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Design and Construction of Automatic Fire Fighting Robot with SMS Notification

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ABSTRACT: The report focuses on the development of an automatic and unmanned firefighting robot, which can be used to detect and extinguish fire. Fires can breakout any time in our homes, workplaces, factories or labs and it is of highest importance that we have a system ready to tackle a dangerous accidents like this. The system currently available are smoke detectors which work well but have certain limitations such as not being able to detect small fire or not having enough coverage by the water showers to extinguish the whole fire. The smoke detectors also do not let people know if or where the fire broke out, which can have long term damaging effects due to delayed response. The proposed model in this report can help with controlling fires before they become disastrous. "Automatic firefighting robot with SMS notification" is easily deployable, can be made to work wirelessly, can detect small fires and also lets the user know where the fire broke out. To fulfill the goal of making this firefighting robot, we designed a robot which can detect small fire(simulated with candle) in a closed room(environment). It uses thermal and IR sensors to detect the fire and then moves towards it and sprays water on it from a safe distance. The fire detection and the movement of the robot towards it is controlled by the motherboard which consists of a Arduino Nano processor. The robot also houses a GSM and GPS modules, which send the user a SMS alerting them of a fire along with its location.

Keywords: Microprocessor, GSM, L293D, Arduino IDE, IR Sensor

1. INTRODUCTION

Firefighting is a necessary yet risky profession. A firefighter must be able to respond swiftly to a fire and safely put it out, limiting more damage and reducing casualties. The gap between firefighting and machinery has now been crossed, allowing for way more advanced methods of firefighting strategy. Fire-fighting robots are one of those examples. These can one day operate alongside firefighters to drastically reduce the danger of injury to victims before it rages out of control. The globe is now experiencing global warming, in which the average temperature of our planet's atmosphere and seas is increasing. Year after year, the rate of growth accelerates. According to studies, our planet's mean surface temperature has risen by around 0.8 degrees Celsius, or about two-thirds of a degree. This means that global warming may lead to more forest fires and fire disasters. As a result, a fire-extinguishing robot is going to become essential to minimize the damage caused by natural or human-caused

fires. The purpose of this project is to design and develop a robot that will help in firefighting, allowing them to make better judgment. This robot is small and quick to deploy. The system is made even more efficient by the SIM, which allow a SMS to be received by a large number of devices boards in a given area using time division multiple access techniques.

2. METHODOLGY

The process of designing the automatic fire-fighting robot will be discussed in detail in this report. This chapter deals with the actual design and construction of the system. The robot can be categorized into 4 parts as given below:

1. Hardware
2. Mechanical Design
3. Block and circuit diagrams
4. Software (Programming)

Project Flow Chart

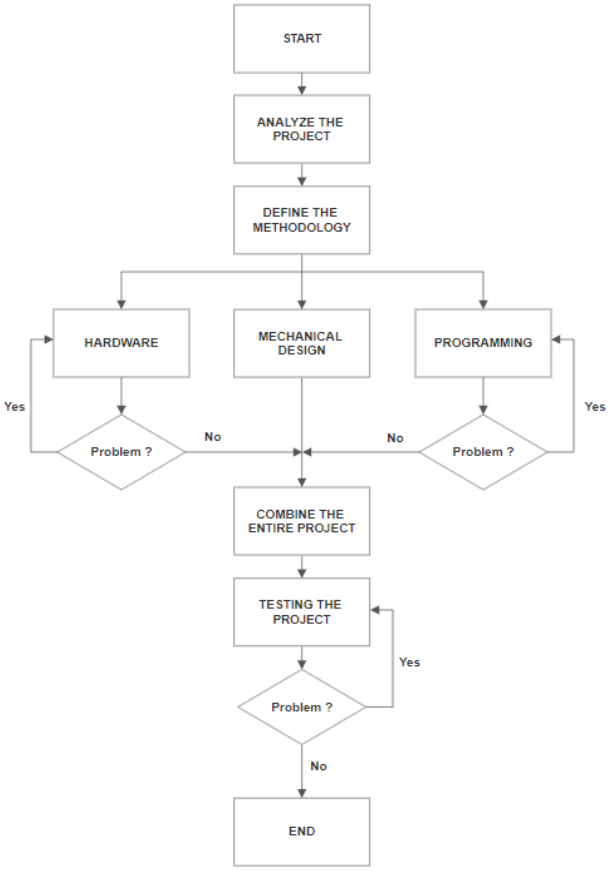

Figure 1: Project Flow Chart

2.1 Block Diagram

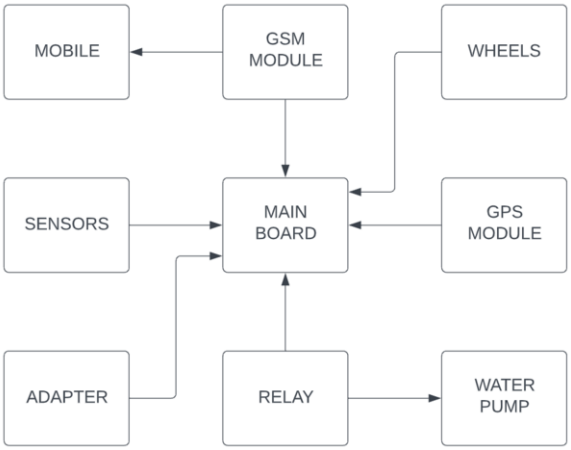

Figure 2: Block Diagram

2.2 Process Flow Chart

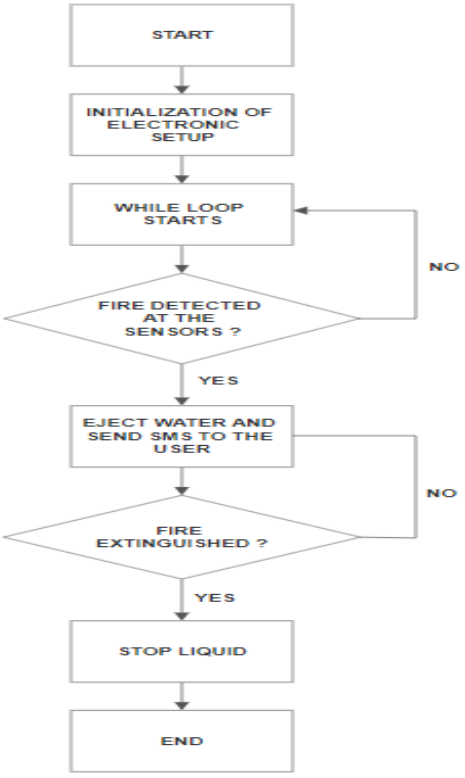

Figure 3: Process Flow Chart

2.3 Hardware Components Used

- Arduino Nano Platform
- GSM SIM 900a shield
- NEO-6M GPS module
- Thermal Sensor
- IR Sensors – 2x
- Motor Driver IC – L293D
- Relay
- Dual Shaft Motors With Big Wheel – 4x
- DC Mini Submersible Water Pump
- Adaptor

2.3.1 Arduino Nano Platform

Arduino Nano is a tiny, comprehensive, and breadboard-friendly chip board (Arduino Nano 3.x). Arduino Duemilanove and Arduino Nano are quite similar when it comes to the available features but the difference lies in their packaging. The platform it uses is ATmega328.

Communication:

Arduino Nano exchanges data from a computer using a USB-B cable and by mounting it on the Arduino software using a virtual port. An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers provide a virtual com port to software on the computer [1]. Every Arduino software has a serial number embedded in it which makes the exchange of data between the microprocessor and the computer very easy and it happens in the form of codes (text). The LED lights on the microprocessor flash when it is connected to a computer.

Technical Specification:[1]

- Microcontroller - atmega328
- Architecture – AVR
- Operating voltage – 5V
- Flash memory - 32 KB of which 2 KB used by bootloader
- SRAM - 2 KB
- Clock speed - 16 MHz
- Analog in pins – 8
- EEPROM - 1 KB
- DC current per I/O pins - 40 mA (I/O pins)
- Input voltage - 7-12V
- Digital i/o pins - 22 (6 of which are PWM)
- PWM output – 6
- Power consumption - 19 mA
- PCB size - 18 x 45 mm

2.3.2 GSM Sim 900A Shield

SIM900A module is made with Duo Band from SIMCOM. It majorly operates on frequencies at around 900MHz. SIM900A is an very tiny and completely wireless module. It has an RS232 chip (MAX232). In mobile to mobile interactions, this module

is considered ideal for SMS transfer uses. It needs a regulated power source. It can be used to make simple audio calls, send SMS, read SMS, answer incoming calls, and so. This is a comprehensive GSM module, made with a heavy duty single-chip that allows it to be tiny in size.

Technical Specification:[2][3]

- Quad-Band GSM/ 850/900/1800/1900MHz
- Compatible with multiple microprocessers such as arduino, raspberry etc
- Power supply 12V 1A – 2A max
- Use in the area of full signal strength
- Perfect for GSM based Microcontroller Projects (better than SIM300 and other GSM Modems)
- Option for connecting MIC and SPEAKER directly to GSM MODEM for calls
- Supports communication through RS232 with DB9 Connector, TTL Pins and I2C Pins

2.3.3 Neo-6m GPS Module

This GPS module has a U-Blox NEO-6M GPS chip in the middle. The chip is tiny, almost the size of a stamp, but still it packs a lot of processing power into its little size. It can exchange data from up to 22 satellites on half a century channels and has incredible sensitivity and precision, while taking only few less than 50 milliamps from the power source. It updates its location up to 5 times per second, something which is not available in its competitors. It also has a horizontal position precision of 2.5 meters.
Technical Specification:[4][5]

- Input Supply Voltage: 3.3V-6V
- On board voltage regulator maintains 3.3V
- I/O Maximum Logic Level: 3.6V
- WAAS (Wide Area Augmentation System) enabled GPS unit
- <1 second to first fix (TTFF) for hot starts
- 27 seconds to first fix (TTFF) for cold starts
- 50 Channel NEMA GPS receiver
- UART: 9600 baud by default, but is configurable from 4800 to 115200 baud
- 5Hz max update rate
- External EEPROM for configuration storage
- Four plated mounting holes, 3mm in diameter
- One additional non-plated mounting/antenna cable hole, 4mm in diameter
- Position Accuracy: 2 m and better with multiple good satellite signals
- Velocity Accuracy: 0.1 m/s
- Maximum Velocity: 500 m/s
- Heading Accuracy: 0.5 degrees while moving
- On board battery for battery backed RAM (BBR)

2.4 Software and programming

2.5.1 Arduino IDE

Arduino IDE is a computer software written in Java and is used to write codes and program the various Arduino processers. It's basically designed for people who are

new to this field and lack the experience of coding and programming. It is designed to have a code editor that has various abilities such as syntax highlighting and etc. And with a single click of a button, it can transfer the code to the Arduino board. This software includes various libraries including a C/C++ library called "Wiring", which makes the input/output operation easier for the user. The programming on the microprocessor has been done using this software and code is available on the full report.

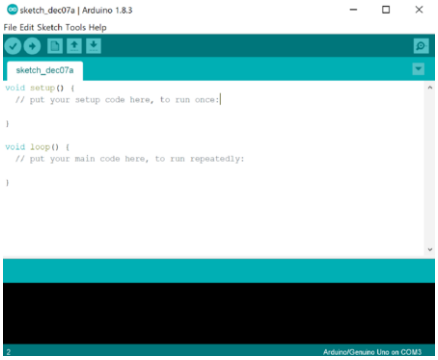

Figure 4: Arduino IDE

3. DATA FLOW DIAGRAM

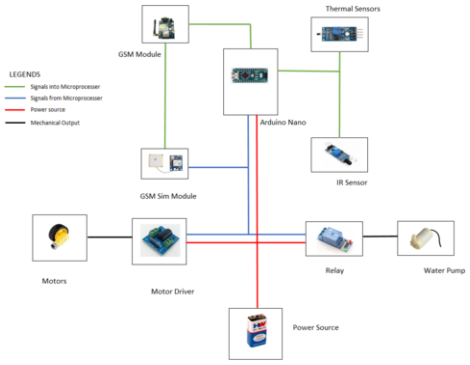

Figure 5: Data Flow Diagram

4. RESULTS AND DISCUSSIONS

Once the parts have been assembled and the coding has been done, the robot is ready to put to work.

1. The robot is switched on by joining the adapter to the GSM module and a 9V battery is attached to give the lacking power required by the water pump.

2. The lights are visible once it is switched on

3. Now, after waiting for 30 seconds to let the robot initialize, a small fire can be put in front of the robot sensor.

4. For example, if the fire is at right to the robots front, the right sensors will show an orange LED, letting the user know that it detects a fire source.

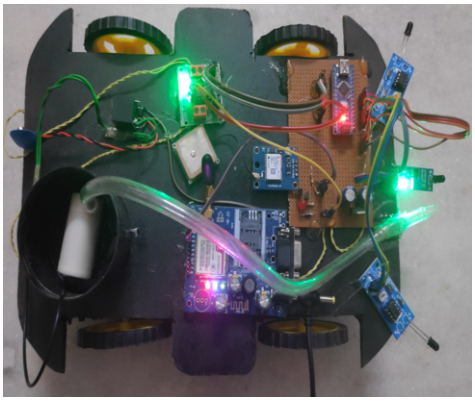

Figure 6: Initial Startup Stage

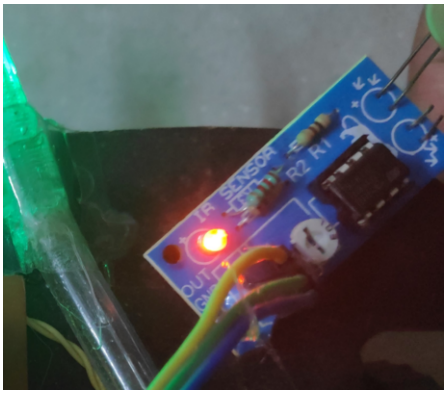

Figure 7: Fire Detected

5. The robot after waiting for few seconds to confirm it as a constant fire source will move towards it by keeping the right wheels fixed and moving both left front and left back wheels to face the fire and move towards it.

6. Once the robot is at an adequate distance from the fire, it will stop and spray the water, extinguishing the fire.

7. While the water is being sprayed, the GSM module will send a SMS to the user and provide them with the location of the fire given by the GPS module.

8. Once the sensors stop detecting a fire, the robot will reset and is ready to be used again.

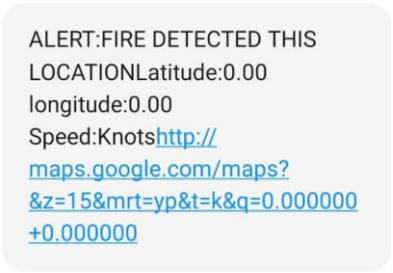

Figure 8: SMS With GPS Location

5. CONCLUSION

All the fundamental actions such as moving forward, turn left and turn right function work flawlessly. The robot has been able to do its job perfectly as shown in the result

section of this report. Once the points given in the future scope section are added to the current model along with increasing its size, it can be used as a proper firefighting robot which can take on multiple heavy fire and deal with it efficiently and alert the user about the fire. As a conclusion, the project was successful, project guidelines were met and the robot ''The Fire Fighting Robot'' has achieved its aim and objective successfully.

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