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Fire Tracking and Suppression Mobile Robot - Design and Construction

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Abstract

Robots are one of the most important devices in the world that work automatically without human intervention. Robot can work for long hours without feeling tired and can be performed work that can be dangerous to human life. Autonomous robots are used today in many areas in our daily lives, for example, industry, Agriculture, Health, Education, scientific explorations and many other fields.Therefore in this research we will going to design autonomous robot that able to find and extinguish fires. In some cases, the dense flames very dangerous to humans live and therefore require intervention of robot. Fire tracking and suppression robot is a robot can automatically find and fighting fire. In this project a camera and flame sensor based on an rotary base was used. It can detect fire in an angle of rotation of 1600. ATmega328 microcontroller based on Arduino Uno board have been used, to control the robot to do the right work without mistakes, ATmega328 based on Arduini Uno board have been used, and it can be programmed using C language by using arduino IDE.

Keywords*: fire tracking, fire suppression, mobile robot*

1. Introduction

Recently, it has sometimes been impossible for firefighting personnel to access the site of a fire, even as the fire causes tremendous property damage and loss of human life, due to high temperatures or the presence of explosive materials or the fire smoke hazard in tunnel fires. In such environments, fire-fighting robots can be useful for extinguishing a fire. Firefighting robots are special robots, which as special fire-fighting equipment can replace firefighters near the scene to fight fire and rescue effectively and carry out reconnaissance missions of the fire [1], [2]. Our future work will be of making a robot with embedding image algorithm to the entire monitoring camera with wireless communication to the robot. That provides more supple to our robot to put out the fire in an entire building. Such a kind of robot will detect the kind of fire and according use an appropriate extinguishing system. Adding multiple security schemes in this robot will make it as advanced security and surveillance robot. If we do this innovative project on large scale it will surely save many lives. As we go into the Future, we will be entering a Technological Era where humans and robots are going to co-exist [3].

Robot is an electromechanical machine and it has the ability to perform tasks on some given electronic programming. This paper studies and implements the method to build a mobile robot. We used camera and flame sensor to detect fire, As well as in the design of robot anti-fire system has been used. For the safety of human before danger we used the early warning system.

2. Block Diagram

In this project we are going to use flame sensor and camera based on servo motor to sense the fire in different directions. When camera and flame sensor detection fire, it's going to send information to microcontroller to analyze it, after that microcontroller send information to motor driver to start movement. When the robot up near the fire, Anti-fire system and early warning system are going to work (Figure 1).

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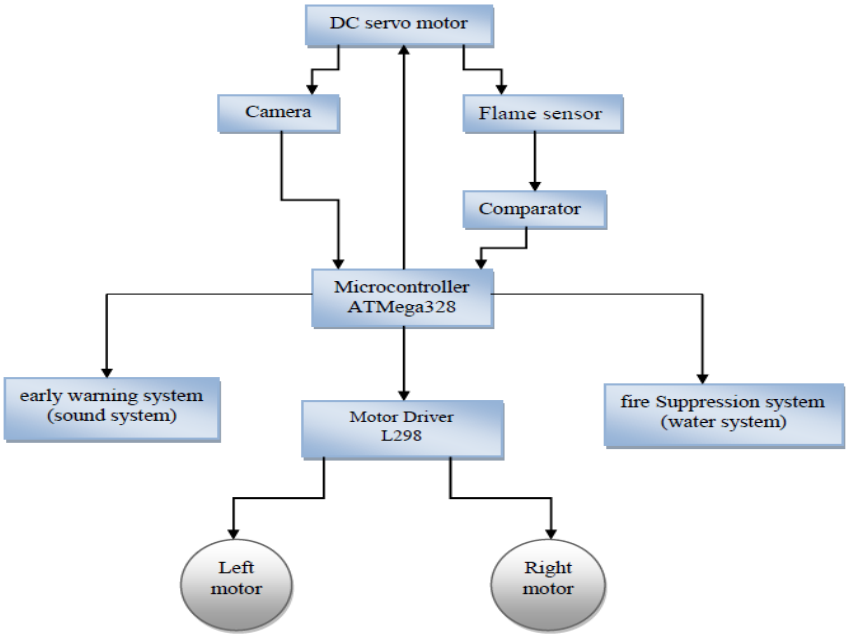

Figure 1. Block diagram

3. Structure of Fire Tracking and Suppression Mobile Robot

The used components in manufacture of fire tracking and suppression mobile robot are as shown in the following Table 1:

Table 1. Used components in the project

No.	Part name	Amount
1	-+ArduinoUno(Atmega328)	1
2	Flame sensor	1
3	Camera-vc0706	1
4	motor (DC servo)	1
5	Geared DC motor	2
6	motor Driver	1
7	Power source	1
8	Body	1
9	Power switch	1
10	Power Cable	1
11	Connecting Cables	As needed
12	Front Support Wheel	1
13	Motor Wheel	2
14	Buzzer	1
15	Water pump	1
16	Water tank	1
17	Bluetooth	1

In this project we were used both flame sensor and camera based on DC servo motor to detect the fire everywhere. To fighting the fire, water system has been used, it contain water pump and water tank. All these parts supplying power from power source. We are going to describe all of our robot components and what is the main work of every one of components.

Micro-controllers: Microcontrollers playing a vital role here in the control of the different units of the robot. We have chosen At-mega328 as a controller which is low powered 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory, 1KB of EEPROM, 2KBvof SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented two-wire serial interface, SPI serial port, six-channel 10-

bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

Sensor: To detect fire flame sensor have chosen. This sensor designed to detect and respond to the presence of a flame or fire. A flame sensor can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flame. We can see in figure2 the flame detector type regions.

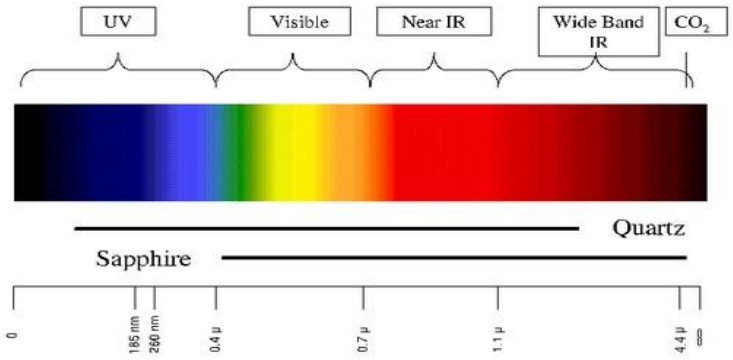

Figure 2. Flame Detector Type Regions

We must get to know our Flame Sensor (Figure 3) [4]:

Usage: These types of sensors are used for short range fire detection and can be used to monitor projects or as a safety precaution to cut devices off / on.

Range: I have found this unit is mostly accurate up to about 3 feet.

How it works: The flame sensor is very sensitive to IR wavelength at 760 nm ~ 1100 nm light.

Analog output (A0): Real-time output voltage signal on the thermal resistance.

Digital output (D0): When the temperature reaches a certain threshold, the output high and low signal threshold adjustable via potentiometer.

Pins: VCC. Positive voltage input: 5v for analog 3.3v for Digital. A0. Analog output, D0. Digital output, GND, Ground

Dimensions: 1.18 in x 0.59 in x 0.20 in (3.0 cm x 1.5 cm x 0.5 cm)

Weight: 0.28 oz (8 g)

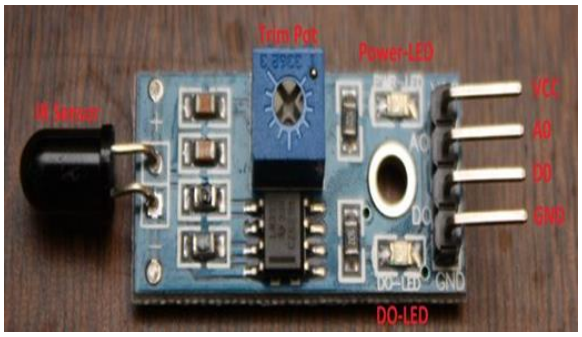

Figure 3. Flame sensor [4]

Camera-vc0706: VC0706 UART VGA Camera is an active pixel array of 649H x 489V. It incorporates sophisticated camera functions on-chip such as windowing, column and row mirroring. It is programmable through a simple two-wire serial bus interface and has very low power consumption (Figure 4) [5].

In this project camera has been used together with flame sensor to detect fire in everywhere. The main work of VC0706 UART VGA Camera is to detect light and send images to micro-controller to know the cause of fire, and after that robot start moving toward the fire.

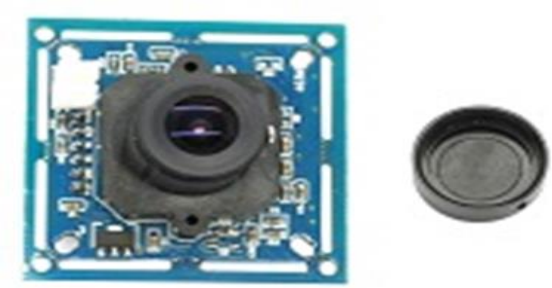

Figure 4. Camera VC0706

Motors: In our project we used two types of motor as follow:

DC servo motor: This motor has been used to control the movement of the flame sensor and camera to right and left to detect the flame in everywhere of the place. It have low power consumption, therefore it is suitable for our Project (Figure 5).

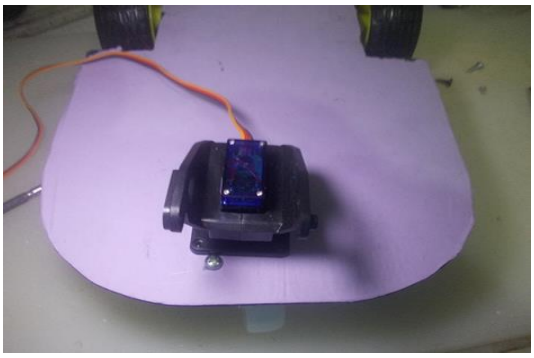

Figure 5. Used DC servo motor

Geared DC motor: Two of these motor have been used to control movement of robot. We used this motor because it has the ability to lifting heavy weights and it is very stabile and can work in DC 3V-6V (Figure 6).

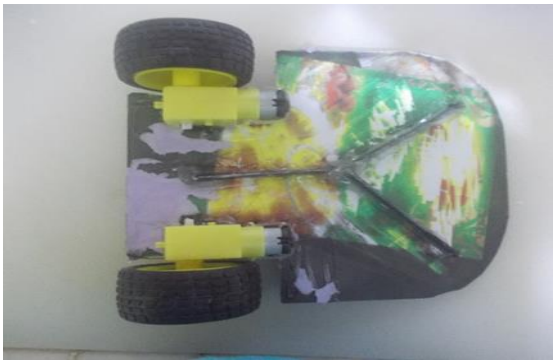

Figure 6. Used geared DC motor in project

Motor driver:

In this experiment, L293 which is quadruple high current bidirectional driver that can drive inductive loads such as motor, relay and solenoid is used to drive DC motor. The objective of this experiment is to understand how the different combination of signals send to L293 will affects the direction of the motor turned and to determine the limitation of L293 and the DC motor (Figure 7) [6].

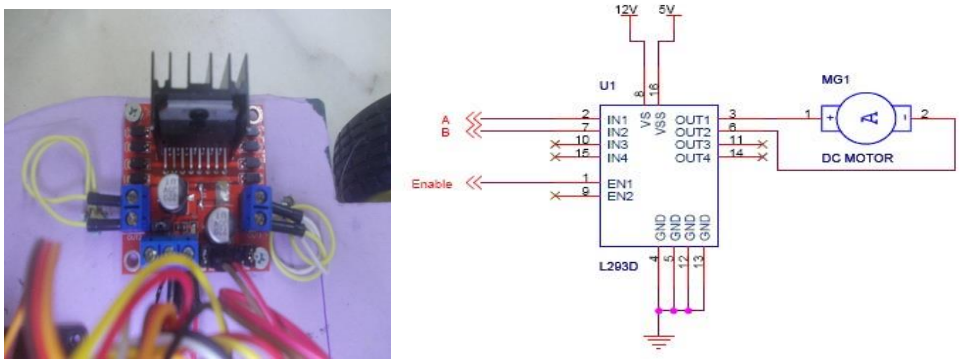

Figure 7. Driver L293 and schema

It's very important using motor driver to control the movement of robot in all directions (right, left, toward and backward). Therefore we used L293 to control motor movement. H-bridge motor controller named L293 was used for the robot. H-bridge is circuits schema shown Figure 8. And from all of that we can describe bidirectional motor control as shown in Table 2.

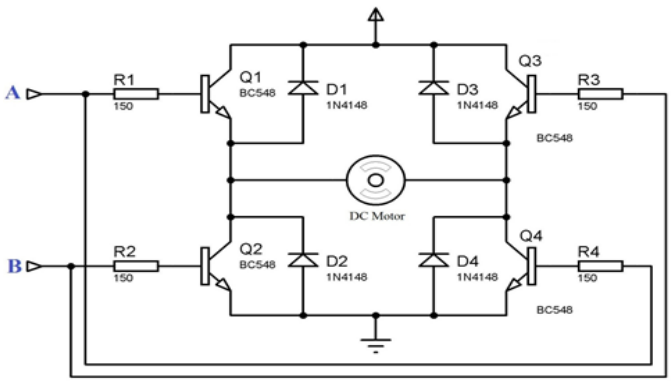

Figure 8. H-bridge

Table 2. Table of bidirectional motor control

Motor 1		Motor 2		Motor 1	Motor 2	Robot
IN A	IN B	IN A	IN B	Direction	Direction	Direction
0	1	0	1	forward	forward	forward
1	0	1	0	backward	backward	backward
0	1	1	0	forward	backward	right
1	0	0	1	backward	forward	left
0	0	0	1	stop	forward	left
0	0	1	0	stop	backward	right
0	1	0	0	forward	stop	right
1	0	0	0	backward	stop	left
0	0	0	0	stop	stop	stop

After processing all the pieces required for the robot industry, we will now linking all the pieces together and after programming microcontroller, robot will be ready for work and its final form as in Figure 9.

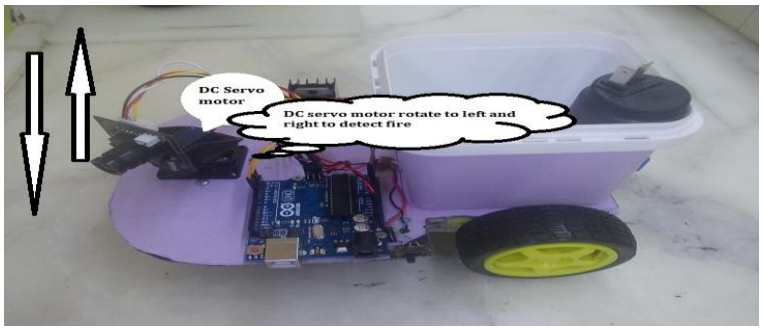

Figure 9. Final form of robot

In our project we use proteus to draw the circuit of our robot. After processing all the pieces and connection between them, fire tracking and suppression mobile robot circuit diagram seems as in the Figure 10 below.

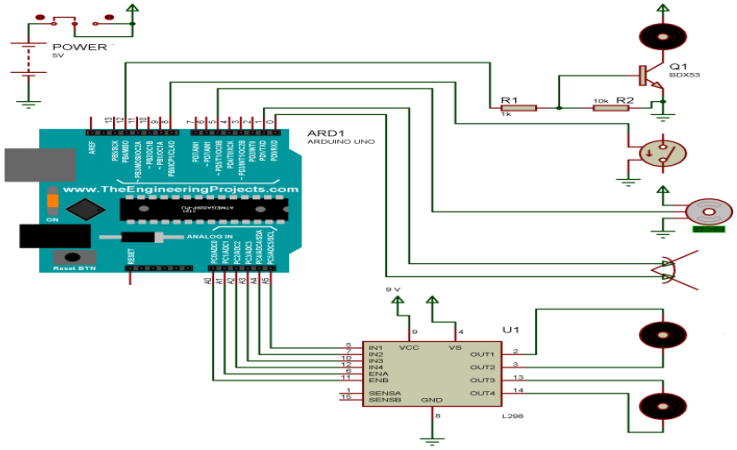

Figure 10. Project circuit diagram

4. Algorithm

In this project the main goal of robot is to find fire and fighting the fire by water system. First a flame sensor going to searches on a fire in all directions because of the movement of servo motor left and right. After finding fire, the flame sensor sends information to comparator and it going to analyze these information's. After that these information's are sending to microcontroller. The microcontroller send information's to, camera to capture images for fire and send it to computer, and motor driver send it after that to motors to start movement toward fire. When robot stand in front of fire, firefighting system starting work to finish fire (Figure 11).

And as we said, to find flame in all directions, servo motorgoing to rotate to right and left to detect flame. And in same time robot start to rotate to left and right too, in this way we have another algorithm for DC servo motor as shown in Figure 12.

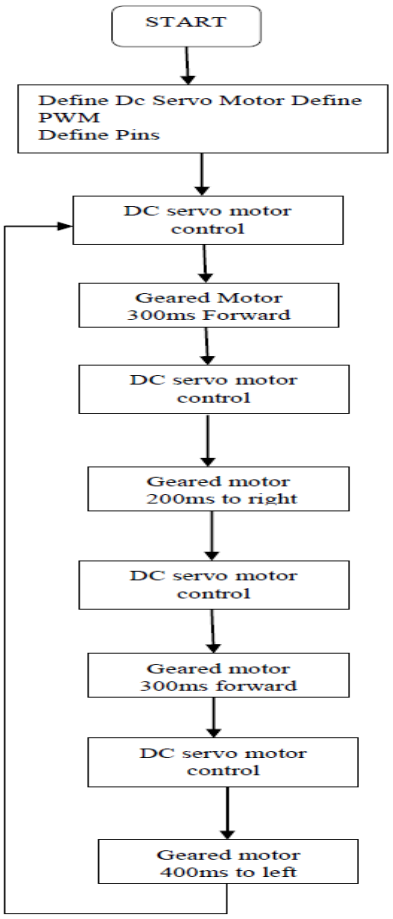

Figure 11. Fire tracking and suppression mobile robot algorithm

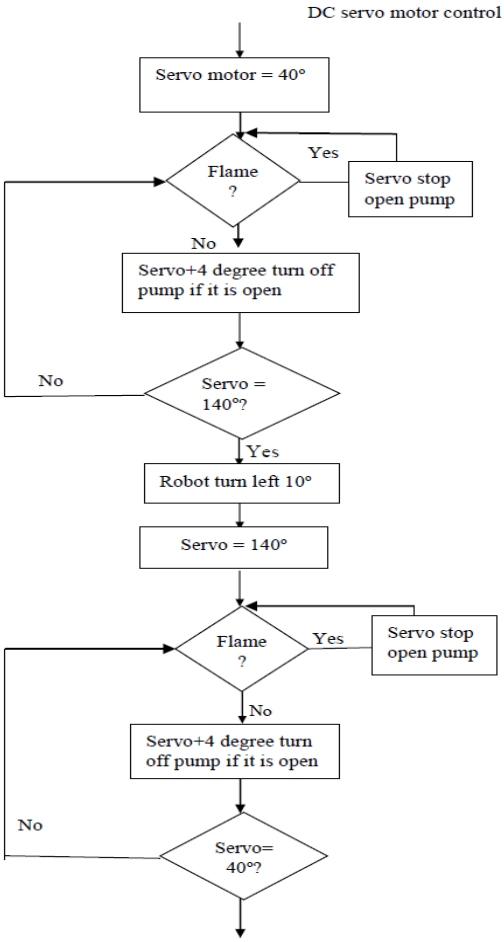

Figure 12. DC servo motor algorithm

6. Conclusion

During the experiment, robot work successfully and all (fire detect, locating and firefighting) systems were worked all successfully. In our experiment flame sensor and camera was placed on the rotor motor (DC servo motor) witch rotate to left and right to detect fire. When detecting fire, flame sensor send signal to agents in order to accomplish their specific goals. And in this experiment many agents were worked together for an only goal.

We used flame sensor her to prevent the fire from spreading which could cause further damage and extinguish before it uncontrollably. This will reduce the loss of properties and the important things and maybe save human lives.

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