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Fire Fighting Robot Using Arduino UNO

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Abstract – The purpose of this project is to provide a design for an Arduino-based Fire Fighter Robot. Arduino is an open source electronics platform that is based on easy-to-use hardware and software. Arduino board can be controlled by sending a set of instructions to the microcontroller. It has been designed to develop a fire-fighting robot using Arduino technology for remote operation. Firefighting is the act of extinguishing fires, i.e.; our robot sprinkles water onto the fire. The robotic vehicle is loaded with a water tanker and a pump to throw water. An Arduino microcontroller is sued for the desired operation. A firefighter robot suppresses and extinguishes firestop prevent loss of life and destruction of property and the environment.

Key Words*: *Arduino IDE, Arduino UNO, Fire Sensor, Servomotor

1.INTRODUCTION

With the ever-increasing technology, the developments are increasing in the face of the situations that cause human life. Every day, the robot industry emerges as a model that is produced as an alternative to the human element in a new branch. Flying, robots, wheeled robots legged robots, humanoid robots, and underwater robots are just some of them. The growing world population is bringing involuntary problems together. Fires are among the most important of these problems. The robot industry has a lot of work in this area. Some of these are fixed mobile robots with different features, which are equipped with different sensors that detect before the fire is out, mobile rescue robots as fire search and rescue equipment, mobile locating robots used for fire detection, fire extinguishing robots in many different models designed to assist firefighters in the fire. This fire-fighting robot can be used as a supplementary to the firefighters in critical situations. To function this robot, a flame sensor, a gas sensor, an IR sensor, and a temperature humidity sensor has been used. The flame sensor is used to detect the fireplace at the same time as the gas sensor informs about the presence of flammable gases, the Passive Infrared Sensor confirms the presence of a human, and the temperature humidity sensor sends statistics about the temperature and humidity of the locality. The robot can run in both a manual control system. The motor driver is used for the bidirectional control of the motors equipped in the robot. Every instruction for motion control is given through Bluetooth.

2. OBJECTIVES

The death rate belongs to fire accidents and forest fires has increased. Initially, this fire starts from a smaller area. If we can find out the starting place before the fire gets widespread, we can inhibit it. In this project, the main objective is to stop the spread of this fire. For that, we have to detect the fire in its initial stage. The fire sensor which is placed in the project will determine the fire. The surroundings of the robot should be tracked for avoiding collisions. A wireless cathartic is fixed to it covers the surroundings. Robot motion plays a major role in the project. Locomotion of the project is controlled by a remote which is done by DTMF IC. The detected fire signal should reach the end user is also an objective of this paper. Reaching of this signal to end user is achieved by using GSM. Coordination of all the equipped parts is also an important factor. All the components are connected to 8051 microcontrollers and it acts as the heart of the project. All the commands related to fire detection signals are given to that microcontroller it operates the remaining components of the robot in moving and pumping of the water. It would be able to operate effectively in unknown environment.

3. LITERATURE REVIEW

[1]. J. Reinhart V. Khandwala (2003) was AL discussed about design and the implementation of the fire-fighting robot. The key design elements of the robot to be discussed include: the assembly and construction of the robot hardware, the processing algorithm based on the sensor's response, and the navigation algorithm that will enable the robot to find inefficient path in and out of the house model.

[2]. Miller, Lynette the construction of each component of the robot that is intended to locate and put out a minor

fire represented by a light emitting diode in a model home was discussed by Daniel Rodriguez (2017) [2]. This essay will discuss every element of the robot, starting with the start signal and moving on to the robot platform, line following, room finding, and, finally, fire detection.
[3]. According to Sahil S. Shah (2013), an embedded system was used to construct a FIREFIGHTING ROBOT. We'll create and test a robot that can put out a fake house fire. It must be capable of independently moving around a simulated floor layout while aggressively looking for a flame. The robot can even serve
as a fire extinguisher in an emergency and a path guider in regular circumstances. In the future, robots that can locate fires before they get out of control will dramatically reduce the danger of injury to victims.

4. IMPLEMENTATION AND WORKING

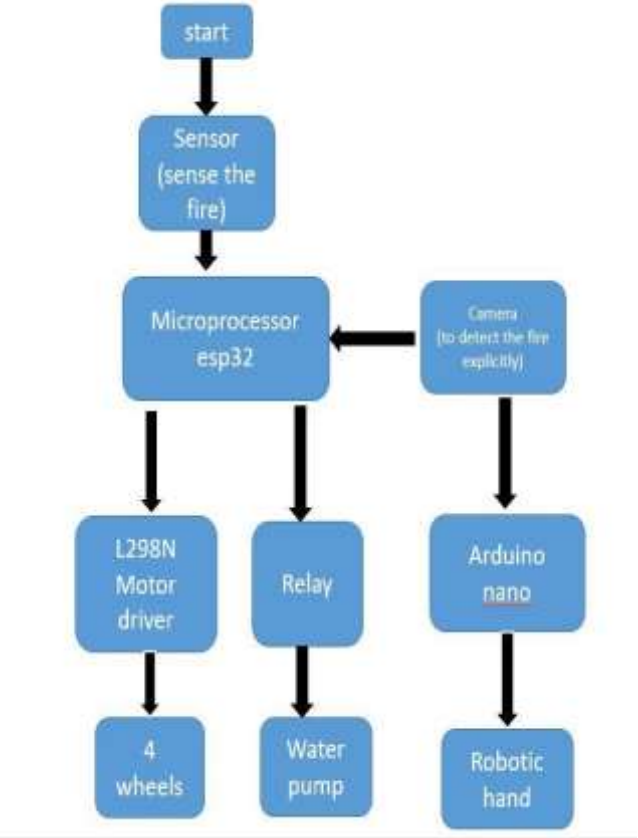

FIGURE 1 BLOCK DIAGRAM

Initially, the proposed robot is controlled by humans who would send commands through Bluetooth which is received by esp32 on the robot Based on these commands, the robot would move towards the fire environment. Once the robot reaches the fire environment, camera and fire sensor installed on the robot would enable the controller to examine the situation. Based on their decisions, the controller would then send commands through Bluetooth to turn on the extinguisher. If the fire was too close, the robot could detect it through its flames sensor and turn on the extinguishers like gas. As soon as the robot receives command from the controller by Bluetooth, the instructions are computed in the ESP32microprocessor. The ESP32 then sends commands to the motor driver, allowing the robot to move according to the human commands. When it is time to extinguish the fire, the signals are sent to the relay by the ESP32 to turn on the water pump. The entire environment is also monitored by human's toensure that the fire is completely extinguished. Another essential component of our firefighting
robot is the robotic hand. This robotic hand issued to clear obstacles in front of the robot to move forward or to move to a desired location. In emergency cases, the robotic hand can also open doors and pick up obstacles, allowing it to rescue humans from fiery situations.

5. CIRCUIT DIAGRAM

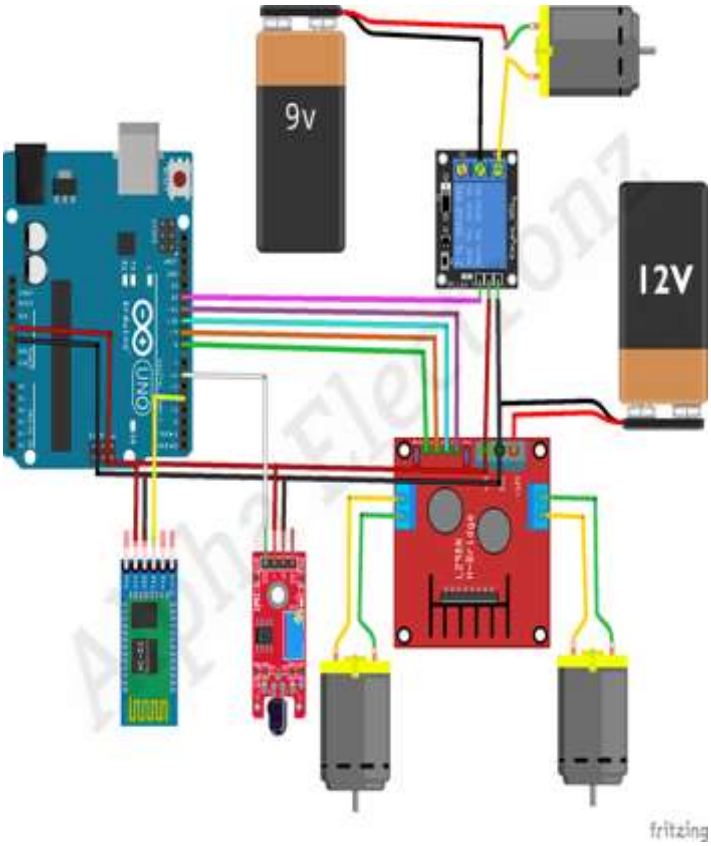

FIGURE 2 CIRCUIT DIAGRAM

The main goal of this project is to locate the fire and put it out with the use of a water syphon. The main aim of the proposed system is to implement a fire detection system which has an alarm system implemented to alert when fire

is detected. The frame of the robot is designed and fabricated which include the water dispensing system, the drive and control system for robot's motion. The AT mega 328P is a main component in the Arduino UNO board. The ATmega328P is good starting point for autonomous application. As it is cost effective widely available. Although ARDUINO is derived from the C and C++ programming languages, it is much simpler than other controller programming. The extinguishing system is managed by the microcontroller. The controller's working voltage is 5 volts, its clock frequency is 16MHz, and the recommended information voltage is 7 to 12 volts, with a range of 6 to 20volts allowed. The main goal of this project is to construct an ARDUINO-based programmed fire-stifling robot that can recognize a fire's location and put it out by activating sprinklers. The engine driver board illustrates the direction of robot development. It is used to provide highvoltage and high current as a yield to power the engines included in the project to construct the robot. The pivot of the wheel, which is responsible for the evolution of the robot, is currently powered by a simple DC engine. Typically, DC engines convert electrical energy into mechanical energy. A syphon is used to syphon water onto the fire in order to put out the fire since a basic engine is being used to pump the water. The extinguishing system's pumping motor regulates the flow of water that exits the pump. Camera is connected to the Arduino via Bluetooth where we can watch the surrounding environment with the help of camera L298N motor driver is been connected to the Arduino board to which external power supply is given. Then 2 dc motors are connected to the motor driver to which tyres of the vehicle can beset. A motor pump is connected to the Arduino with the help of a relay to pump the water in order to extinguish the fire.

6. COMPONENTS

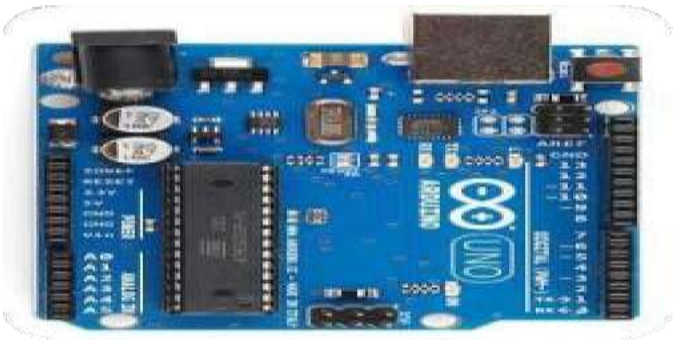

FIGURE 3 ARDUINO UNO

Arduino is an open-source platform used for building electronics projects. Arduino consists of both physical programmable circuit board and a piece of software, or IDE (Integrated Development Environment) that runs on our computer. It is used to write and upload computer code to the physical board. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. The input voltage of the UNO board varies from 7V to 20V.

FIGURE 4 MQ-2 Gas SENSOR

The MQ-2 Gas Sensor is a semiconductor sensor used to detect gases such as LPG, methane, propane, hydrogen, and smoke. It operates at a voltage of 5V DC and has a built-in heater that also requires 5V. The sensor provides both analog and digital output, making it compatible with microcontrollers like Arduino for fire detection and gas leakage systems. Its detection range varies depending on the gas: for LPG, it can detect concentrations from 200 to 10,000 ppm, and for smoke, it ranges from 50 to 1,000 ppm. The sensor has a fast response time of less than 10 seconds and operates effectively in temperatures from -20°C to +50°C. For initial use, a preheat time of 24 to 48 hours is recommended to ensure accurate readings. The MQ-2 is compact, lightweight, and widely used in safety monitoring and automated fire detection systems.

FIGURE 5 FLAME SENSOR

The flame sensor is an electronic sensor used to detect the presence of fire or flame in its vicinity. It works by sensing infrared light emitted by flames and can quickly respond to fire sources. The sensor typically operates at 3.3V to 5V and provides both digital and analog outputs, making it compatible with microcontrollers like Arduino. Flame sensors are widely used in fire detection and safety systems due to their fast response time, reliability, and ease of integration into automated firefighting robots or alarm systems.

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FIGURE 6 SIM 800L

The SIM800L is a compact GSM/GPRS module that operates on quad-band frequencies (850/900/1800/1900 MHz), making it compatible with 2G networks worldwide. It works at a voltage of3.4V to 4.4V DC, with an optimal supply of 4V, and communicates with microcontrollers like Arduino via UART (TX/RX) interface. The module supports sending and receiving SMS messages, making voice calls, and transmitting data over GPRS using TCP/IP and HTTP protocols. It requires an external or onboard antenna for proper signal reception and has a peak current consumption of up to 2A during transmission. The SIM800L operates reliably in temperatures ranging from -40°C to +85°C and is widely used in embedded projects, IoT applications, and automated alert systems due to its small size and versatility.

FIGURE 7 SERVO MOTOR

FIGURE 8 RELAY MODULE

A relay module is an electrically operated switch used to control high-voltage or high-current devices with a low-voltage signal from a microcontroller like Arduino. It consists of a coil, an electromagnetic actuator, and one or more sets of contacts that open or close when the coil is energized. When the Arduino sends a control signal to the relay, the coil generates a magnetic field that moves the contacts, allowing current to flow to the connected load, such as a water pump or motor. Relay modules provide electrical isolation between the low- voltage control circuit and the high-power load, ensuring safety and preventing damage to sensitive components. They are widely used in automation, home appliances, industrial systems, and robotics projects to switch AC or DC devices on and off reliably

FIGURE 9 SERVO MOTOR

A motor driver is an electronic device that acts as an interface between a microcontroller, such as Arduino, and high-current motors. Microcontrollers cannot supply sufficient current to drive motors directly, so the motor driver amplifies the control signals to operate the motors safely. It allows control of the direction and speed of DC motors or stepper motors by using input signals from the microcontroller, often through PWM (Pulse Width Modulation). A commonly used motor driver, like the L293D or L298N, can drive two DC motors independently and can handle currents higher than the microcontroller's output. Motor drivers also provide protection features such as preventing back EMF from damaging the controller.They are widely used in robotics, automated systems, and applications requiring precise motor control, such as your Arduino-based firefighting robot.

FIGURE 9 RELAY MODULE

The LM2956 is a low-dropout (LDO) voltage regulator designed to provide a stable and regulated output voltage for electronic circuits. It can efficiently convert higher input voltages to a lower, constant output voltage, ensuring sensitive components receive a consistent supply. The regulator operates with low quiescent current, making it suitable for battery-powered and portable applications. It provides short-circuit protection, thermal shutdown, and overload protection to prevent damage to connected devices. The LM2956 is commonly used in embedded systems, microcontroller-based projects, and robotics to power components such as sensors, motors, and control boards safely and reliably. Its compact design allows easy integration into small circuit boards, making it ideal for projects like Arduino-based firefighting robots

7. RESULT

An autonomous firefighting robot has been developed that is capable of spotting flames andsmokes and successfully putting them out. This robot is perfectly capable of moving forward, left, and right. The robot's movement is managed by the Arduino code in conjunction with the motors. A warning about the dangerous environment will be displayed on the virtual terminal if any of the flame sensors or smoke sensors are activated. If no such detection is made, a safe environment will be presented. Upon receiving a signal indicating dangerous environment, the motor will begin to rotate and transport the robot to that location, where it will begin to pump water using a water pump.

8. CONCLUSION

The Fire Fighting Robot is powerful enough to put out small-scale fires. In darker environments, it is more sensitive to fire flame. It was created as a robot preventer because it can quickly detect fire and put it out before it spreads. This multisensory-based robot might provide a defense against all fire risks. This robot includes a number of sensors, including flame. A water spraying system is activated to put out the fire if it is detected. This robot's design also has a higher reserve capacity to fight against huge fires, and an updated sensing unit can even provide early fire detection in all situations with sufficient budget and scope

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