CHAPTER THREE

SYSTEM DESIGN

3.1 Project overview

The main aim of thesis work is implementation of the avoidance obstacle system using fuzzy logic in the ATMEGA16 Microcontroller. To implement this avoidance obstacle system is considered which consists of DC motors, driver (l293D), ultrasonic sensor, and display module.

3.2 control system

As shown in figure 3-1, this project is mainly focus on DC motor speed and distance control system by using microcontroller. The actual distance has been measured using ultrasonic sensor and feedback to microcontroller. Microcontroller sends pulses to the driver to control the dc motors.

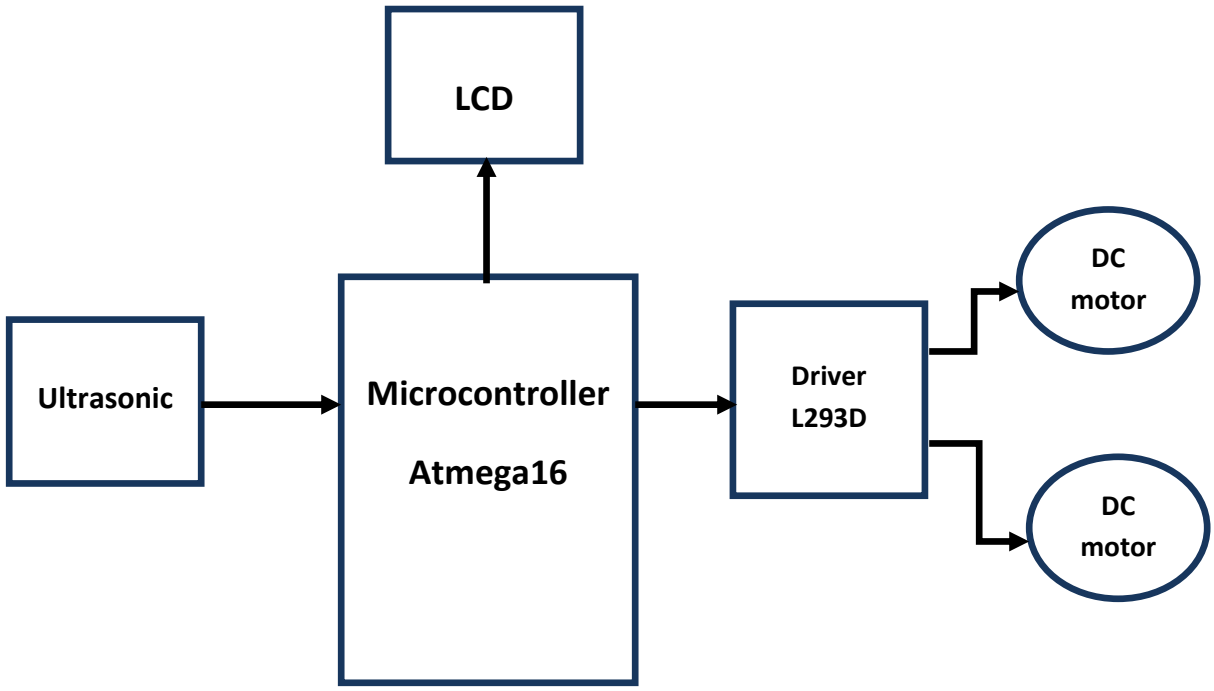


Figure 3-1: Main control system block diagram

3.3 System design

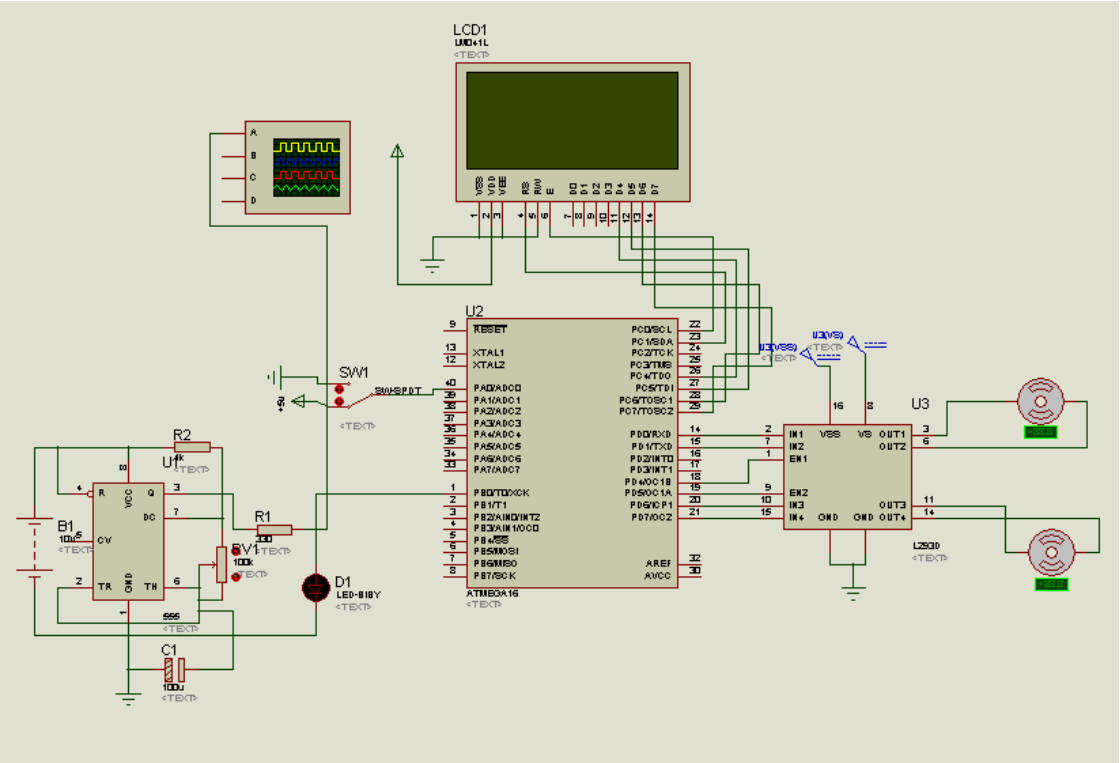


Figure 3-2: The system circuit.

3.4 Circuit Description

The system components are:-

3.4.1 Ultrasonic Sensor

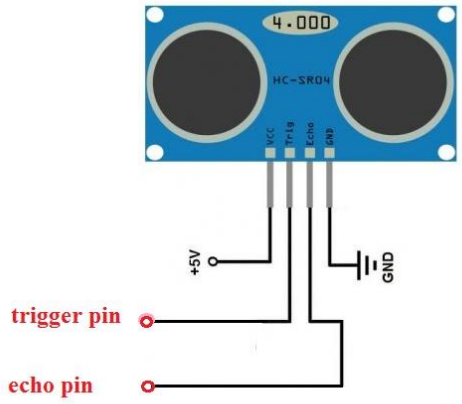


Figure 3-3: ultrasonic pins

The ultrasonic sensor is used for obstacle detection. Ultrasonic sensor transmits the ultrasonic waves from its sensor head and again receives the ultrasonic waves reflected from an object.

It is able to measure distances from 2cm to 400cm with an accuracy of about 3mm. This module includes ultrasonic transmitter, receiver and its control circuit, Module has 4 pins:

1. **VCC** – 5V, of the power supply
2. **TRIG** – Trigger Pin
3. **ECHO** – Echo Pin
4. **GND** – - the power supply

TRIG and ECHO pins can be used to interface this module with a microcontroller unit. These are TTL (0 – 5V) input output pins.

Steps that must be followed to work the sensor

1. Microcontroller send trig to "Trig" pin of the sensor high for 10μs. This initiates a sensor cycle.
2. The sensor Generates 8 pulses everyone 40KHz, 8 x 40 kHz pulses will be sent from the transmitting piazza transducer of the sensor, after which time the "Echo" pin on the sensor will go from low to high.
3. The 40 kHz sound wave will bounce off the nearest object and return to the sensor.
4. When the sensor detects the reflected sound wave, the Echo pin will go low again.
5. The distance between the sensor and the detected object can be calculated based on the length of time the Echo pin is high.
6. If no object is detected, the Echo pin will stay high for 38ms and then go low.

Here the ultrasonic is replaced with an equivalent 555 timer circuit.

3.4.2555 timer

As shown in figure 3-4, the 555 timer is an extremely versatile integrated circuit which can be used to build lots of different circuits. Frequently, the 555 is used in actable mode to generate a continuous series of pulses.

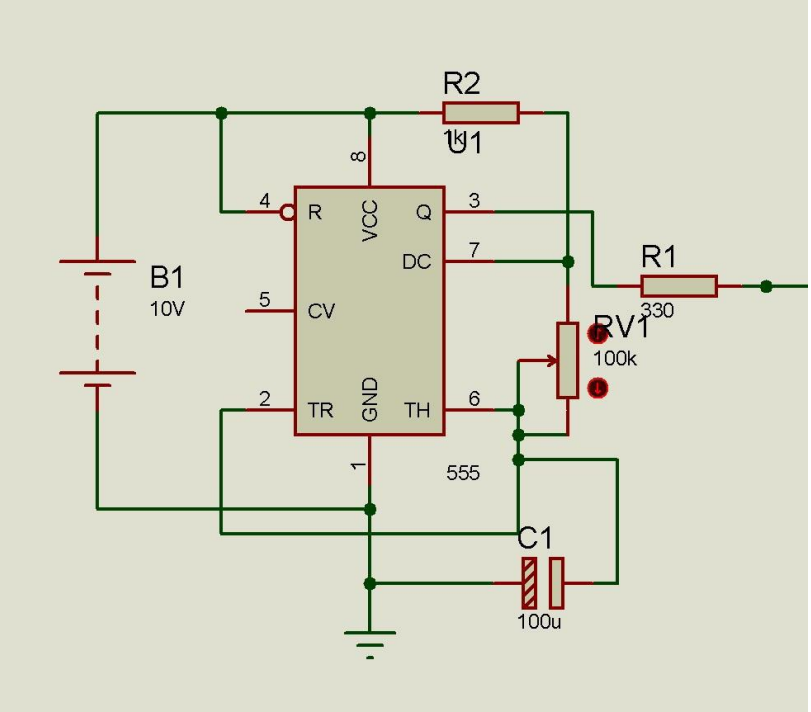


Figure 3-4: The 555 timer (sensor).

3.4.3 ATMEGA16 microcontroller

Is the main controller receives readings from sensors to determine reactions of the system.

3.4.4 LCD

Used for displaying all the activities that the microcontroller is working on (number of pulse, status of counter, direction and distance).

3.4.5 DC motors

Used to converts direct current (electrical energy) into mechanical energy.

3.4.6 Driver L293D

As shown in figure 3-5, this motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins.

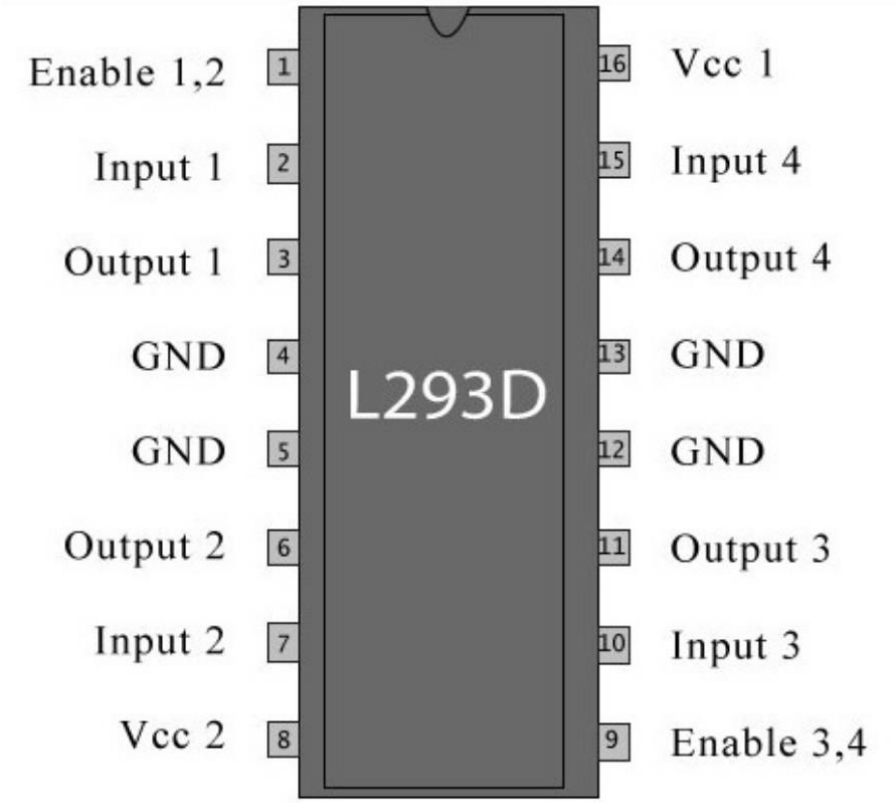


Figure 3-5: L293D IC

Table 3-1: L293D pins layout.

Enable 1,2	Enable pin for motor 1; active high
Input 1	Input 1 for motor 1
Output 1	Output 1 for motor 1
GND	Ground (0V)
GND	Ground (0V)
Output 2	Output 2 for motor 1
Input 2	Input 2 for motor 1
VCC 2	Supply voltage for motor s; 9-12V (up to 36)
Enable 3,4	Enable pin for motor 2; active high
Input 3	Input 1 for motor 2
Output 3	Output 1 for motor 2
GND	Ground (0V)
GND	Ground (0V)
Output 4	Output 2 for motor 2
Input 4	Input 2 for motor 2
VCC 1	Supply voltage ; 5V(up to 36)

Here is the truth table representing the functionality of this motor driver:

Table 3-2:

pin 1	Pin 2	Pin 7	Function
High	High	Low	Turn Anti-clockwise (Reverse)
High	Low	High	Turn clockwise (Forward)
High	High	High	Stop
High	Low	Low	Stop
Low	X	X	Stop

High ~+5V, Low ~0V, X= either high or low (don't care).

In the above truth table, if Pin1 (E1) is low then the motor stops, irrespective of the states on Pin2 and Pin7. Hence it is essential to hold E1 high for the driver to function, or simply connect enable pins to positive 5 volts.

With Pin1 high, if Pin2 is set high and Pin7 is a pulled low, then current flow from Pin2 to Pin7 driving the motor in anti-clockwise direction, If the states of Pin2 and Pin7 are flipped, then current flows from Pin7 to Pin2 driving the motor in clockwise direction.

3.5 Fuzzy Control System

There are two main fuzzy inference systems (fuzzy logic approximate) which Mamdani and Sugeno. The most commonly used fuzzy inference technique is the so-called Mamdani. In 1975, Professor Ebrahim Mamdani of London University built one of the first fuzzy systems to control a steam engine and boiler combination (Mamdani and Assilian, 1975). He applied a set of fuzzy rules supplied by experienced human operators. Figure 2-1 shows the Fuzzy Decision Making controller is made up of three steps:

1. Fuzzification: Converts controller inputs into information that the inference mechanism can be easily use to activate and apply rules.
2. Rule base: A set of IF-Then rules which contains a fuzzy logic quantification of the expert’s linguistic description of how to achieve good control.
3. Defuzzification: This converts the conclusions of the interface mechanism into actual inputs for the process.

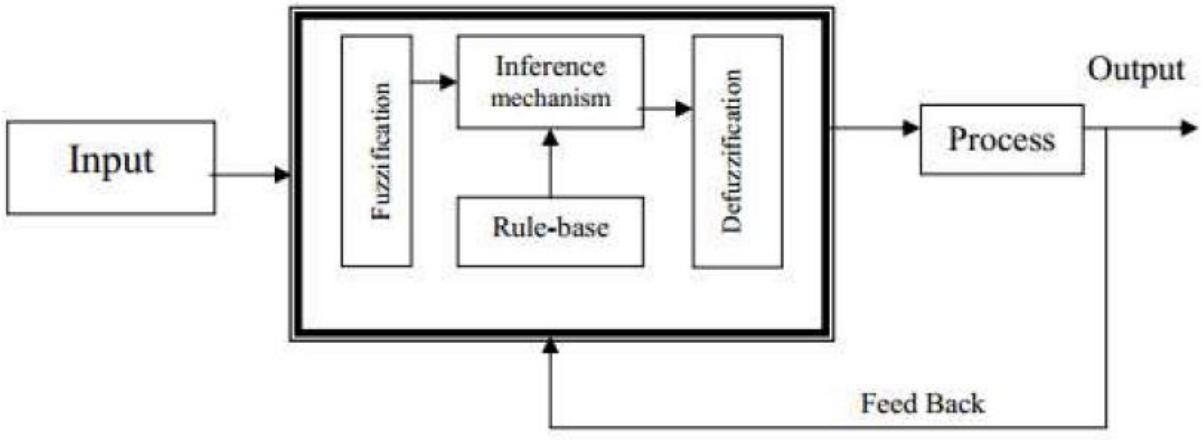


Figure 3-6: Fuzzy Logic Controller.

In this project, the Fuzzy Logic Controller (FLC) designed to control the motion of the robot. There have two inputs which is distance sensor and velocity of robot car. The one output is direction of DC motor.

3.6 Obstacle Avoidance

Distance crisp value between robot and surrounding objects measure by ultrasonic sensor circuit for distance measurement which used to build the fuzzy membership function. The acquired information from the sensor shows that there exist obstacles nearby robot. When a robot is close to an obstacle, it must change its direction to avoid the obstacle.

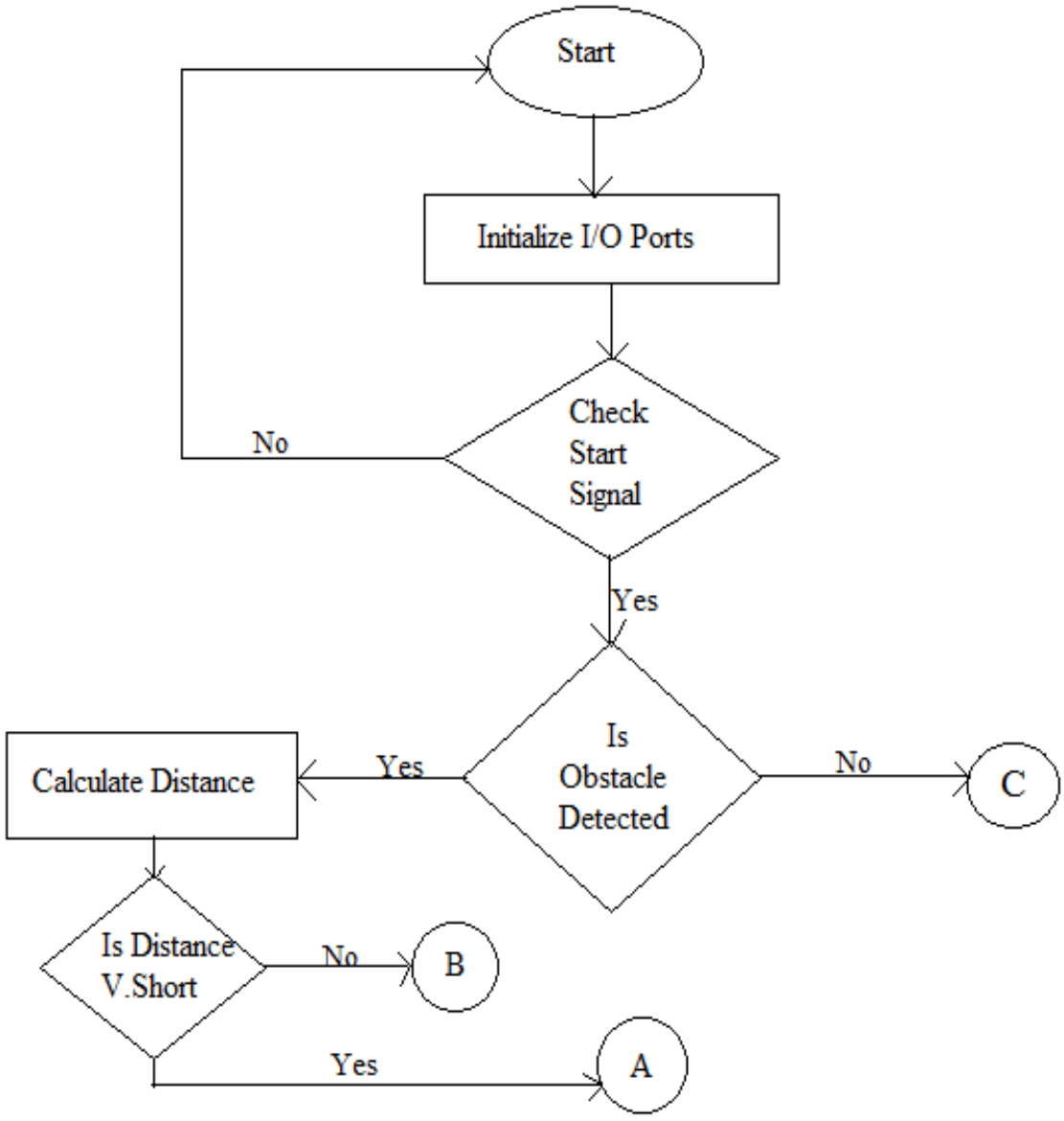
The fuzzy rules used for obstacle avoidance by the robots are listed in Table 3-1 as rules:

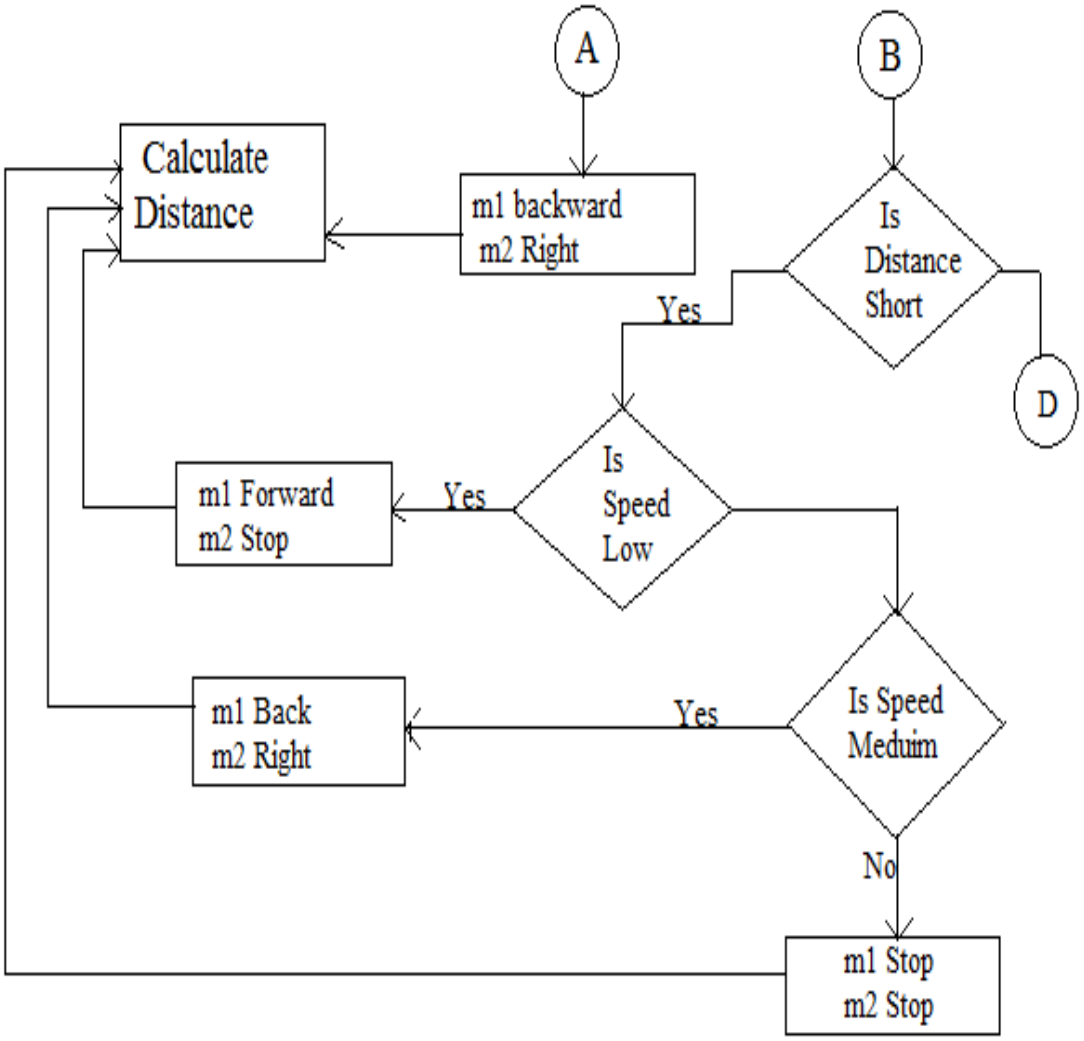
Table 3-3: Fuzzy logic rules for two DC motors.

Rule no.	**Distance**	**Velocity**	**Motor 1 (forward\back)**	**Motor2 (left\right)**
1-	V. Short	Low	Back	Right
2-	V. Short	Medium	Back	Right
3-	V. Short	Fast	Back	Right
4-	Short	Low	Forward	Stop
5-	Short	Medium	Back	Right
6-	Short	Fast	Stop	Stop
7-	Medium	Low	Forward	Stop
8-	Medium	Medium	Forward	Stop
9-	Medium	Fast	Backward	Left
10-	High	Low	Go fast	Stop
11-	High	Medium	Go fast	Stop
12-	High	Fast	Go fast	Stop

3.7 control system Flow charts and state Diagram

The flow chart shows in figure 3-7 illustrate the general flow Chart of the control system.




A
B
Calculate Distance
m1 backward
m2 Right
Is Distance Short
Yes
D
m1 Forward
m2 Stop
Yes
Is Speed Low
m1 Back
m2 Right
Yes
Is Speed Meduim
No
m1 Stop
m2 Stop

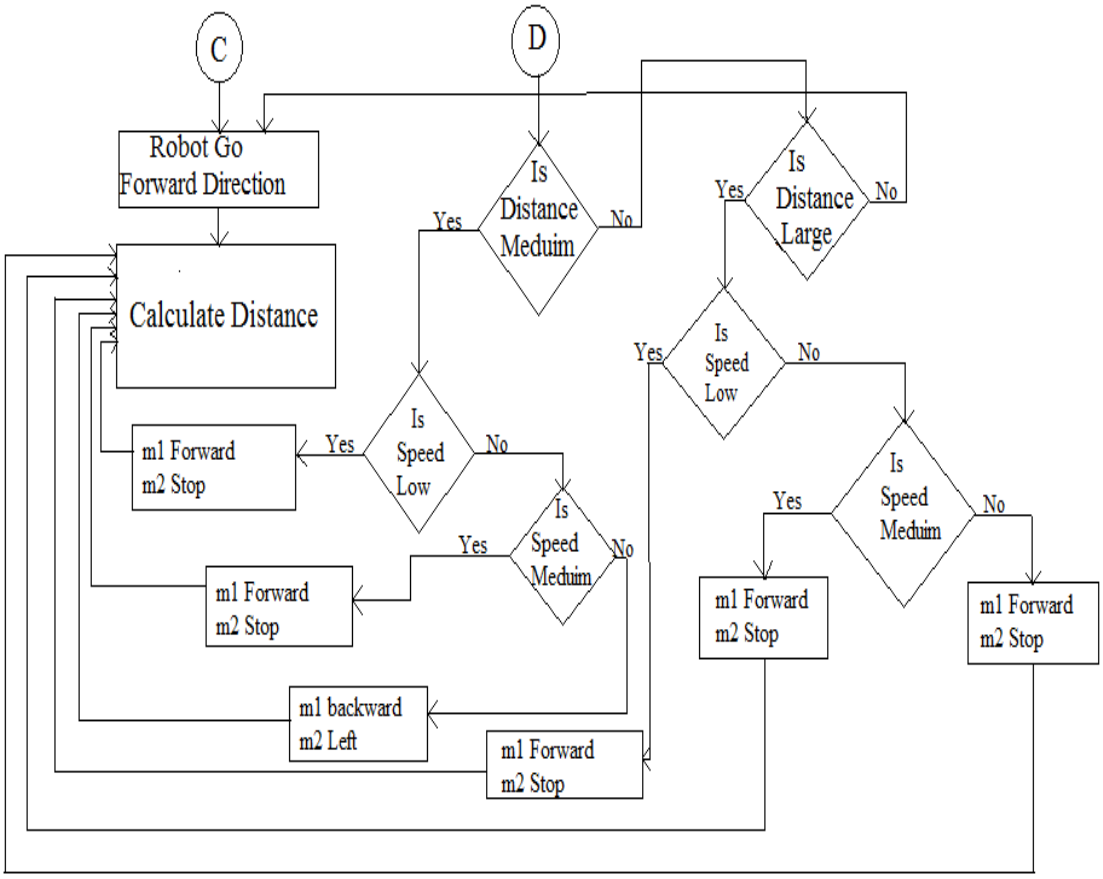


Figure 3-7: Flow chart