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DEVELOPMENT OF A FIRE EXTINGUISHING ROBOT WITH SMS ALERT FEATURE

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ABSTRACT: Fire incidents are disasters that can potentially lead to the loss of life and property. It can also cause damage and permanent disability to the affected victim. Firefighters are primarily tasked to handle fire incidents, but they are often exposed to high risks when extinguishing the fire, especially in a hazardous area. A one-stop solution for all fire-related accidents like fire outbreak, smoke and combustible gas leakage is hereby considered. This study presents the development of a fire extinguishing robot with an SMS alert feature that can sound an alarm to occupants of the building, send an alert SMS message to the registered phone number, and also proceed to extinguish the fire unmanned. It is designed to be compact for ease of movement into narrow spaces. The robot is equipped with an ultrasonic sensor to avoid collision with any obstacle and surrounding objects, while the flame sensor alongside a smoke sensor, was used to detect the fire. This developed autonomous system demonstrates the capabilities of identifying fire locations automatically and extinguishes the fire using the stored water in the container on it.

Keywords: fire alarm, SMS, ultrasonic sensor, robot, flame sensor, smoke sensor.

INTRODUCTION

A robot is a machine designed to execute one or more tasks automatically with speed and precisions. The study of robotic is evolving and developing area in our today's world; it is the simplest way for various technology modifications. Numerous studies have shown that robot can be beneficial to humans in different fields like medicine (Jeelani, 2015.), and rehabilitation (Aliff and Dohta, 2015.). Over the years, robots have also been introduced in various industrial applications. Industrial robots are multi-functional manipulators designed from specialized materials, gadgets or devices through different program movements to perform various tasks (Lee and Park, 2017).

Haksar and Schwager(2018) developed a bump-and-go robot, programmed to respond in a particular way to different external stimulus. This robot uses bumper sensors to detect obstacles. When the robot is turned on, it moves in a straight direction until it comes in contact with an obstacle, which triggers its bumper sensor. The robot then gets a programmed instruction to back off, turn in the right direction and then move forward. This is its response to every bump. In this way, the robot can change direction every time it encounters an obstacle.

Ramya and Palaniappan(2012) designed a microcontroller-based toxic gas detecting and alerting system. The system will automatically generate an alert that sends messages to a registered number. Hazardous gases like Liquefied petroleum gas (LPG) and propane were sensed and displayed each second in the liquid crystal display (LCD).

MATERIALS AND METHOD

In this paper, a fire fighting robot is proposed. The main function of this robot is to become an unmanned support vehicle, developed to detect and extinguish the fire. By using such robots, fire identification and rescue activities can be done with higher security without placing firefighters at high risk and in dangerous conditions. In other words, robots can reduce the need for firefighters to get into dangerous situations. Additionally, having a compact size and automatically controlled robot will also aid the extinguishing of fire in narrow spaces like tunnels or hazardous environments such as nuclear power plants (Nuţă and Orban, 2015).

Smoke Detector Unit

The smoke detector (Figure 1) used in this design is the MQ5 gas sensor, they are used in detecting leakage of gas such as LPG, natural gas, town gas, cooking fumes and cigarette in homes and industries.

Figure 1: Smoke Sensor

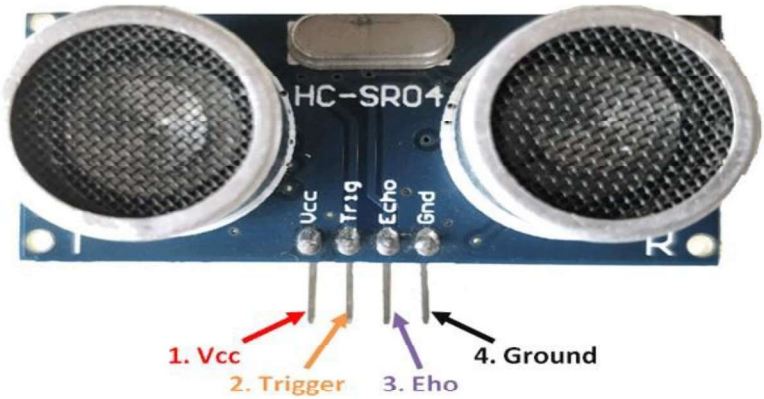
Infrared (IR) Flame Sensor

IR sensors like all other photo-sensor works on the principle that a photon of sufficient energy can knock out electrons leading to a change in the resistance of the circuit. The flame sensor is shown in Figure 2can be used to detect fire source or other light sources of the wavelength in the range of 760nm - 1100 nm(Fairchild Semiconductor Corporation, 2017).

Figure 2: IR Flame Sensor

Ultrasonic Sensor

An Ultrasonic sensor (Figure 3) is a device that measures the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.



[1] Figure 3: Ultrasonic Sensor

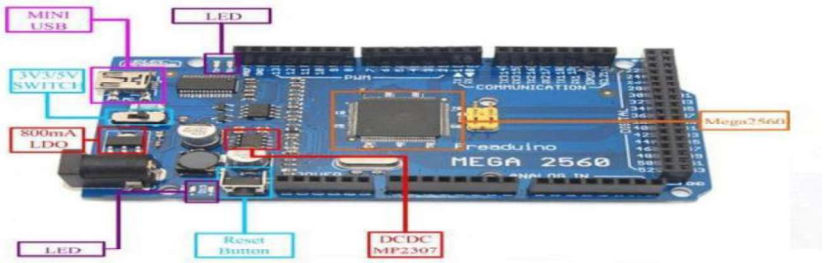
SG-90 Servo Motor

A servo motor (Figure 4) is an electrical device that can push or rotate an object with great precision. If we want to rotate an object at some specific angles or distance, then we use a servo motor. It is made up of a simple motor that runs through a servo mechanism. The position of a servo motor is decided by an electrical pulse and its circuitry is placed beside the motor.

[2] Figure 4: SG-90 Servo Motor (Wikipedia, 2018)

Arduino Mega

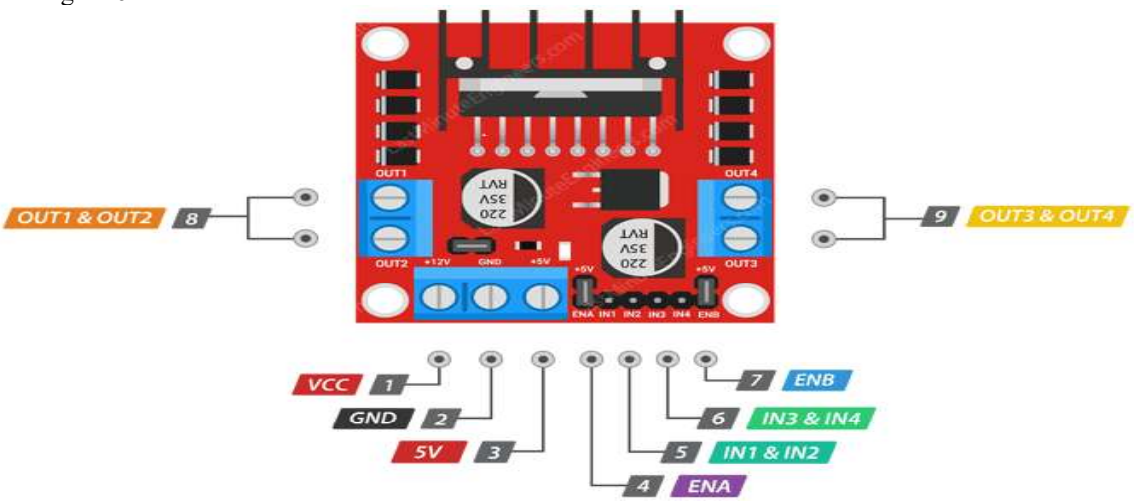
The microcontroller used in this work is the Arduino Mega. It is the brain of the system which interfaces the sensing and actuating devices to perform the required functions, and also controls all the activities of the system. To power the Arduino MEGA microcontroller board, a 9v battery is used, to ensure easy portability of the project. This is done by simply connecting the + end of your battery to Arduino Vin and the - end to Arduino ground. Figure 5 shows the Arduino Mega board



[1] Figure 5: Arduino Mega (Satbhai, 2016)

L298D Motor Driver IC

At the heart of the module is the big, black chip with a chunky heat sink is an L298N. The L298N is a dual-channel H-Bridge motor driver capable of driving a pair of DC motors. That means it can individually drive up to two motors making it ideal for building two-wheel robot platforms. The picture of the L298N motor driver is shown in Figure 6.



[3] Figure 6: L2983D Motor Driver

DC Motors

A Direct Current (DC) motor (Figure 7) is a rotating electrical device that converts the direct current, of electrical energy, into mechanical energy.

[4] Figure 7: DC Motor

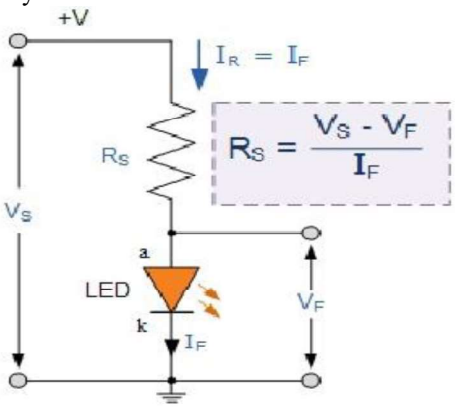
GSM Module

SIM800 is a quad-band GSM/GPRS module that works on frequencies GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz(Shanghai SIMCom Wireless Solutions Ltd, 2013). This module is responsible for sending the SMS alert to a predefined mobile number.

[2] Figure 8: SIM800 GSM Module

Light Emitting Diodes

A Light Emitting Diode or LED as it is more commonly called, is a specialized type of PN junction diode, made from a very thin layer of fairly heavily doped semiconductor material. Two LED's are visible in the design as indicators, the blue LED indicates the presence of smoke and blinks steadily, the white LED indicates the presence of fire as detected by the FLAME sensor.



[3] Figure 9: LED schematic symbol (Wikipedia, 2018)

System Operation

The system block diagram, flow chart and circuit diagram are as shown in figures 10, 11 and 12 respectively.

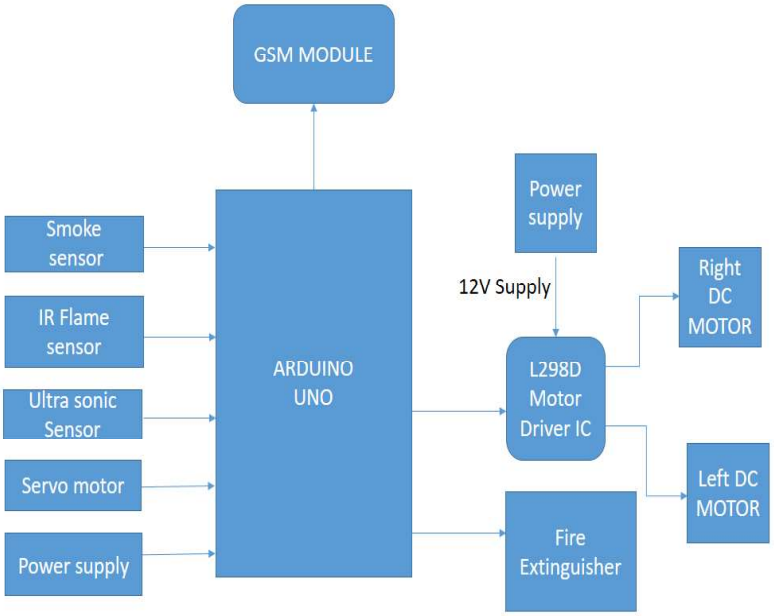
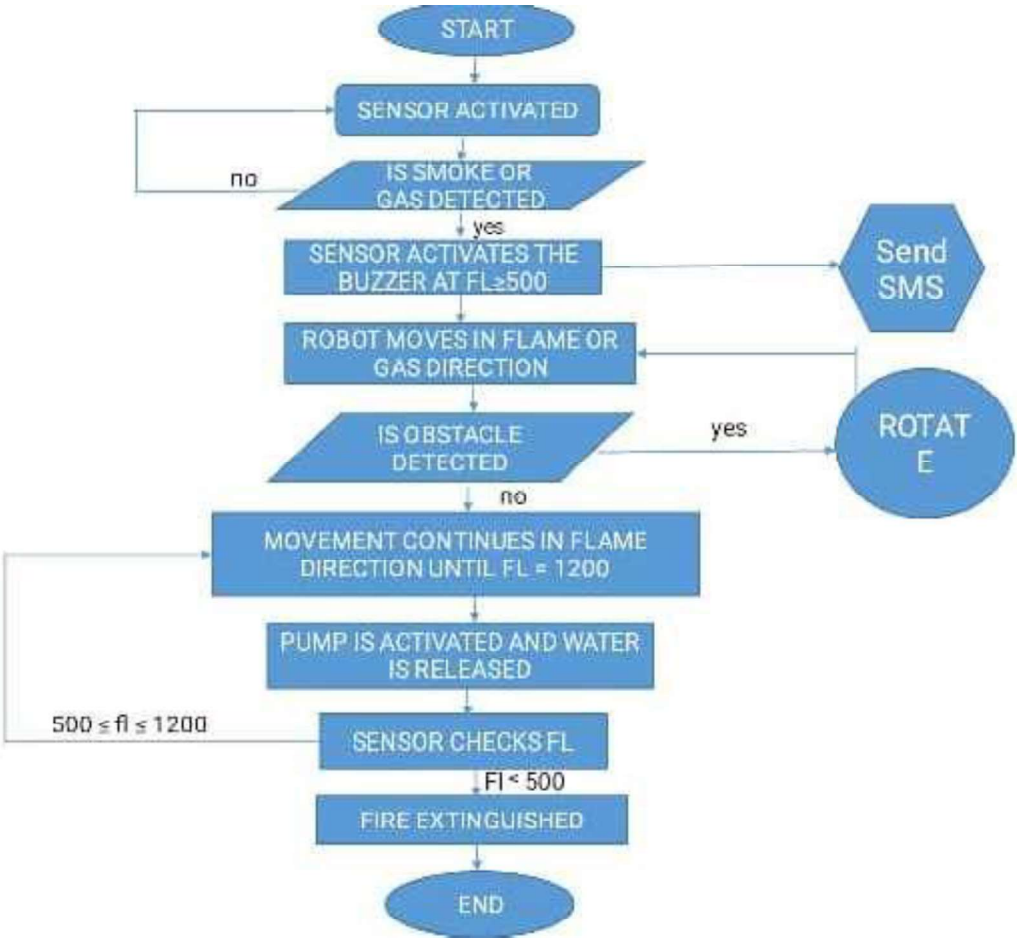


Figure 60: Block Diagram of the System

[5]



[6]

[7] Figure 11: System Flow chart

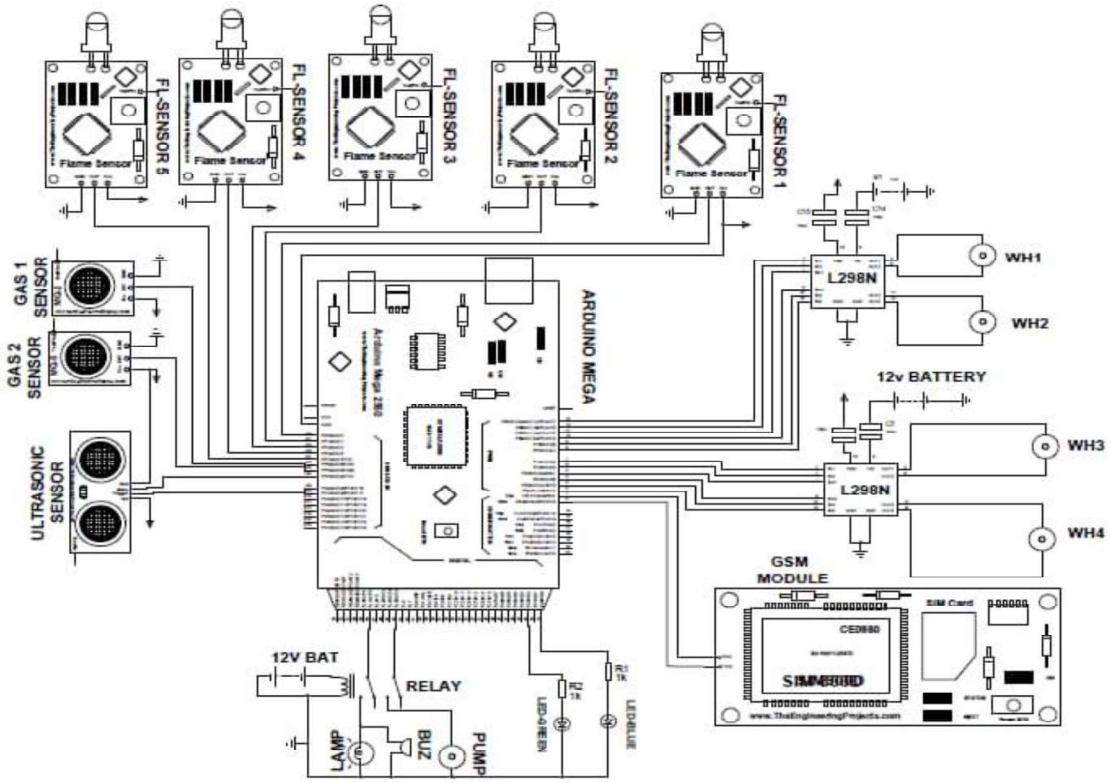


Figure 12: Circuit Diagram of the System

The robot chassis comprises four geared DC motors, four wheels, a battery holder, screws and connecting wires were connected. The following procedures were taken in connecting the motor

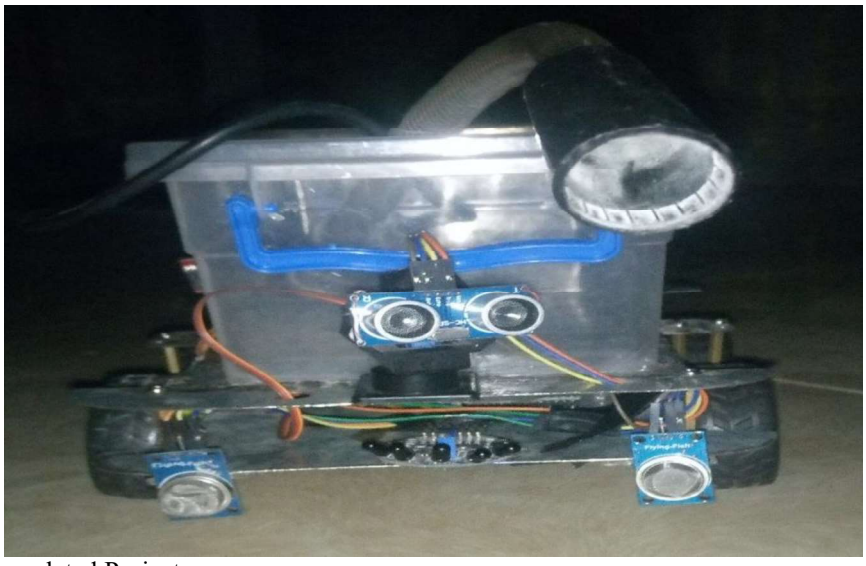
i. The terminals of the gear DC motor were first soldered
ii. Then the gear motor to the acrylic plate
iii. A switch was added to the battery holder so has to turn the robot on or off

[8] Figure 7: Gear Motor attached to the galvanized plate

iv. The motor driver was mounted on the galvanized plate and the gear motor was connected to it.
v. MQ2 and MQ5 smoke sensor was connected to the galvanized plate
vi. The five-way IR flame sensor was screw to the galvanized plate
vii. Screw down the Arduino mega microprocessor and interface the entire components to the microprocessor for proper control.
viii. Mount the tank on the galvanized plate and put inside the tank a DC pump and the outlet connected to a sprayer tube.

ix. Mount a battery holder and connect the battery terminals to power the Arduino and the motor driver according to the circuit diagram.
x. Interface the mounted SIM module to the Arduino microcontroller after it has been screwed down to the acrylic plate and a micro-SIM card is inserted.

The robot was switched on using a switch that kept the system in hibernation as long as there was no presence of fire in its environment having to put on a red LED bulb to show that the robot is ON.
In testing the robot firewood was used as a source of fire outbreak and obstacles were set on the path of the robot towards the fire. The firewood generated enough smoke and flame which in turn made the robot move autonomously.



[9] Figure 8: Completed Project

CONCLUSION

The development of an autonomous firefighting system with an SMS alert feature has been developed and implemented. This study has therefore provided a solution to the problem of a sudden fire outbreak by developing an extinguishing robot for a fire outbreak. The sensors used in this design can sense both gas leakages and fire with high sensitivity. In the case of a fire outbreak, the system is designed to work for three hours provided the lithium-ion battery is fully charged. The major drawback of the system from the test is the dependence on the GSM module, in places with no network coverage the GSM module won't be able to send an SMS notification.

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