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Automated Fire Detection And Extinguishing Bot

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Abstract:
In today's commercial and industrial world, automation plays an important role. It's a concoction of different elements arranged in order to regulate, direct, sense and command it to achieve a desired result. "**Fire Detection and extinguishing Bot**" employs the use of artificial intelligence and embedded system technology to efficiently solve the problem of fire outbreaks. It can be a better alternative to the existing manual fire extinguishing system where human life (firefighters) is at risk. The idea here is to build a prototype based on the Arduino Mega 2560 microcontroller. It should be able to efficiently detect the source of fire outbreak and then successfully navigate towards it to extinguish the fire effectively. Being wireless, the bot has a widely effective area of operation and on further development, it can also be used in real life situations to tackle and extinguish fire outbreaks efficiently. Firefighting is a dangerous occupation. But it is important at the same time. It is the job of a firefighter to be able to get to a fire quickly and safely extinguish it, preventing further damage to property and human lives. So, combining technology to save lives seems a great way to make this job more convenient. And building robots that can simplify hazardous human tasks, is the key to a safe and better future.

Keywords: Fire-fighting, bot, artifical intelligence, prototype.

I. INTRODUCTION

It all started when Alan Turing thought that machines can be taught to think like human beings and used to solve real world problems. And now if you look at the modern world of computing, the field of artificial intelligence has evolved by leaps and bounds. Unforeseen fire accidents can occur anywhere and anytime and have often resulted in huge loss of property and human lives, since times immemorial. There are many reasons for a fire outbreak to occur. Most common being an electrical short circuit, or gas leakages. And once the fire outbreak occurs , the natural human tendency is to escape from the place of accident as panic strikes in . The Automated Fire Detection And Extinguishing bot can play a vital role in such situations, since robots are free from the human factor of emotions like panic, fear and anxiety. Hence it can be used to effectively tackle such tens and dangerous situations, immediately. The proposed automated prototype will detect the direction of fire outbreak , navigate towards it and efficiently extinguish the fire at its source. A vertical square threaded shaft is embedded in it so that it can detect fire on vertical as well as on ground level.

II. DESIGN CONCEPT

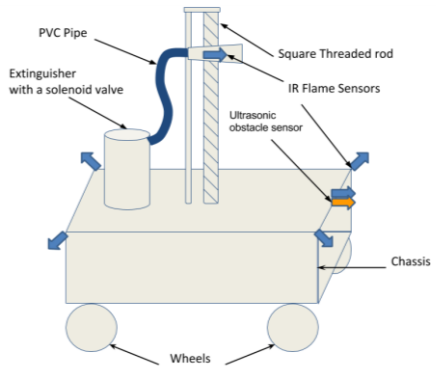

Figure.1. 2D Diagram of BOT

The prototype is designed in such a way that it could effectively sense the direction of fire outbreak and navigate towards it , avoiding obstacles in its path. Upon reaching the source of fire outbreak the extinguishing mechanism starts and the sensor attached to vertical threaded shaft detects the exact location of fire outbreak and extinguish it.
The bot design is classified into three categories; the detection module, the navigation module, the extinguishing module.

A. Design Of Detection Module

For detection of fire IR flame sensors are used. These sensors are most popular short range flame detection sensors. It detects the flame or light source wavelength in the range of 76 cm to 110 cm, the lighter test flames up to 80cm, the greater the distance the greater the flame. The detection angle is about 60 degrees; the flame spectrum is particularly sensitive. It has potentiometer for adjustment. The working voltage is 3.3V-5V.Output format: Analog switch output (0 and 1). Function findRange calculates the range of the IR sensors such that its range is divided into regions no fire, distance fire, close fire, spray distance Every region is given a set of actions to be performed if the analogRead takes value in that region.

B. Design Of Navigation Module

Standard wheels of diameter 7cm are used for the purpose of navigation which is driven by DC motors. Two motors are used for driving wheels which are of 100 rpm and one motor which is of 200 rpm is used for vertical movements. DC Motor drivers: It can regulate 2 bi-directional DC motors with individual 8-bit speed selection (so, about 0.5% resolution)
An Ultrasonic sensor is attached to the front side of the bot to detect obstacles in its path.

C. Design Of Extinguishing Module

The vertical square threaded shaft and the extinguishing module works simultaneously. The square thread rod is a common screw thread type, used in high load applications such as lead screws. It is the lowest friction and most efficient

thread form. The greatest advantage of square threads is that they have a much higher intrinsic efficiency than trapezoidal threads. In this design, threaded shaft will be adjusted on Center of Gravity (CG) of the chassis by ball bearing to ensure smooth functioning. This rod is attached with a DC motor (200 rpm) near its base to keep it rotating in clockwise-anticlockwise directions and to manage its directional flow; this structure has one IR flame sensor attached to it. This entire structure is attached to a guide rod in case of any balance issues. Fire extinguisher is mounted on the chassis area. Further it is attached to nozzle by a PVC pipe. For automatic release of the gas, regular spray type extinguisher (10 bar CO2 pressure) with a solenoid valve attached to its releasing end is used. **Solenoid valve** is an electromechanically actuated valve to control the flow of gases. When a strong current (12 V) is passed through the coil the plunger is pulled toward the centre of the coil which results into opening of the release mechanism. Solenoid valve is used because it can be actuated whenever needed just by passing a current signal. This assembly is specially used to avoid manual operation of the extinguisher.

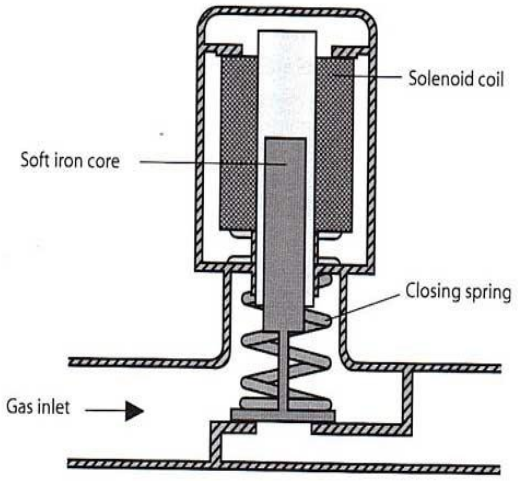

Figure.2. Solenoid Valve

II. ELECTRONIC DESIGN AND DEVELOPMENT

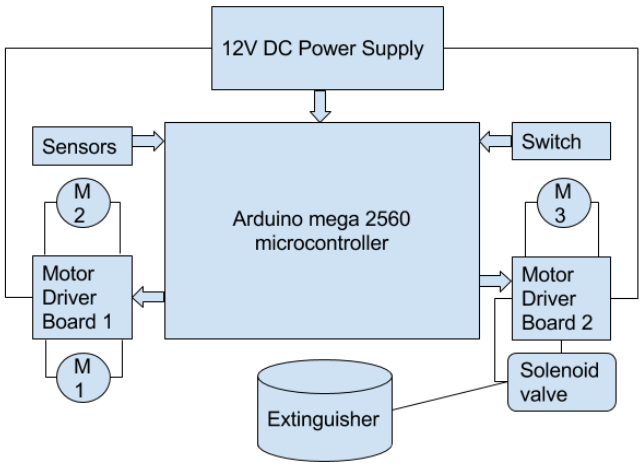

Figure.3. Block diagram of the system

The main components of the bot are: Microcontroller (Arduino mega 2560) IR sensors, Motor Drivers, Motors, Actuator.
Microcontroller (Arduino mega 2560): The Arduino Mega 2560 is a microcontroller board based on the ATmega1280. It has 54 digital pins which could be used as an input or output using some built in functions. They operate at 5 volts, could provide or receive a maximum of 40mA and has an internal pull-up resistor of 20-50 K-Ohms. IR sensors: These sensors are connected to ADC pins of the microcontroller. Motor drivers: Motor drivers are connected to describe the direction of the movement of the bot. It is used to give high voltage and high current to motors which are required for the movement of the bot. Motors: DC motors are used for rotation of the wheels which is responsible for movement of the bot. Usually DC motors convert electrical energy to mechanical energy. In this project we use two motors for rotation of the wheels and one motor for rotation of square threaded rod. Actuator: An actuator requires a control signal and source of energy. The control signal is relatively low energy and may be electric voltage or current. Solenoid valve is fitted to the extinguisher, which drives the extinguisher.

III. PROGRAMMING

The algorithm is developed in such a way that all the three modules of detection, navigation and extinguishing are synchronized to operate and carry out the designated tasks effectively. The idea behind detection is that a certain threshold value of fire is set, according to the UV range of flame and the IR sensors are programmed in such a manner that it can immediately detect the change in the UV value. In case of a fire outbreak, the value is bound to cross the threshold value, hereby activating the IR sensors. There are six IR sensors for comprehensive coverage of fire detection area. Whenever any IR sensor detects fire, it rotates accordingly till the front IR sensor brings it in-line with the source of outbreak. Once the bot in in-line with fire, it is programmed to move forward along the line of fire and stop up to a certain safe distance from fire. The vertical square threaded rod then comes into play and detects the vertical height of fire outbreak. Eventually, once the exact source of fire outbreak is detected, the extinguishing mechanism is activated, thereby activating the solenoid valve, which in turn activates the actuator and the fire is extinguished successfully. The micro-controller is programmed in such a way that there is a proper interaction between these modules and efficiency is maintained in its operations.

Algorithm:

1. Start
2. Define ports for all the sensors. //IR1, IR2...IR6, Ultrasonic, Driver ports
3. Read analog input from IR1, IR2...IR5
4. If value Of(IR1|| IR2 || IR3 || IR4 || IR5) < Threshold_value {

4.1. Sort the values and prioritize the sensor with minimum value

4.2. IR= Min_val

4.3. if(IR1==IR)

Perform left rotation until IR2 < threshold_value

else if(IR3==IR)

Perform right rotation until IR2 < threshold_value

else if(IR4==IR)

Perform right rotation until IR2 < threshold_value

else if(IR5==IR)

Perform left rotation until IR2 < threshold_value

4.4. Read analog input from IR2

Range= find_Range (IR2)

4.5. switch(Range)

{ Case 0:

{ //Sprayable distance region

Downward movement of clamp and read analog input from IR6
Spray when IR6 < threshold_Value
}
Case 1:
{ //Close fire region
Run forward until Range ==0 and avoid obstacles
}
Case 2:
{ //Distant fire region
Run forward until Range ==0 and avoid obstacles
}

Case 3:
{ //No fire region
Downward movement of clamp and read analog input from IR6
Spray when IR6 < threshold_Value
}
}

IV. RESULTS

No	Case(Direction of fire)	Actions performed by system
1	Fire on left side	1.Top-left IR activation 2.BOT turns left 3.Middle IR activation and move forward 4.Stop at a safe distance 5.Vertical detection and extinguishing
2	Fire on right side	1.Top-right IR activation 2.BOT turns right 3.Middle IR activation and move forward 4.Stop at a safe distance 5.Vertical detection and extinguishing
3	Fire on backside -right	1.Bottom-right IR activation 2.Rotate right until middle IR activation 3.Move forward and stop 4.Vertical detection and extinguishing
4	Fire on backside -left	1.Bottom-left IR activation 2.Rotate left until middle IR activation 3.Move forward and stop 4.Vertical detection and extinguishing
5	All sensors getting activated* (Special case)	1.Sort input from all the active sensors 2.Prioritize minimum value and repeat
6	Obstacle in the navigation path	1.Step backwards and rotate 2.Move forward again

V. CONCLUSION

The "Fire Detecting and Extinguishing" robot is fully automated and wireless, which will help in an extended and wider range of applications and real world scenarios. The vertical square threaded rod, which will sense the source of fire outbreak in a vertical direction, upon further development, it could be used in rescue operations in tall buildings/skyscrapers wherein it's difficult for firefighters to reach and save the trapped victims. Preprogramming the robot with a custom floor plan and map of rooms and locations would make it easy to find and extinguish a fire before humans are even aware of the situation. Many of the methods used in this project, specifically in the navigation aspect, are still under research and development. Everyday, people are coming up with possible improvements, with their own algorithms in C++ or Python. Since it is built on an Arduino microcontroller, the said prototype will be small in size yet effectively durable. It will be capable of successfully extinguishing fires up to the intensity of approximately 5 to 10 candles. Our robot is versatile and could also be used as a tool for development in the field of automation and artificial intelligence. Every module of this bot can be further researched and improvised to make it scalable for industry level applications.

VI. ACKNOWLEDGMENT

It is a matter of great honor to bring out the synopsis report on the project: “Fire Detection and extinguishing bot” We experience immense pleasure in stating that we have secured the excellent guidance of project guide Prof. Sumithra T V. We have received their whole hearted assistance, inspiration, encouragement and valuable guidance in all phases of our project. We also take the opportunity to thank our Principal Dr. Ramesh Vasappanavara, HOD, Dr. Leena Ragha for their valuable help. We also thank all the faculty and staff who have helped us directly or indirectly. Lastly we cannot forget to thank our group members and our class friends who directly or indirectly gave us ideas and help for this project. Also we are thankful to the non- teaching staff for providing the various facilities for this project.

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