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VIRTUAL INSTRUMENTATION CONTROL OF A MINE DETECTING ROBOT VIA ONLINE

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ABSTACT

This paper describes the use of fuzzy logic controller to control the speed of DC motor. The use of LABVIEW tools and fuzzy logic membership as software development tools for system design is emphasized. Hardware implementation is based on PIC microcontroller without the need of any additional components for the fuzzy logic controller. The system performance is evaluated in comparison with a MATLAB\stimulant tool. Adaptive fuzzy logic controller of DC motor for mine detecting robot through online with help of web based service using LabVIEW tools. A mine detecting robot is design with IR sensor, metal detector and RF camera. The motion of the robot is directed by the fuzzy logic controller and obstacle avoidance with help of RF camera. The location of the robot and mine is known through GPS.

Key word: fuzzy logic,GPS metal detector, LABVIEW

1. INTRODUCTION

A mine detecting robot is a programmable and multi-functional machine, able to extract information from its surrounding using metal sensors, obstacles avoided using photo detector to plan and execute collision free motions within its environment without human intervention. Navigation is crucial issue for robots that claim to LABVIEW through online. A Navigation system can be divided into two layers: High Level global planning and Low-level reactive control. Several artificial intelligence techniques such as reinforcement learning, neural networks, fuzzy logic and genetic algorithm. Skid‐steered mobile robots have been widely used in exploring unknown environments and in military applications. In this paper, the tuning fuzzy Vector Field Orientation (FVFO) feedback control method is proposed for a four track wheel skid‐steered mobile robot (4‐TW SSMR) using flexible fuzzy logic control (FLC). The extended Kalman filter is utilized to estimate the positions, velocities and orientation angles, which are used for feedback control signals in the FVFO method, based on the AHRS kinematic motion model and velocity constraints. In addition, in light of the wheel slip and thebraking ability of the robot, we propose a new method for estimating online wheel slip parameters based on a discrete Kalman filter to compensate for the velocity constraints [1].Teleoperation of such a mobile robot is a challenging task that requires an efficient interface and a reliable real-time robot control to avoid obstacles. The system enables the user (base station) to send commands to the remote station (mobile robot), and receive scanned data and images from the environment through the internet and mobile DTMF signal [2]. An object tracking system that tracks and recognizes everyday objects in an everyday environment. Passive RFID tags are attached to the objects to enable object recognition. The system consists of static sensors embedded in the environment and sensors mounted on mobile robots, the system can estimate them by using an SIR particle filter that integrates the data obtained by the static sensors and the data obtained by the sensors on the mobile robots [3]. The efficiency of the teleoperated system depends not only on the skill and handling experience of the operator, but also on others factors that influence the system. To improve the performance of remote controlled mobile robots to facilitate, in a future, the daily activities of people. It is for this reason that Oklahoma State University (OSU) created the competition Mercury Remote Robot Challenge 2011 to control Wheeled Mobile Robots (WMR) via internet [4]. Adaptive fuzzy logic controller for BLDC motor drive has been proposed. The controller consists of two structures, one is fuzzy PD controller and the other one is fuzzy PI controller. Based on speed error signal received, switching take place between these twocontrollers. Fuzzy logic tool box under MATLAB environment is used to design the proposed adaptive fuzzy logic controller [5].

2. PROPOSED SYTEM

The goal of the proposed system is to prepare an outdoor mobile robot platform for a humanitarian demining application. The system consists of PIC microcontroller with inbuilt A/D converter which is configured as bomb detecting robot. The global positioning system (GPS) is attached to robot to trace the position of the robot. The client system with network interface card (NIC) is the user of the robot. The client and the robot are communicated through internet. In client system, the data socket protocol in LAB VIEW serves as the communication tool for internet. The bomb detecting Robot is connected to the server computer using a DAQ board and its IP address is noted. The specified direction of the robot by means of LAB VIEW is transmitted from client system to the robot through internet.

3. ROBOT DESIGN

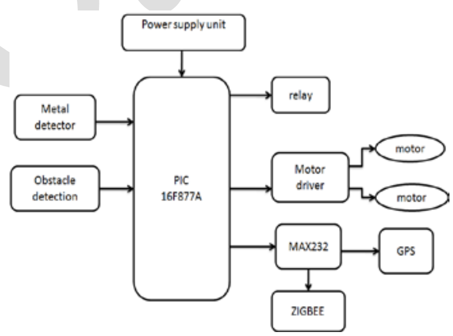
The robot was designed and developed should have most of the facilities as in search robot such as collision avoidance system, automation of movement by programs and also movement should be controlled through Internet. The robot design should be compact so that it can even scan small paths and turnings and also it should weigh less so that if the robot is usedfor mine detection it should not activate the mine if it steps on the mine accidentally.

The robot was designed small to reduce the weight and it was powered by two12volts DC motors, the robot provisions for the electronic modules which are going to be placed on the robot itself, the robot also has provisions for search coil and also the infrared sensor.
The robot movement can be controlled by three systems provided

- The infra-red collision avoidance system
- Internet control system using Lab View

The motor drive circuit for the 12volts DC motor was designed by calculating the input voltage and full load current for the motors. The robot unit uses 8 bit PIC microcontroller to receive the output from the Server unit and to do the specified function. The switching speed of the motor by the driver circuit is very fast so the movement of the robot can be controlled quickly when it is used in close environment to avoid he collision of the robot. The electronic modules are selected and constructed to work at 12volts and it consumes less power, so the robot can be operated through battery itself .The system consists of PIC microcontroller with inbuilt A/D converter which is configured as bomb detecting robot. The global positioning system (GPS) is attached to robot to trace the position of the robot. The client system with network interface card (NIC) is the user of the robot. The client and the robot are communicated through internet. In client system, the data socket protocol in LAB VIEW serves as the communication tool for internet. The bomb detecting Robot is connected to the server computer using a DAQ board and its IP address is noted. The specified direction of the robot by means of LAB VIEW is transmitted from client system to the robot through internet.

ROBATIC VECHILE:



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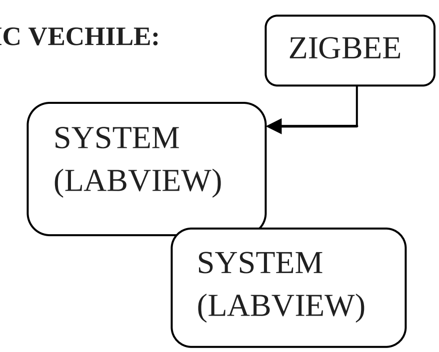


4. MATHEMATICAL MODEL OF DC MOTOR

To be modeling a DC Motor, simple circuit of its electrical diagram as shown in Fig. 2. is considered. [1-2], to be Modeling and Simulate the DC motor, the following steps are to be made step by step;
Step1: Represent the DC motor circuit diagram.
Step2: Represent system equations.
Step3: obtain the state space model.

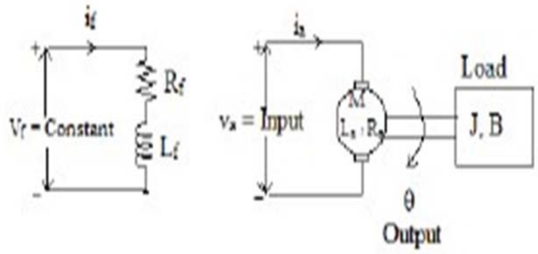


Figure2. DC motor

A. Loop System Consideration:

To perform the simulation of the system, an appropriate model needs to be established. Therefore, a model based on the motor specifications needs to be obtained. Fig. 2 Shows the DC motor circuit with Torque and Rotor Angle Consideration.

B. System equation

The motor torque T is related to the armature current, i, by a torque constant K;

T= Ki (1)

The generated voltage, ea, is relative to angular velocity by;

Ea =k m (2)

From Fig. 2 we can write the following equations based on the Newton'slawcombined with the Kirchhoff's law:

$$J\frac{d^2\theta}{dt^2} + b\frac{d\theta}{dt} = Ki \qquad (3)$$

$$L\frac{di}{dt} + Ri = V - K\frac{d\theta}{dt} \qquad (4)$$

C. State-Space model for DC Motor

The dynamic equations in state-space form are thefollowing

$$\frac{d}{dt}\begin{bmatrix}\theta\\ \dot{\theta}\\ i\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & -\frac{b}{J} & \frac{K}{J}\\ 0 & -\frac{K}{L} & -\frac{R}{L}\end{bmatrix}\begin{bmatrix}\theta\\ \dot{\theta}\\ i\end{bmatrix} + \begin{bmatrix}0\\ 0\\ \frac{1}{L}\end{bmatrix}V$$

$$y = \begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}\theta\\ \dot{\theta}\\ i\end{bmatrix}$$

5. DRIVE SYSTEM OF MOTORS IN THE SYSTEM

The motor drive system using PWM signal is shown in fig 3

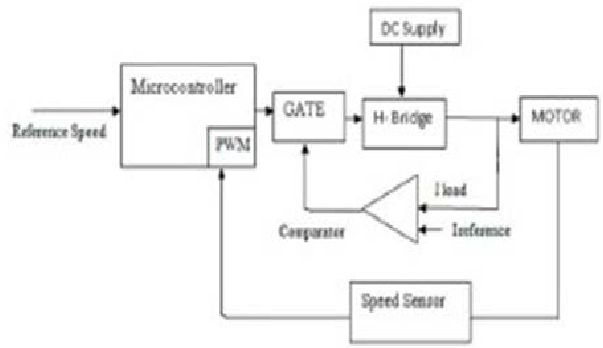


Fig 3Motor control system

6 .H-BRIDGES

DC Motors can rotate in two directions depending on how the battery is connected to the motor. Both the DC motor and the battery are two terminal devices that has positive and negative terminals. In order run the motor in the forward direction, connect the positive motor wire to the positive battery wire and negative to negative. However, to run the motor in reverse just switch the connections; connect the positive battery wire to the negative motor wire, and the negative battery wire to the positive motor wire. An H-Bridge circuit allows a large DC motor to be run in both directions with a low level logic input signal. The H-Bridge electronic structure is explicit in the name of the circuit - H - Bridge.

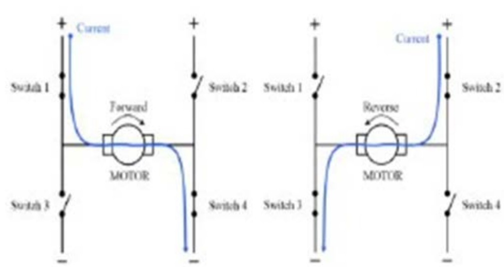


Fig 4 H-bridge structure

If it is desired to turn the motor on in the forward direction, switches 1 and 4 must be closed to power the motor. If it is desired to turn the motor on in the reverse direction, switches 2 and 3 must be closed to power the motor. Fig. 4 shows the H-Bridge driving the motor in both forward and reverse direction. L293D is a dual H-bridge motor driver, so with one IC we can interface two DC motors which can be controlled in clockwise and anticlockwise direction [2][5].

7. FUZZY LOGIC CONTROLLER

Today, there are number of products in the market which are controlled by fuzzy logic in which different types of FLC are used, the block diagram of the fuzzy logic controller. In general this type of FLC contains four main parts, two of which perform transformations; which are:

a) Fuzzifier (transformation 1)
b) Knowledge base
c) Inference engine
d) Defuzzifier (transformation 2)

Fuzzification measures the values of input variable and converts input data into suitable linguistic values Knowledge base consist a database and provides necessary definitions, which are used to define linguistic control rules. This rule base characterized the control goals and control policy of the domain experts by means of a set of linguistic control rules. Decision-making logic or inference mechanisms main part of a FLC. It has the capability of simulating human decision-making based on fuzzy concepts and of inferring fuzzy control actions employing fuzzy implication and the rules of inference in fuzzy logic.

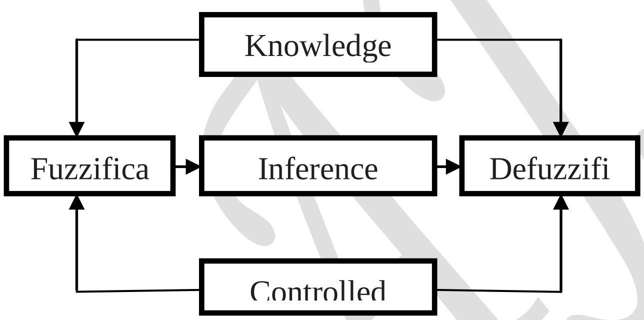
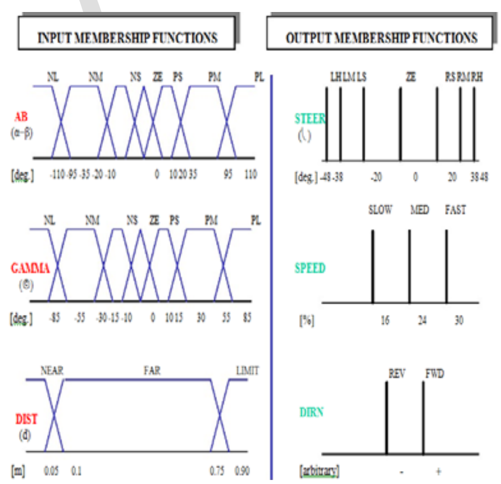


Fig 5 Block diagram of Fuzzy logic controller

The crisp value of the steering angle is obtained by the modified "centroidal"deffuzification (Mamdani inference).Defuzzification is a scale mapping, which converts the range of values of output variables into corresponding universe of discourse and also yields a non-fuzzy control action from an inferred fuzzy control action. This transformation is performed by Membership Functions (MF). In FLC, number of MF and their shapes are initially determined by user. A process of defuzzification is said to occur, when fuzzy concepts can be logically described in terms of(the relationships between) fuzzysets, which makes it possible to define variations in the meaning or applicability of concepts as quantities. Effectively, qualitative differences may then be described more precisely as quantitative variations or quantitative variability (assigning a numerical value then denotes the magnitude of variation).

A. Implementation of flc in dc motor

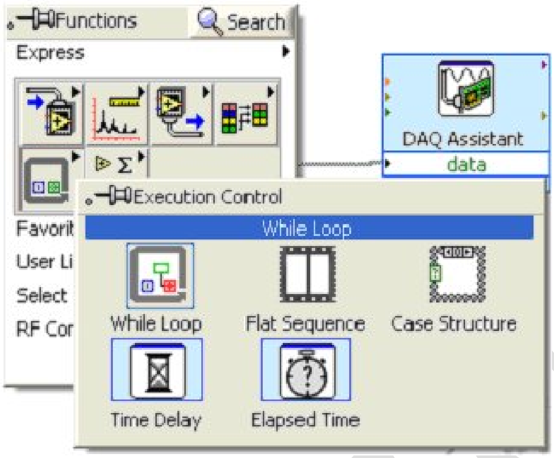
The controller observes the speed loop error signal and correspondingly updates the controller output so that the actual motor speed matches the reference set speed. There are two input signals to the fuzzy controller, the error E=set speed –actual speed and the derivative of error, CE. In a discrete system, dE/dt = E/ t = CE/Ts, where CE= E in the sampling time Ts. With constant Ts, CE is proportional to dE/dt. The input variables, error and error rate and output variable, the control action, are represented as linguistic values as follows; ZE = Zero, PS =Positive Small, PM =Positive Medium, PB =Positive Big NS =Negative Small NM = Negative Medium, NB =Negative Big [15-16],[19]. After selecting appropriate number of input and output variables and their linguistic values, we have to draw the membership function for these linguistic values. The membership functions of the proposed system are shown below



Membership functions of input and output of fuzzy

B.DATA SOCKET TRANSFER PROTOCOL

Data Socket greatly simplifies this task by providing a unified API for these low-level communication protocols. Transferring data across computers with Data Socket is as simple as using a browser to read Web pages on the Internet. Data Socket Transfer Protocol based on TCP/IP through which data is passed between Data Socket clients known as Data Socket Reader and Writer applications-using the Data Socket Server. Once connected to a Data Socket Server from Data Socket Reader and Writer applications using the DSTP URL scheme, as demonstrated in the following example URLs.The following URL connects to the data item named wave on the Data Socket Server running on the localComputer: dstp://localhost/wave The following URL connects to the data item named wave on a Data Socket Server running on a network computer named lab:dstp://lab/wave.



8. RESULTS AND CONCLUSION

The results of the implemented system are the assembly software programming of the control circuit, the process is very simply and the procedure can be mentioned as the following steps. Initialization Ports Declaration: all Port A's pins are declared as inputs, four MSB Port B pins are declared as outputs.

Start program:
Check RA4 (MSB) high or low
Check RA3 high or low
Check RA2 high or low
Check RA1 high or low
Check RA0 high or low
Determined outputs:

If all inputs data are low outputs RB0-RB3, "1010" for freely going forward. If metal sensor RA0 and RA1 are high, outputs"1111" to stop. GPS data is obtained from output port. When the IR sensor detects the obstacle the set speed of the motor is reduced and the direction is changed.

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