Rope Climbing Fire Extinguisher Robot

Science Fair Project Report

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ARRAHMAAN
INTERNATIONAL SCHOOL

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CONTENTS

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ABSTRACT

Robot is a machine that performs various complex tasks there are many type of robots such us fixed base robot, mobile robot, humanoid robot etc. In this paper ROBE CLIMBING FIRE EXTINGUISING ROBOT is proposed. This robot is equipped with flame sensor, smoke sensor, PIR motion sensor used to sense environmental fire and feed the signals to the microcontroller in order to extinguish the fire. This robot implements the concept of environment fire sensing. Proportional motor control the motor driver is used for bidirectional contract of the motors equipped in the robot. If fire is detected with the help of sensors, MCU operates water pump mechanism. The main objective is to detect fire in the disaster prone area also provides audio and visual indications, Extinguishes fire on detection, Reduces the efforts of human labour and level of destruction.

The principles used in this design are such that enable our robot to be extended to a more robust system to be used to combat actual fires in residential (or) commercial settings. The requirement of this project is to create a rope climbing robot is fully autonomous. This means that once the robot is started by the user it navigates, searches for fire and extinguishes the fire on its own, with no assistance (or) input from the users. In order to reach this goal we made many critical decisions on motors, sensors, fire extinguishing mechanical parts and general design for our robot.

INTRODUCTION

Arduino UNO:

The Arduino UNO is the micro controller board based on the ATmega 328(datasheets). It has 14 digital input/output pins (of which 6 can be used as PWM outputs). 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and reset button. It contains everything needed to support the micro controller. Simply connect it to a computer with a USB cable (or) Power it with a AC to DC adapter (or) battery to get started .The UNO differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega 328 programmed as a USB-to-serial converter. "UNO" means one in Italian.

- Takes or read data from the sensor and controls all the functions of the whole system by manipulating these data.
- Control the movement of robot

FLAME SENSOR:

- This module is sensible to a flame and its radiation. It can also detect in the range of wane length from 760 nanometer to 1100nn.
- The flame sensor detection angle of about 60 degrees particularly sensitive to the spectrum of the flame.
- Adjustable sensitivity in blue adjustment of the potentiometer.
- Operating voltage of 3.3V-5V. The output form digital switching output (0 and1) and analog voltage output AO.
- Fixed both holes for easy installation.
- Small PCB boards size 32mm×14mm.
- Use LM393 as comparator chip.
- Maximum output current in 15 mA.
- LED lights indicators. Power (red) and digital switching output (green).
- The operating temperature is 25°C-85°C.

SMOKE SENSOR-MQ-2:

The MQ2 gas sensor is capable of sensing the gases like ammonia nitrogen, aromatic compounds, sulfide, smoke, alcohols. It consists of a boost converter within it called PTI 301.the operating voltage of this gas sensor is from 2.5V to 5V. This gas sensor has a lower conductivity to clean the air as a gas sensing material increases. This gas sensor can be used to detect the smoke benzene, steam and other different harm full gases. The MQ-2 gas sensor costs in low to purchase.

PIR MOTION SENSOR:

A passive infrared sensor (PIR-sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room (or) wall (or) outdoors. When a warm body like a human (or) animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves.

ARDUINO PRO MINI:

Arduino Pro Mini is a microcontroller board on the ATmega 328. It has 14 digital input/output pins) of which 6 can be used as PWM outputs, 6analog inputs, an on – board resonator, a reset button and holes for mounting pin headers. It operates a 5 voltage supply.

Arduino DC motor driver:

L298N Driver: The L298N is a dual H-bridge motor drive which allows speed and direction control of two DC motor at the same time the module can drive DC motor that have voltage between 5 and 35V, with a peak current up to 2A.

Motor drives are not used only for motors. They are used for any device that usually draws more than 50-100 mA.

Maximum current of microcontroller output (typically 10-20mA) is not enough to drive motor coil. Connecting motor directly to micro controller will damage microcontroller output transistor.

MOTOR DRIVER:

Provides an interface between the 5v logic signal from the micro controller & the high current/ high voltage power side to drive the motor. Motor is an electromechanical device, which convert electrical energy to rotation/mechanical energy. DC geared motor is used to drive the robotic vehicle.

VISUAL INDICATION &AUDIO ALARM:

- Visual indications are used here for indicating the conditions of the sensors, different colored LED's are used here.
- If any of the sensor output will be high, MCU will turn ON the audio alarm for intimating the condition to others.
- Buzzer is interfaced to the MCU via the transistor acting as a switch.
- MCU send high signal to BC547.

GEAR MOTOR:

The 12v DC gear motors are simply an extension of the DC motors. it consists of a gear assembly attached to the motor. The gear assembly is used for reducing the speed and increasing the torque of the motor. The speed can be reduced to any desirable figure by using the correct combination of gears in a gear motor. Gear reduction is the concept where gears reduce the speed of the vehicle but increase its torque. The speed of motor is counted in terms of RPM (rotations of the shaft per minute). This 12V DC gear motor has a RPM of 60. This speed is capable of changing its value, according to the input voltage given to drive the motor.

RELAY AND DRIVER CIRCUIT:

- Interfacing is required for connecting a relay with any microcontroller.
- Relays are inductive loads and controller water pump.
- Driving circuit is fixed between relays and processor pins.
- The output of the micro controller is fed to the relay driver for current boosting.
- The output of this magnetizes the relay.
- Relay is used to control the water pump.

WATER PUMP:

- Used to pump water when an abnormal condition arises in the system.
- When excess temperature smoke and flame detected, the water pump starts pumping water.
- Water pump is connected to the relay, the relay becomes energizes according to the instruction from MCU
- Water pump-3V-6V.

ROBOT BODY:

The robot body consists of wheels which are to drive the robot and extinguishing components like water tank, pump and sprinkler. A water tank with pump is placed on the robot body and its operation is carried out its operation is carried out from the Arduino through the proper signal from the transmitting end. The entire operation is controlled by an Arduino. A motor driver IC is interfaced to the Arduino through which the controller drives the gear motor for the movement of the robotic vehicle.

STATEMENT OF THE PROBLEM

The main objective is to build a rope climbing fire extinguisher to detect fire in the disaster prone area also provides audio and visual indications, Extinguishes fire on detection, Reduces the efforts of human labour and level of destruction.

HYPOTHESIS

Flame sensor will be more effective than smoke sensor in case of Rope Climbing Fire Extinguisher Robot

DESIGN OF STUDY

INDEPENDENT VARIABLE:

- Types of Sensor (Smoke sensor, Flame sensor)

DEPENDENT VARIALBE:

- Distance travelled
- Efficiency of Robot

CONTROLLED VARIABLES:

- Size of the rope
- Space between the two wheels of the robot on either side
- Micro Servo Motors
- Time taken

MATERIALS:

- Arduino UNO
- Fire sensor (or) flame sensor
- DC supply (12v)
- DC Gear Motor
- (L 293D) Moto driver 1c module

- Robot chassis with motors and wheel
- A small can
- Connecting wires
- PIR sensor
- Switch
- Soldering iron
- Screw driver
- Spanner

PROCEDURE:

- Assemble the 2 chassis with one caster wheel (for rotation) using bold and nuts.
- Fit four motors between the chassis board.
- At the top of the chassis, fit motor drive and Arduino board.
- Connect the Arduino board and motor drive using wires.
- Connect fire sensor to Arduino board.
- Connect relay to the motor drive.
- On the top of the motor drive make a rectangular stand and place water tank.
- Inside of the tank, place normal water pump with tubes.
- Connect the pump to the relay.
- Connect mini Arduino with PIR sensor and buzzle through wires.
- Connect 12V DC adapter to the socket in the Arduino board.
- After the first level of assembling test the robot for fire sensor. Measure the efficiency.
- Change the fire sensor to flame sensor and check the efficiency.
- Compare the efficiency achieved by the sensors using the same motor by the formula,

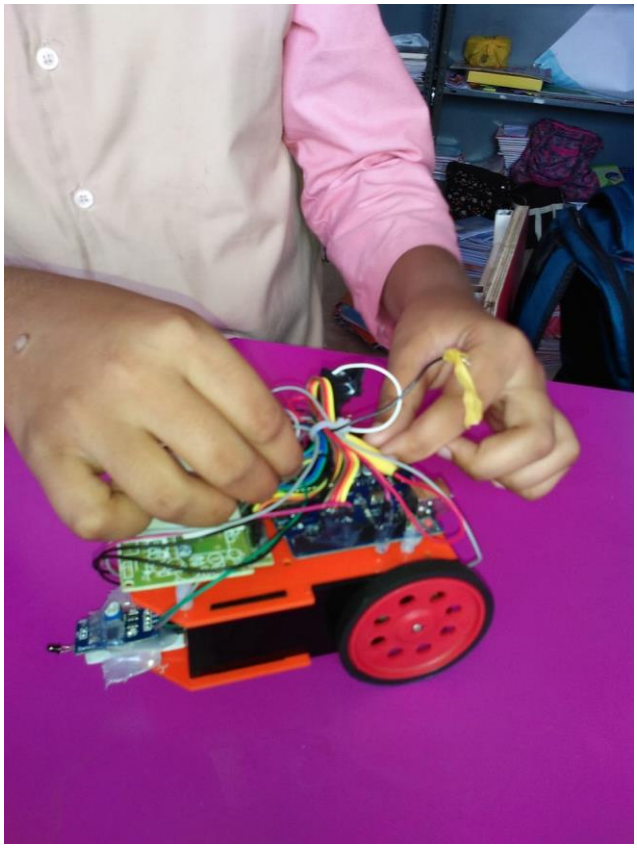
$$\text{Speed} = \frac{Distance\ travelled}{Time\ Taken}\ \text{m/s}$$

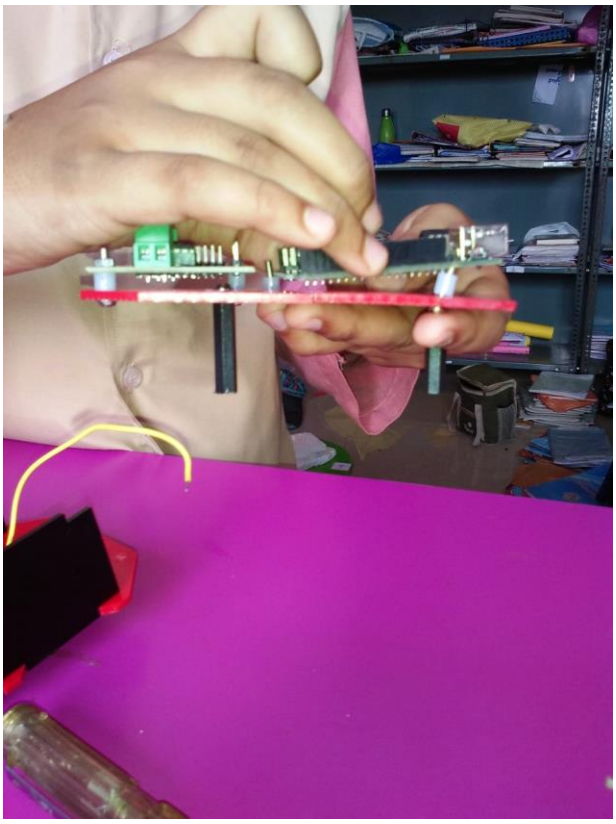
and by keeping the time as a controlled variable(time=30 seconds)

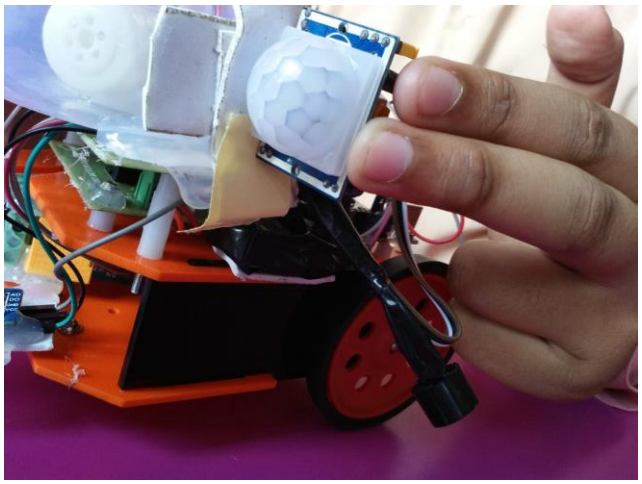
WORKING:

- Consist of flame sensor, smoke sensor and human motion sensor, MCU water pump and geared motors.
- The robot continuously monitors variations of the surrounding area using these sensors.
- Robotic vehicle moves through the disaster area as per the instructions from MCU.
- Whenever the temperature exceed a limit value and flame and smoke detected MCU identifies that there is presence of fire and operate water pump.
- MCU operates the relay through the relay interface.
- Audio and visual indications are attached to the robotic system.

COLLECTION OF DATA- PHOTOGRAPHS







Second Trial

Fixing Rope and checking for trial

Qualitative Data:

DATE ANALYSIS:

TABLE 1: (ON FLOOR)

TIME: 30 SEC

S. No	Trail	Distance travelled by Flame Sensor	Distance travelled by Smoke Sensor
1.	Trial 1	55 cm	7 cm
2.	Trial 2	60 cm	8 cm
3.	Trial 3	65 cm	5 cm
4.	Trial 4	63 cm	6 cm
5.	Trial 5	58 cm	5 cm
	AVERAGE	60 cm	6.2 cm

TABLE 2: (Climbing Rope)

TIME: 30 SEC

S. No	Trail	Distance travelled by Flame Sensor	Distance travelled by Smoke Sensor
1.	Trial 1	25 cm	5 cm
2.	Trial 2	19 cm	7 cm
3.	Trial 3	28 cm	5 cm
4.	Trial 4	16 cm	4 cm
5.	Trial 5	21 cm	6 cm
	AVERAGE	21.8cm	5.4cm

Calculation:

$$\text{Speed} = \frac{Distance\ travelled}{Time\ Taken}\ \text{m/s}$$

FOR TABLE :1(ON FLOOR)

A. FLAME SENSOR

SPEED=0.6m /30 s=0.02 m/s

B. SMOKE SENSOR

SPEED=0.062 m / 30 s =0.002 m/s

FOR TABLE :2 (Climbing Rope)

A. FLAME SENSOR

SPEED=0.218 m /30 s=0.007 m/s

B. SMOKE SENSOR

SPEED=0.054 m / 30 s =0.0018 m/s

RESULTS AND DISCUSSION

After the first Trial:

- After assembling the first level set up, the PIR sensor gets repaired often. So I use to change that 2 times.
- While fixing the Arduino board with the chassis, I felt somewhat difficult to screw because of the tight space.
- I trailed the robot with flame sensor for multiple times. But due to splash of water, the fire sensor gets struck. So I try to find best way to prevent the water splash on fire sensor.
- Also while tightening the Arduino board, the plastic body of the chassis gets broken often. So I decided to change into metal body with suitable tyres and start the second trial for the robot.

Final trial:

- Using the same procedure and components I assemble the robot again using the metal body.
- Here I used 4 motors for this metal body.
- First, I tested the speed for both flame and smoke sensor on the floor. Secondly I tested how far it is climbing on the rope.
- In both cases, I found the flame sensor robot covers long distance at the controlled time than the smoke sensor robot.

CONCLUSION

- My Hypothesis, “Flame sensor will be more effective than smoke sensor in case of Rope Climbing Fire Extinguisher Robot” has been proved.
- Flame sensor is more effective than smoke sensor in case of Rope Climbing Fire Extinguisher Robot.
- Here we successfully developed the ROPE CLIMPING FIRE EXTINGUSHER ROBOT.
- Robot detects flame, smoke and human motion sensor at the site where the robot exists.
- The movement of this robot vehicle is controlled by MCU as the program.
- This robot is helpful in those area where natural calamity and bomb explosion where occurred.
- If fire is detected with the help of sensor, MCU operates the water pump mechanism through relay circuit.

APPLICATION

- Can be used in server room.
- Extinguishes fire where probability of explosion is high.
- Usable in power plant control rooms, captain bridges, flight control centers.
- Disaster area monitoring and rescue.

FUTURE ENHANCEMENT

FUTURE SCOPE:

- Remote control of robot.
- Camera and video transmission can be added.
- Improve weight capacity of the robot.
- It is used to put out large fires.

In future I want to invent low cost Fire extinguisher robot with very high efficiency that can save life and property of humans.

ACKNOWLEDGEMENT

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