristics these are sending or Receiving signal as input, Working Capability or Computational method and intelligent output or Result. To complete those characteristics there must have some logical rules that should be establish into the robot as programming infrastructure. If we want to establish the artificial neural network of a robot then Fuzzy Logic is the must. Fuzzy Logic simulates the human decision-making techniques and acts with hazy and imprecise information. It deals with ambiguous and imprecise information. This makes distortion of the real-world problems which is based on the amount of truth rather than

usual true/false or 1/0 like Boolean logic. The Researcher Zadeh in his research paper "Fuzzy Sets" first introduced us the Fuzzy logic and earlier in 1965 The Nobel man Lofti introduced us in shortly. At present, there is a vast need of the logic even its uses in a various sector for various purpose fulfil. On the other way, artificial neural network (ANN) is a network of efficient computing systems the central theme of which is borrowed from the analogy of biological neural networks. Where Fuzzy logic is largely used to define the weights, from fuzzy sets, in neural networks. In the Fuzzy logic of neural networks, the values must not be crusty and the system should be done in parallel. Even in a fuzzy system, we can learn the data easily with the help of artificial neural networks.

II. ROBOTIC SYSTEM AND ATTITUDE

Basically Robots are the artificial agents according some predefined system, which acts in the real world environment as programmed wise or depends on sensing. Especially AI is a part of robotics, which is a combination of EMC Engineering that means Electrical Engineering, Mechanical Engineering, and Computer Engineering for making successful design and application of robots. The attitude of a robot varies depending on the basis sensing system and decision making process that's totally is dependent on logic. Robot system is composed of an agent and its environment. The agents act in their environment. The environment may contain other agents, as shown in Fig.1.

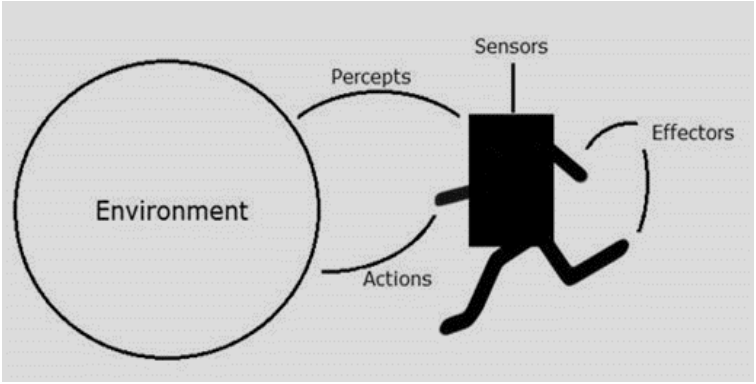

Fig.1 Agent and Environment

From the environment when the system sensing there works a logic that decides what types of precepts is receiving and after that some action will be taken on the basis of program. Robot always does the logical behaviour according to the input. So the Logic must be correct to act accurately. On the other hand PID controller is needed here which is universally accepted and most commonly used controller in industrial application because PID controller is simple, provide good stability and rapid response. PID stands for proportional, integral, derivative. For managing the loop system of Robot there must need a PID controller which will help to control the Precepts and actions to get the output of a robot accurately. The Closed loop system of three-label PID (proportional–integral–derivative) Controller shown in Fig.2.

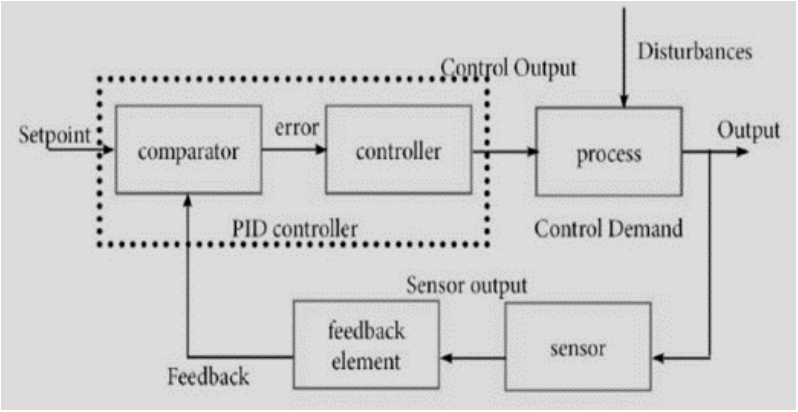

Fig. 2. The closed loop system

III. FUZZY LOGIC TO CONTROL THE ATTITUDE OF ROBOTIC SYSTEM

Human Have positive or negative attitude But Robot don't have only the positive or negative attitude. Robot has the Logical attitude depending on sensing and logic that is drawn in the robotics system. According to the Theory of Fuzzy Logic we know that it is a method of reasoning that resembles human reasoning. The access of fuzzy logic imitates the way of decision making in humans that involves all average possibilities between digital values YES and NO. The human decision is a range of possibilities between YES and NO, such as −

CERTAINLY YES
POSSIBLY YES
CANNOT SAY
POSSIBLY NO
CERTAINLY NO

The main points of using Fuzzy logic are, Fuzzy logic is useful for commercial and practical purposes. It can control machines and consumer products. It is not sure that it will give the accurate reasoning, but most likely it will be an acceptable reasoning. In this way Fuzzy logic independently gives a guidance to deal with the ambiguity in engineering. Whereas the robot operate in real physical world and the Inputs of robots is analogy signal in the form of speech waveform or images. They need special hardware with sensors and effectors where acceptable reasoning is needed. The Fuzzy logic does the same thing. For a successful fuzzy logic interface the user or the provider must have to implement a knowledge base that will contains the membership function with some set of rules and the system input will be taken by the interface kernel. According this the basic structure of fuzzy logic system in fig.3.

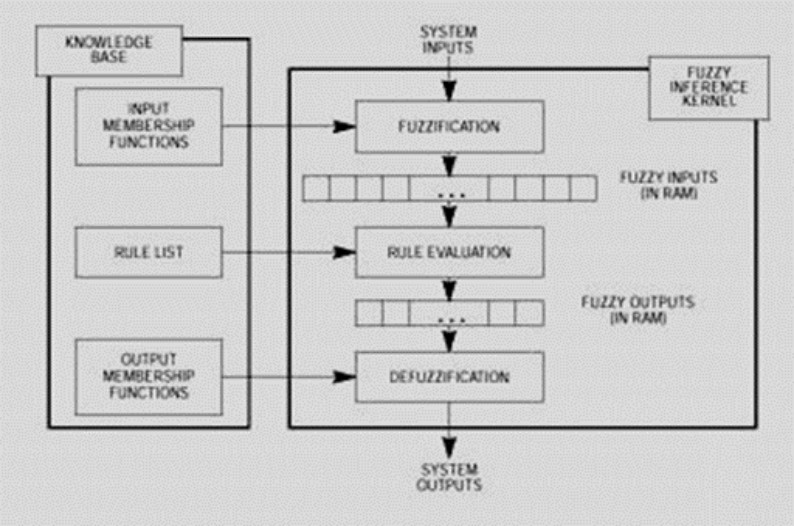

Fig. 3. The basic Structure of fuzzy logic

A. *Fuzzy Logic Systems Architecture*

It has four main parts these are listed below in details.

1) Fuzzification Module: It transforms the system inputs, which are crisp numbers, into fuzzy sets. It splits the input signal into five steps shown in Fig.4. Basically this is a traditional system, in details is figure out in bellow points.

LP	x is Large Positive
MP	x is Medium Positive
S	x is Small
MN	x is Medium Negative
LN	x is Large Negative

Fig.4 Five steps of input signal

2) Knowledge Base: Here It will store using IF-THEN rules in straight.

3) Inference Engine: It replicate the human argument action by making fuzzy inference on the inputs and IF-THEN rules.

4) Defuzzification Module: It mutates the fuzzy set of logics which is obtained by the assume engine into a fresh value.

B. *Reasons to Use the fuzzy logic to control the attitude of robotic system*

Robotic sensing used to perceive the accurate environment and sends it to robots that uses algorithms which require a feedback. Basically the visual sensing system of a robot is based on anything from the traditional camera, sonar, and laser to the new technology radio frequency identification (RFID) that will transmit the radio signals which would be tagged on an object that spills back an identification code. This will contains mainly the three procedures, these are—sensation, estimation, and matching. After sensing the thing accurately then the topic of belief comes. To Control the Attitude there must need some strong logic. That's why the fuzzy logic comes. The use of a fuzzy system mainly requires some expert knowledge about the controlled process and neural networks which need a sufficient number of learning patterns criteria. At present the fuzzy logic is widely used to define the weights from fuzzy sets, in artificial neural networks. When founded accurate values are not possible to apply, then fuzzy values are used. I had already studied and founded that method of training and learning that help neural networks perform better in unexpected situations. At that time fuzzy values should be more preferable than the fresh values which has found. When we use fuzzy logic in ANN then the values must not be crisp and the process should be in parallel. To establish a fuzzy system we all need to set up a microcontroller and the micro controller must follow some instructions. If we design like that there will be mainly 3 instruction set these are MEM which will evaluates the trapezoidal membership function and the REV/REVW which will used to performs un/weighted Minimum/maximum rule evaluation and the WAV that performs as average defuzzification. These will work accordingly to the basic rule of FL we described on fig.3. Basically the MEM function works for y-value after getting the input as x and membership function. The MEM function always will produce the fuzzy values and also will get the fuzzy output. If we apply according these in an robust sensing air-cooler which able to get the temperature of outside and inside both according Resistive Temperature Detectors (RTD) simply sensor then here is an example of work with 3 conditions: [1] if the climate is FROSTY and air is HIGH, then the temperature set on HIGH [2] if the climate is WARM and air is low/medium, then the temperature set on LOW [3] if the climate is HOT and air is LOW, then the temperature is off. This will evaluate with REV/REVW. In defuzzification Strategy (WAV) when the raw output is evaluated then it will evaluate a sum of all amount to get a decision according to the REV/REVW. There must need a kernel which contains all of these instructions that helps to make a complete fuzzy system. Fig.5. Here is a membership function of FL.

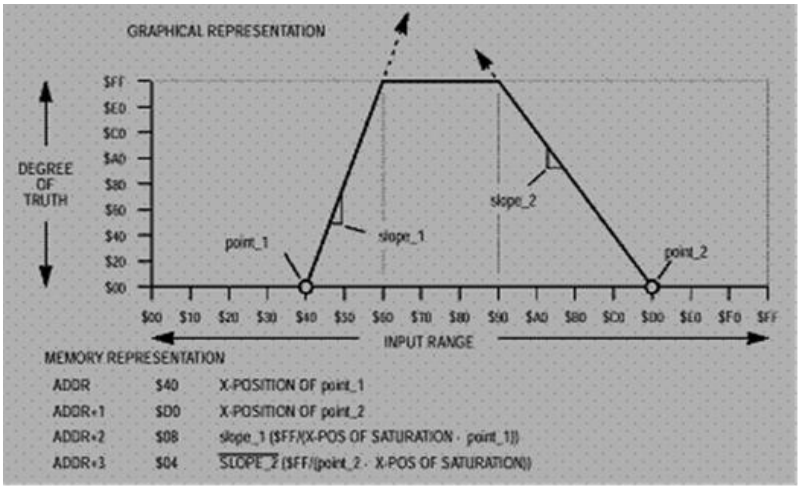

Fig.5. Membership function of FL in trapezoidal form.

Here the membership function always follow a technique that is drawn in fig.6. Here is a graphical technique.

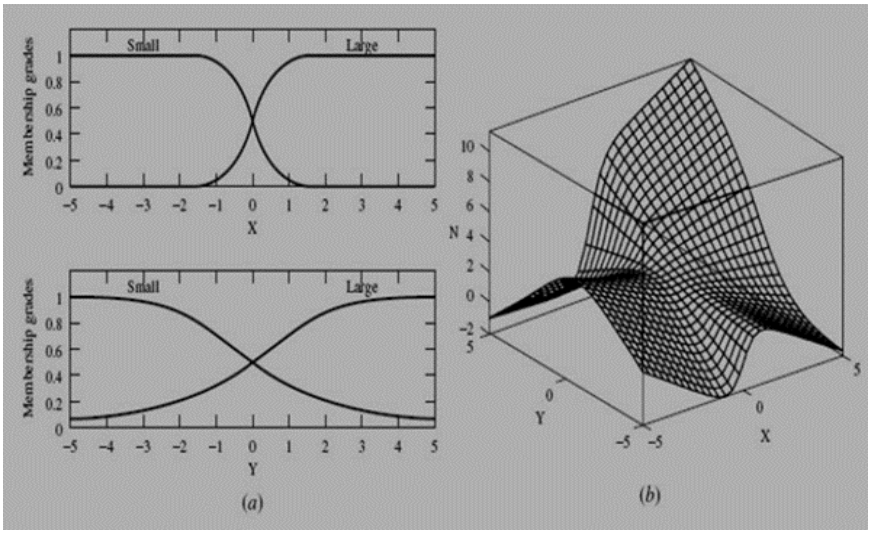

Fig. 6. Graphical technique of inference

According all of these we can control the attitude easily using the upper criteria. That's why it's like an undeniable truth is only fuzzy logic (FL) can easily control the complex and all types of sensing and robotic attitude. Thus we get a standard output. Here is a conceptual model of getting the accurate output. Here the value should be fresh or crisp.

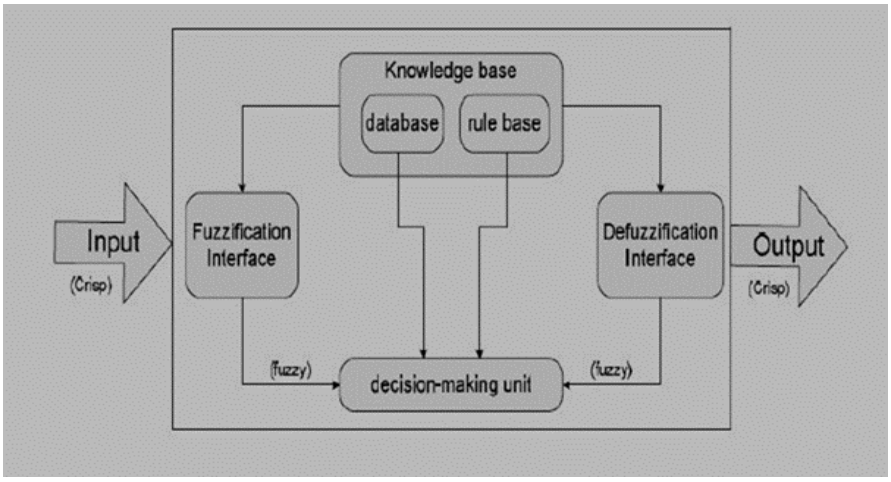

Fig. 7. Input output overview according FL

C Areas of Fuzzy Logic

1) *Aerospace:* In aerospace, fuzzy logic is used in the following areas - Altitude control of spacecraft, Satellite altitude control, Flow and mixture regulation in aircraft dicing vehicles
2) *Automotive:* In automotive, fuzzy logic is used in the following areas -Trainable fuzzy systems for idle speed control, Shift scheduling method for automatic transmission, intelligent highway systems, and Traffic control.
3) *Business:* In business, fuzzy logic is used in the following areas −Decision-making support systems, Personnel evaluation in a large company
4) *Defence:* In defines, fuzzy logic is used in the following areas − Underwater target recognition, Automatic target recognition of thermal infrared images, Naval decision support aids, Control of a hypervelocity interceptor, Fuzzy set modelling of NATO decision making.
5) *Electronics:* In electronics, fuzzy logic is used in the following areas − Control of automatic exposure in video cameras, Humidity in a clean room, Air conditioning systems, Washing machine timing, Microwave ovens, Vacuum cleaners.
6) *Finance:* In the finance field, fuzzy logic is used in the following areas − Banknote transfer control, Fund management, Stock market predictions
7) *Industrial Sector:* In industrial, fuzzy logic is used in following areas − Cement kiln controls heat exchanger control, Activated sludge wastewater treatment process control, Water purification plant control etc.
8) *Manufacturing:* In the manufacturing industry, fuzzy logic is used in following areas − Optimization of cheese production, Optimization of milk production
9) *Marine:* In the marine field, fuzzy logic is used in the following areas − Autopilot for ships, Optimal route selection, Control of autonomous underwater vehicles, Ship steering
10) *Medical:* In the medical field, fuzzy logic is used in the following areas − Medical diagnostic support system, Control of arterial pressure during anaesthesia.
11) *Transportation:* In transportation, fuzzy logic is used in the following areas − Automatic underground train operation, Train schedule control, Railway acceleration, Braking and stopping.
12) *Pattern Recognition and Classification:* In Pattern Recognition and Classification, fuzzy logic is used in the following areas − Fuzzy logic based speech recognition, Fuzzy logic based, Handwriting recognition, Fuzzy logic based facial characteristic analysis, Command analysis, and Fuzzy image search.
13) *Psychology:* In Psychology, fuzzy logic is used in following areas − Fuzzy logic based analysis of human behaviour, Criminal investigation and prevention based on fuzzy logic reasoning.

IV. CONCLUSIONS

In robotics system we will get the desired attitude when Fuzzy logic will be applied according to the PID controller. There is also a reverse relationship between neural network and fuzzy logic. Two major reasons to build neural trained fuzzy logic are new patterns of data can be learned easily with the help of neural networks hence, it can be used to pre-process data in fuzzy systems. Other is its capability to learn new relationship with new input data, can be used to refine fuzzy rules to create fuzzy adaptive system. Fuzzy logic is widely implemented to decide the weights, from fuzzy sets, in artificial neural networks. That's why Fuzzy logic is essentially needed to control the system of AI of robotics.

ACKNOWLEDGEMENT

In general no one can able to give the standard definition for a robot. Yet, there are some crucial quality that a robot must have and this helps us to decide what is and what not a robot is. It will also help us to decide what appearance we will need to frame into a machine before it can count as a robot. This Conference paper was done to get more clear view of the robotic system & how to control the attitude of that system efficiently. The Author would like to thank the numerous researchers upon whose work these design patterns are based. Also acknowledged a couple online picture illustrations used in this paper for clarifying the established ideas and technologies.

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