DESIGN & NAVIGATION OF MOBILE ROBOT

USING FUZZY LOGIC

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***Abstract* - Nowadays, the impacts of robots in industry are unquestionable, and robotic arms are implemented in most productive industries. Design and manufacture of this type of arm's are in demand in most of the industrial countries. Present working is focusing on mainly in the development of a robotic arm (manipulator) for the remote maintenance application especially used in Nuclear reactors. Here we are looking mainly on the Design, modeling and navigation by using fuzzy logic toolbox of a manipulator in virtual environment. The simulation of robot systems is becoming very popular, especially with the lowering of the cost of computers. The robot navigation has been done by considering inputs like left obstacle distance, right obstacle distance, front obstacle distance and heading angle and the outputs are left wheel velocity and right wheel velocity by using Matlab. The different membership functions like triangular and Gaussian are used to achieve the accuracy in navigation. Experimentally it is proved that the accuracy of Gaussian membership function over other membership function is more. So for mobile robot obstacles avoidance Gaussian membership function is most recommended for achieving accuracy in navigation.**

Keywords: fabrication, mobile navigation, inspection operations.

I. INTRODUCTION

The term Robot brings to our mind various images from some of the best science fictions like Isaac Asimov's I-Robot and the most recent movies like Terminator and Wall-E. The term robot was derived from the English translation of a fantasy play written in Czechoslovakia around 1920. Mankind has always strived to give life-like qualities to its artifacts in an attempt to find substitutes for himself to carry out his orders and also to work in a hostile environment.

The popular concept of a robot is of a machine that looks and works like a human being. The robot technology is advancing rapidly. The industry is moving from the current state of automaton to robotization, to increase productivity. Robots are now commonly employed in hostile environment, such as at various places in an atomic plant for handling radioactive materials.

A robot is defined in numerous ways by different people and organizations. The robot is defined by the Robot Institute of America (RIA): A robot is a reprogrammable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks. Robots are increasingly used in various applications like, handling dangerous materials, assembling products and inspection, Spray finishing ,polishing and cutting, military tasks, hospital operations, security systems, and agriculture.

II. LITERATURE SURVEY

Luk et al [1] has developed a climbing service robot to perform non-destructive testing of various welds on the main reactor cooling gas ducts at Sizewell 'A' Power Station in the UK. Yusoff et al [2] has developed an air conditional route wireless inspection robot. The movement and speed of the wireless inspection robot can be controlled remotely by using a joystick. M. Z. A. Rashid et al [3] has developed a Hexapod Robot with Maneuverable Wheel. Hexapod robot is a robot that has six legs to walk or move. The purpose of the hexapod robot with maneuverable wheel is to ease the movement either on the flat surface or on the inclined surface. B.L. Luk et al [4] developed the Robug IIs is a legged climbing robot designed to work in relatively unstructured and rough terrain. The sensing technique used in Robug IIs is mainly tactile sensing. . Mohd et al [5] has developed wireless mobile robotic arm for hazardous applications. The robot can able to orient its position forward, reverse turn right and left for a certain distance depending upon the operator. X.B. Peng et al [6] has developed FIVIS (flexible in-vessel inspection system) especially for EAST superconducting that has actively cooled plasma facing components (PFCs). Laurent Gargiulo et al [7] has developed an Articulated Inspection Arm (AIA) which aims at demonstrating the feasibility of a multi-purpose in-vessel Remote Handling inspection systems.

Y. Perrot et al [8] has proposed a part of the remote handling (RH) activities for the future fusion reactor. Cameron S and Probert P [9] the Oxford University Robotics Research Group has been working for several years to improve the ability of automated guided vehicles. The book includes work on control, sensing technologies, sensor management and data-fusion.

III. METHODOLOGY

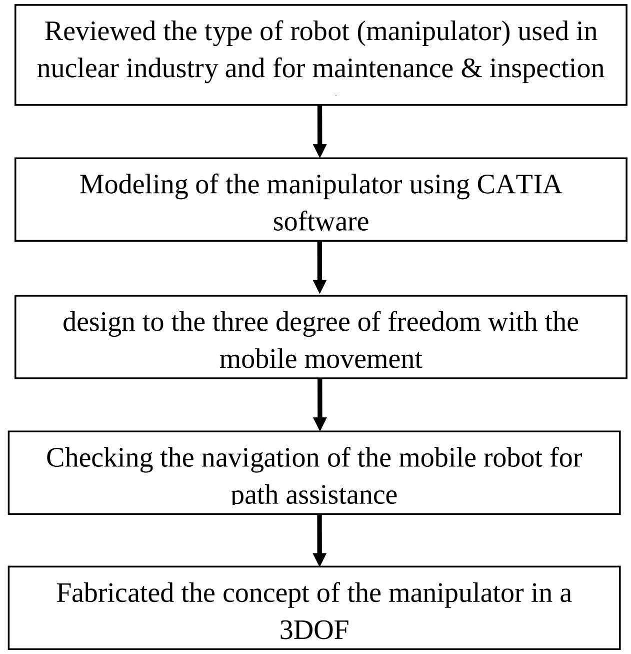

Fig. 1: Methodology of the work

III. FABRICATION OF MANIPULATOR FOR THREE DEGREE OF FREEDOM

A robotic arm is a type of mechanical arm can also term as manipulator, usually programmable, with similar functions to a human arm. The base of the robot is a linear joint which is driven by rack pinion mechanism. A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion shown in figure. After the base a linear, the manipulator after entering into the reactor has to orient up and down so for this a rotational joint is placed such that it can able to orient it angle. With the DC motor of certain torque is attached to the link to rotate on it own axis. The gripper is the end part of the manipulator, where it holds camera for visual inspection and in case of replacement of tiles it can catch a mechanical drive system and the other supporting devices also when it is going into the real time application. Design process is the integral part of Industrial Design and this project is an example for the effective utilization of design process. The main processes involved in building this robot are: machining the manipulator body, machining the drive mechanism for the manipulator, shearing of the sheet metal, bending of the sheet metal, machining the mobile platform, procuring the drives, control units, wheels, battery, etc.,

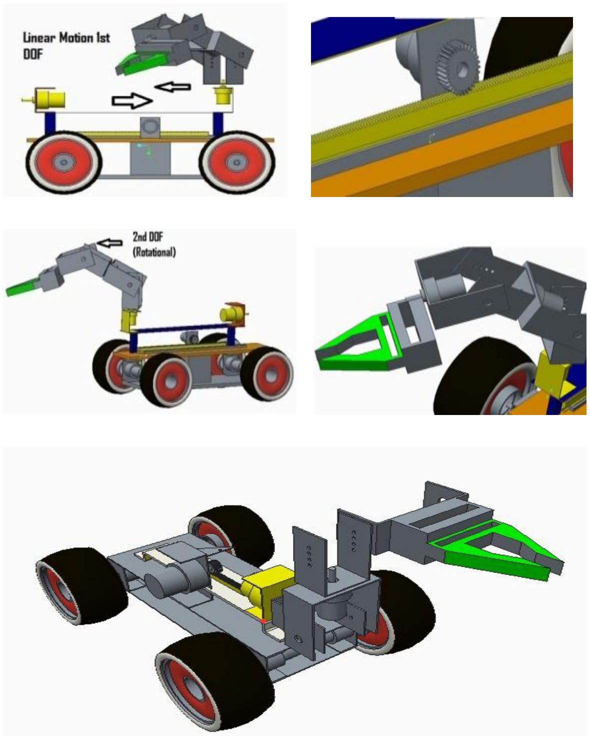

Fig. 2: CAD models of the manipulator

This manipulator has few distinctive parts that define its basic shape and structure which are not readily available off the shelf and had to be designed and fabricated exclusively.

Fig. 3: navigated mobile robot using fuzzy logic

This describes about inputs such as left obstacle distance, right obstacle distance, head angle and front obstacle distance.

The ranges for triangular membership functions are as follows:

1. Left obstacle distance (0-4)
2. Right obstacle distance (0-5)
3. Front obstacle distance (0-6)
4. Heading angle (-180-180)
5. Left wheel velocity (0-2)
6. Right wheel velocity (0-3)

The following are the rules for the triangular membership function

1.If(LOD is S)and(ROD is S)and(FOD is S)and(HA is S)then(LWV is S)(RWV is S)
2.If(LOD is S)and(ROD is M)and(FOD is M)and(HA is M)then(LWV is F)(RWV is M)
3.If(LOD is M)and(ROD is F)and(FOD is S)and(HA is F)then(LWV is M)(RWV is S)
4.If(LOD is F)and(ROD is S)and(FOD is M)and(HA is S)then(LWV is F)(RWV is M)
5.If(LOD is S)and(ROD is M)and(FOD is S)and(HA is M)then(LWV is S)(RWV is F)
6.If(LOD is M)and(ROD is S)and(FOD is M)and(HA is S)then(LWV is F)(RWV is S)
7.If(LOD is F)and(ROD is M)and(FOD is F)and(HA is M)then(LWV is S)(RWV is F)
8.If(LOD is S)and(ROD is M)and(FOD is M)and(HA is F)then(LWV is S)(RWV is S)
9.If(LOD is F)and(ROD is S)and(FOD is F)and(HA is F)then(LWV is S)(RWV is M)
10.If(LOD is S)and(ROD is M)and(FOD is M)and(HA s S)then(LWV is M)(RWV is F)
11.If(LOD is M)and(ROD is M)and(FOD is M)and(HA s M)then(LWV is S)(RWV is M)
12.If(LOD is S)and(ROD is S)and(FOD is F)and(HA is S)then(LWV is M)(RWV is S)

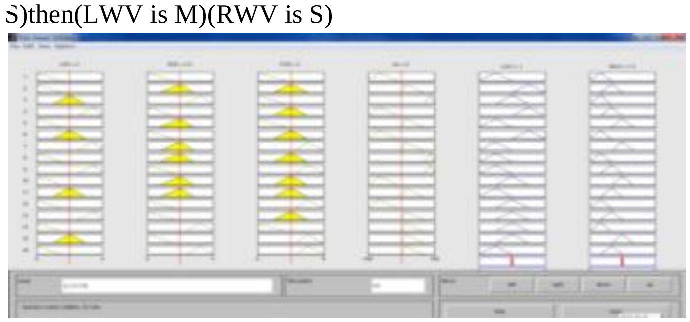

Fig. 4 Rule viewer for triangular membership function

Similarly rules are framed for the Gaussian membership function also.

Velocity analysis for triangular and Gaussian membership functions.

Table: 1 Result of velocity control using triangular membership

Left obstacle (m)	Right obstacle (m)	Front obstacle (m)	Heading angle (Degree)	Left wheel vel m/sec	Right wheel vel m/sec
0.105	0.883	0.47	Any	0.5	0.501
0.346	0.733	0.47	Any	0.5	0.501
0.496	0.733	0.47	Any	1	1.5
0.947	0.733	0.47	Any	0.5	0.5
0.195	0.244	0.157	Any	0.5	0.5
0.0752	1.26	2.17	Any	0.789	1.06
0.135	0.883	0.157	Any	0.5	0.5

In this case we are checking whether the left wheel velocity and right wheel velocity is changing or not according to our desire or it fails somewhere. For this here we are presenting a set of data that shows that the velocity change of left wheel and right wheel is in accordance with our requirements.

Table: 2 Velocity Analysis for Gaussian membership function

Left obstacle Mts.	Right obstacle Mts.	Front obstacle Mts.	Heading angle degree	Left wheel vel m/sec	Right Wheel vel m/sec
0.105	0.883	0.47	Any	0.601	0.691
0.346	0.733	0.47	Any	0.514	0.523
0.496	0.733	0.47	Any	0.514	0.515
0.947	0.733	0.47	Any	0.559	0.564
0.195	0.244	0.157	Any	0.513	0.514
0.0752	1.26	2.17	Any	0.943	1.2
0.135	0.883	0.157	Any	0.512	0.703

By seeing the results, the accuracy of Gaussian membership function over triangular membership function is more. So for any moving robot Gaussian membership function is recommended to use for accuracy in navigation

V. CONCLUSIONS

The main purpose of the manipulator design is, low cost of production, use of readily available material and easy fabrication process.

In this work, the modeling of the manipulator is done; there was flexibility in the design of this three degree freedom robot. The concept was shown in a three degree of freedom manipulator just to enhance the concept of reality. The new developed robot system is going to have a great demand in the future as well flexible for the operation various task.

As a future work, comparison of the theoretical result obtained from the current analysis with the experimental results of a real robotic manipulator of six DOF. The wrist design is also planned. More robust artificial algorithm will be implemented to control the navigational path of the currently developed mobile robot in a dynamically cluttered environment.

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