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Autonomous Fire Detecting and Extinguishing Robot

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Abstract— Fires can start from the smallest spark. If left unchecked, wildfires can go on to devastate people and property. An effective and reliable means of detecting and extinguishing fire is necessary. The firefighting robots can save a lot of lives someday, the lives of those affected by the fire disaster as well as lives of those people working as the firefighters, It can be useful in certain types of incidents where the environment will be very dangerous for the humans such as the hazardous materials, the radioactivity or the propane tank which can explode. In Our Proposed System we are using Arduino with an automatic system to continuously monitor the fire in a predefined path. Proposed system consists of Gas sensor, fire sensor, Motor driver, DC motor, water pump motor, Servo motor and Arduino board. The Servo Motor system SG90 is used for sprinkling the water. Different specialized sensors will be connected to the Arduino board. As for programming, Arduino IDE coding will be implemented to give sensor inputs so that we can govern the movement of the automated system. GSM Modules alongside GPS will be connected to the Arduino board so that it can immediately notify the fire-station which is within the reach.

I. INTRODUCTION

The Autonomous Fire Detecting and Extinguishing Robot is developed for the systems available for firefighting at residential areas and extinguishing forest blazes. Our proposed system is a small robot which can be usedto control the fire from spreading at the initial stage of an incident of fire. By using such robots, the work of fire detection and extinguishing can be done without risking the life of firefighting human agents. In addition to this, small size and autonomous control enables the robot to be used when fire occurs in small and narrow spaces with hazardous environments which are difficult to be accessed by humans. Moreover, this robot can increase the capacity, security, workability, effectiveness and quality of the task of firefighting.

A. Literature Survey

Fire is defined as the possibility of an unwanted hazard which can cause potential loss of life and property [9]. This project is an Autonomous Fire Detecting and Extinguishing Robot without user intervention and it is designed and implemented using ATMEGA 16 Microcontroller (MCU) [10].
Under the mighty ruler of Rome Augustus the first formal firefighting began. Since then it has continuously evolved. Earliest recorded are the usage of the fire extinguisher pump. Then came the German invention of the first force and suction

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fire and safely douse the fire, obstructing further damage and rescue victims to a safer location from the hazard. Technology has made it possible to design simple and efficient fire fighting systems. Modern firefighting systems use inert gases such as Nitrogen with water mist to extinguish fire [8]. Robots were designed to locate a fire, before it creates havocs. [5]. Robots have attained immense popularity due to progress in the fields of computing and nano technologies [10]. The robots have the potential to prevent human loss of life. After studying the existing fire fighting systems, this system is proposed to control the fire at the earliest before help arrives and the fire rages out of control.

B. Materials Used

- Arduino Uno board
- IR based Flame Sensors (Three units)
- (SG90)Servo Motor
- Motor Driver L293D
- Robot Chassis of Metal
- Breadboard
- DC Motors (Two units)
- Wheels (Two units)
- Castor Wheel
- 12V DC Pump
- 5V Relay
- 4V 1.5Ah Lead Acid Battery
- Switch and Connecting wires
- Container for keeping Water
- Silicon pipe for water delivery
- LCD
- Voltage Sensor

II.METHODOLOGY USED

The design is split into three parts such as mechanical structure, hardware components and programming [3].

A. Mechanical Structure

For supporting a robust surface for the robot, a metallic robot chassis is used. Two wheels at the hind side of the system and a castor wheel on the anterior side. The castor wheel provides 360 degrees of portability to the automated system. The body of the automated system is of acrylic sheets which has resistivity to higher temperatures. This body can be useful for protection of the internal electro-circuits from physical factors such as heat and mechanical-spontaneous jerks [7].

The flame sensing detectors are placed in the anterior side for the detection of fire in the system. The holder which has water is in the middle of the chassis to balance the gravity in center and prevent the system from overbalance.Voltage sensor is used to monitor the battery level and displays it in LCD.

B. Programming

For the programming part, robotic controls for mobility, fire detection and extinguishing, Arduino IDE is used. The Algorithm for the source code is given below

III. BLOCK DIAGRAM AND EXPLANATION

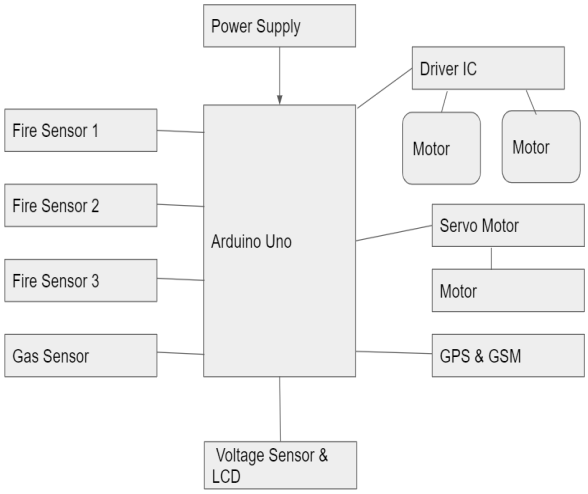

Fig. 1. Block Diagram

The above shown is the block diagram for the Autonomous Fire Detecting and Extinguishing Robot. Three flame sensors : left flame sensor, right flame sensor and centre flame sensor are connected to the Arduino Uno board as the input parts [1]. The L293D motor driver module is used for driving the two geared DC motors like the Left DC Motor and the Right DC Motor. The motors are to give direction to the automated system based on the flame area i.e. the input received from the flame sensors.

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A. Circuit Description

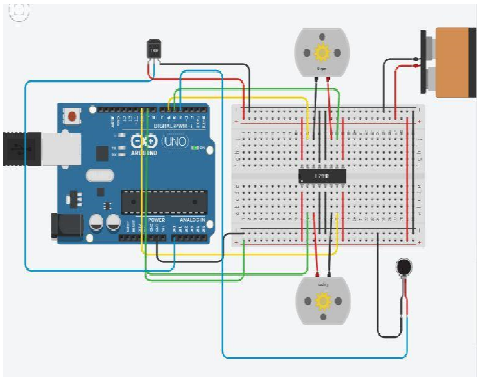

Fig. 2. Circuit Description

The flame sensors and the servo motor are given Vcc and Gnd commonly through a small breadboard. The input pins of flame sensors are interfaced to the Digital Pins of the arduino uno board (any pins from 0 to 13). The PWM pin of the Servo Motor SG90 is also interfaced to one of the digital pins. The pins IN1, IN2, IN3 and IN4 of the L293D Motor Driver Module are also interfaced to the digital pins. The OUT1, OUT2, OUT3 and OUT4 pins of the Motor Driver Module are used in the Left and the Right DC motor.

[3] emphasized that people who are visually impaired have a hard time navigating their surroundings, recognizing objects, and avoiding hazards on their own since they do not know what is going on in their immediate surroundings.

IV. ALGORITHM

Following steps are followed for the programming of the robot to detect and extinguish fire.

1. Start
2. Read the Inputs from the Flame Sensors
3. If no flame is detected, proceed forward (both the motors on)
4. If flame is detected by the right sensor, the move right and stop at a certain distance and start DC Pump and Servo motor. (right motor off, left motor on)
5. If flame is detected by the left sensor, the move left and stop at a certain distance and start DC Pump and Servo motor. (left motor off, right motor on)
6. If flame is detected by the center sensor, the move forward and stop at a certain distance and start DC Pump and Servo motor. (both the motors on)
7. Voltage sensor is used to monitor the battery level and displays it in LCD
8. Stop

V. WORKING CONCEPT

One of the crucial integrant of this fire fighting robot is the Fire Sensor Module otherwise known as the flame sensor. The image of the same is displayed below.

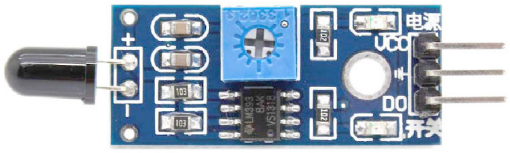

Fig. 3. Fire Sensor Module

Here an **IR Receiver (Photodiode)** is used to detect the fire. The flame generally gives rise to some Infrared light rays, these light rays are absorbed by the IR receiver on the module. [7] proposed a novel method for secure transportation of railway systems has been proposed in this project. In existing methods, most of the methods are manual resulting in a lot of human errors. This project proposes a system which can be controlled automatically without any outside help. This project has a model concerning two train sections and a gate section..

A. Working

After turning on the robot it moves in the forward direction and during this process both the motors are in ON condition. If in case no flame is sensed and detected by the flame sensor then the water pump and the servo motor will remain in OFF state.

As soon as the flame is detected the fire robot moves towards it and stops at a distance where it can access the fire spot. After detecting, both the

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motors turn ON. Here, the water motor and the servo motor turn ON. Henceforth, the water is invariably dispersed onto the flame till the flame recedes or extinushes. After extinguishing the flames both the servo and the water pump motor turn OFF automatically. This way we can achieve efficient power consumption. The robot now starts moving again in order to detect the flame. [5] discussed about Nanorobots Control Activation For Stenosed Coronary Occlusion, this paper presents the study of nanorobots control activation for stenosed coronary occlusion, with the practical use of chemical and thermal gradients for biomedical problems.

When there is detection of flames by the left flame sensor, the speed of the robot slows down and moves closer to the flame upto a certain distance towards the left having the right motor ON and the left motor OFF. After detecting, both the motors turn ON. Here, the water motor and the servo motor turn ON. Henceforth, the water is invariably dispersed onto the flame till the flame recedes or extinushes. After extinguishing the flames both the servo and the water pump motor turn OFF automatically. The robot proceeds further. When there is detection of flames by the right flame sensor, the speed of the robot slows down and moves closer to the flame upto a certain distance towards the right having the right motor OFF and the left motor ON. After detecting, both the motors turn ON. Here, the water motor and the servo motor turn ON. Henceforth, the water is uniformly dispersed onto the flame till the flame recedes or extinushes. After extinguishing the flames both the servo and the water pump motor turn OFF automatically. The robot proceeds further. We have interfaced GSM modules with the G.P.S to the Arduino UNO board. With the help of the G.P.S system the location will be traced and via GSM module a message will be the nearest fire station, this alerts the fire station to be ready to take action in case the fire is out of control and voltage sensor is used to monitor the battery level and displays it in LCD

.

VI. ANALYSIS

Our main motto was to develop the entire prototype of the robot. There can be improvisations in the coding sections for betterment of the design whenever necessary. These improvisations can be done based on what sort of output we are expecting. Several trials were conducted based on varied distances using the robot. The more the distance the weaker the power becomes to detect the flame. Therefore, this robot is worthy of operating in plain terrain. Further development plans can include extemporization where the robot can also work in uneven terrain and paths where human interventions might be difficult. [9] discussed about a system, GSM based AMR has low infrastructure cost and it reduces man power. The system is fully automatic, hence the probability of error is reduced. The data is highly secured and it not only solve the problem of traditional meter reading system but also provides additional features such as power disconnection, reconnection and the concept of power management.

VII. SCOPE AND LIMITATIONS

{There exists a large scope of improvisation by converting the land terrain robot into a drone operated robot. This will also facilitate the locomotion of the robot to travel to hard lying areas. This drone adaption can also provide better security to the robot itself. Real time image capturing and spraying of water or fire subsidizing agents can be carried out in a wider perspective[9].

VIII.CONCLUSION

Based on the prototype the objectives were successfully achieved. However the robot has its own limitations as mentioned above. But in the suitable conditions it operates well without any glitch and snag. After further improvisations like adding the ultrasonic sensor, gas sensor, led display, smoke sensor, it is possible to use this robot in practical real time situations [7].

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