CSE461: Introduction to Robotics

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Project Report on "Firefighting Robot"

Group: 05

Section: 01

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Theoretical Background Motivation:

Robots are created so that human labor is reduced and moreover when it comes to the point that a robot would reduce risk of human life in places where hazardous incidents like fire might occur. We planned on creating a firing fighting robot that would be able to maneuver through builds and send us data that would be useful for the firefighters and moreover it can also spray water or co2. We are using sensors and that sensors will be equipped on to a body that would have wheels and would be able to move around on commands from the user.

Overview of Proposed Robotic System (Features and Functionalities)

Fire Suppression:
Our robotic system has a fire extinguishing system that will involve a water pump.

- **Water Pump**: The small water pump will bear water and if required it will provide water.

Real-Time Monitoring & Remote Control:
The robot can be moved based on how we want it via remote. And all sorts of data and information of the surroundings can be collected with the help of sensors.

Temperature Sensing:

The robot also has a temperature sensor attached to it that can continuously detect the temperatures in its environment.

Power System:

Rechargeable batteries are used to power the robot and the other components, as these can guarantee longer runtime in critical and tough firefighting situations.

3. Hardware

Main Components:

The firefighting robot, we designed, includes many different critical hardware components, consisting of sensors, communication modules and actuators. These components are chosen on the basis of their functionalities and utilities and price efficiencies.

1. Microcontroller: Arduino Uno:
It is like the brain of the robot, that connects all the components and sensors to read information and make decisions.

- **Market Price: 780TK**

2. Flame Sensor (IR Infrared Flame Sensor Module)

- With the help of infrared emissions, the sensor determines fire and delivers a message to the microcontroller when there is presence of flames.
- **Market Price: 75TK**

3. Smoke Sensor (MQ-2 GasSmoke Sensor)

- This sensor monitors the quality of air and identifies if smoke is present, enabling the detection of fire even before the smokes start.
- **Market Price: 140 TK**

4. Ultrasonic Sensor (HC-SR04)

- This sensor enables the robot to move independently, by identifying and avoiding obstacles that come in its way.
- **Market Price: 100TK**

5. Temperature Sensor (DHT11 Digital Temperature Sensor)

- Monitors ambient temperature, helping detect fire intensity and ensuring that the robot's components are not overheating during operation.

The temperature sensor is used for measuring the temperature. By the help of it we can know the conditions of the environment. We can easily monitor the temperature.

● **Market Price: TK 180 TK**

6. Water Pump (12V Mini Submersible Water Pump)

● Water spraying on detected fires gives the potential to reduce fires.
● **Market Price: 160 TK**

7. Motor Driver (L298N Dual H-Bridge Motor Driver)

● Manages the power sent to the motors, which in turn controls how the robot moves.
● **Market Price: 180TK**

8. DC Motors 4 PCS (12V DC Geared Motors)

● Motors are used for the movement of a robot.
● **Market Price: 1800 TK**

9. Bluetooth Module (HC-05)

It will enable navigation within a building or small area. Mainly for short range operation.

● **Market Price: 340 TK**

10. Battery (Lithium-polymer Battery Pack 12V 900mAh)

The battery is giving power to the robot and ensures the operation.

● **Market Price: 1200 TK**
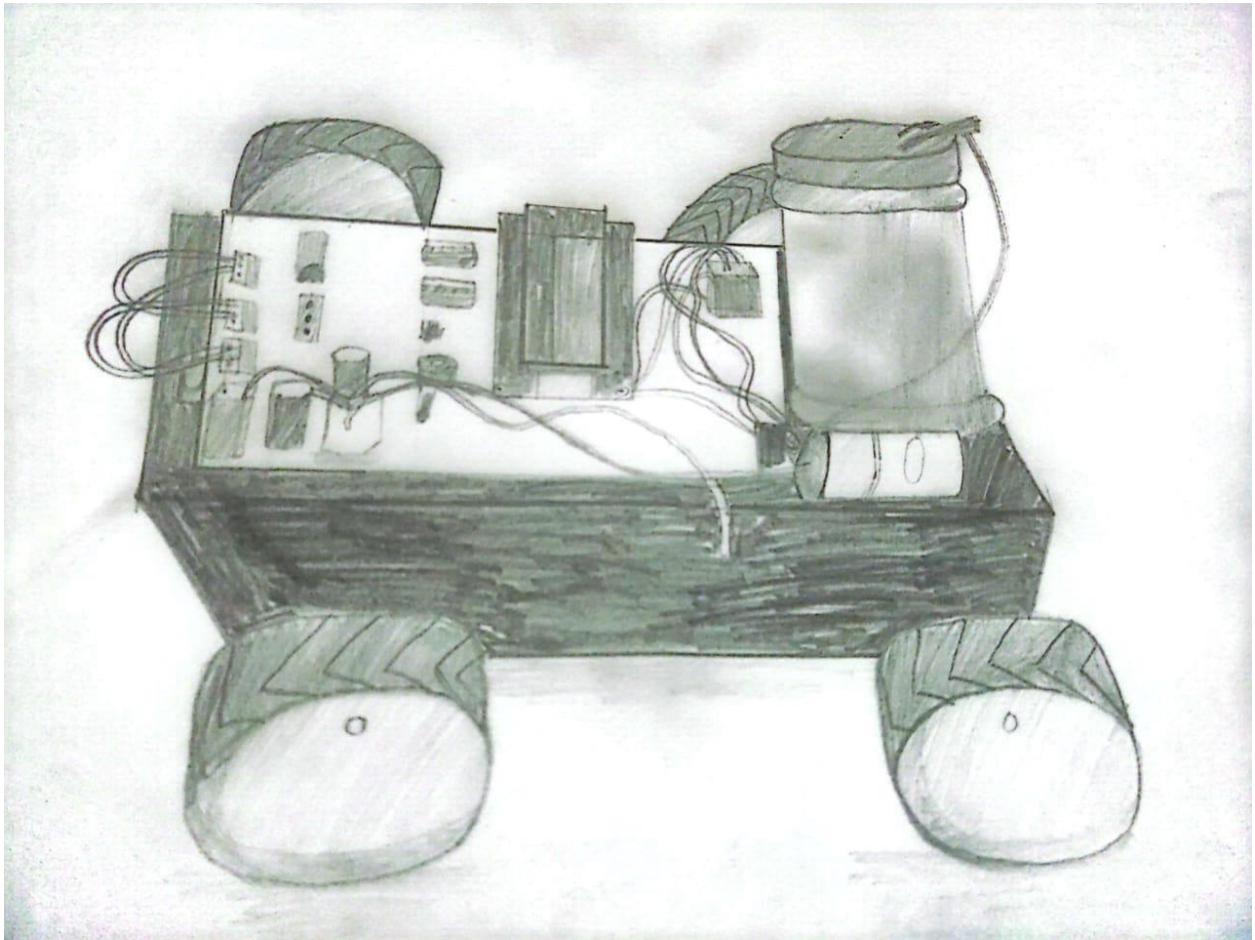
11. Wheel 4PCS: 400 TK
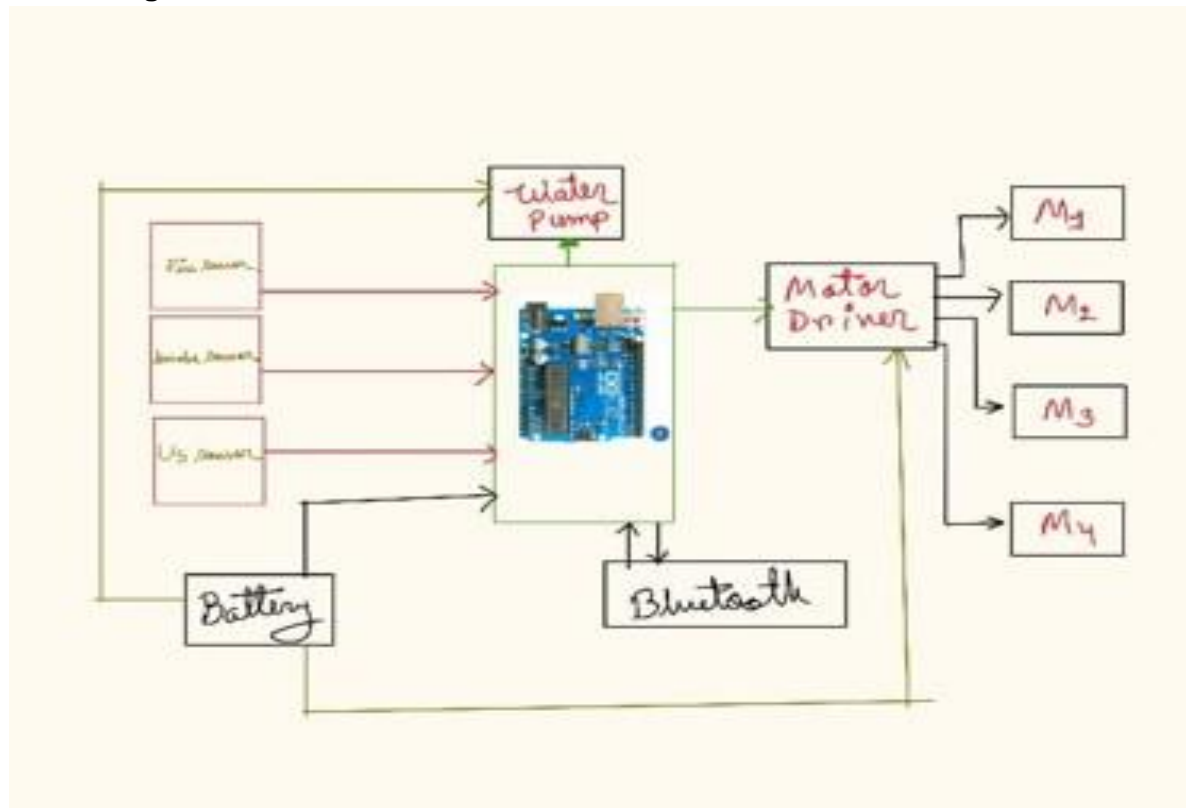
Total price: 5355 TK

Fire Detection Pseudo code:

Begin

Read flame sensor data
Read smoke sensor data
Read temperature sensor data
If (flame detected or smoke detected or temperature > threshold) then
    Move toward fire
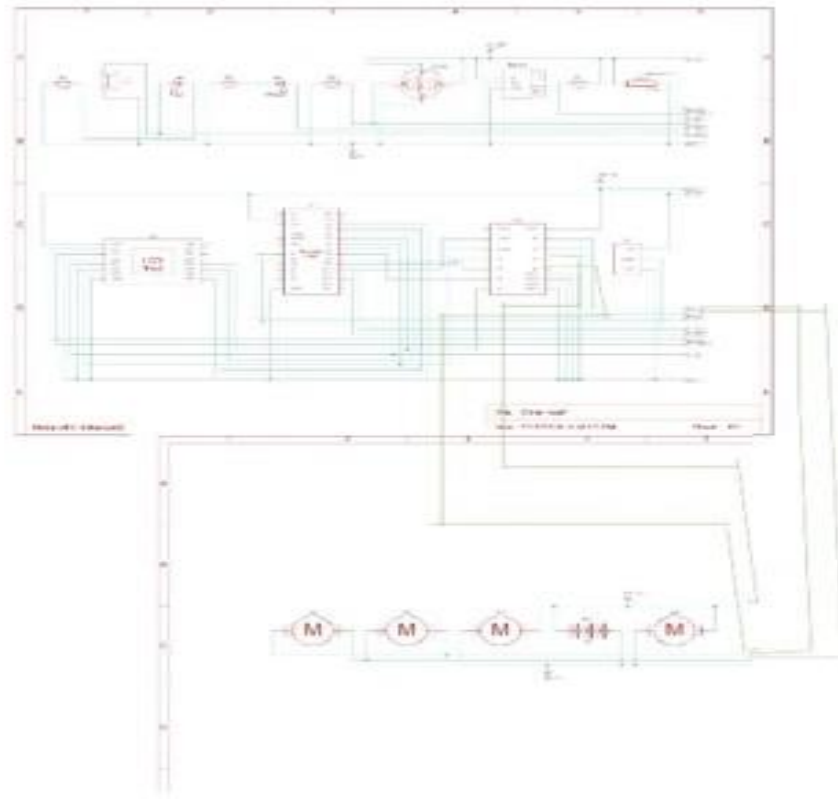   Activate water pump
Else
    Continue scanning
End

Sketch:

Block Diagram:

Circuit Diagram:

Connections:

- Microcontroller: Sensor and actuator will be connected to the relevant pin.

- Flame Sensor: We are going to connect the Analog pin for the input.

- Smoke Sensor: We are going to connect the Analog pin for the input.

- Ultrasonic Sensor: We are going to use digital pins for the Trigger and Echo.

- Temperature Sensor: Then connect the Data pin to a digital pin.

- Motors: We are going to use an H-bridge motor driver and it will connect with the digital pin.

- Water Pump: It will be connected by a relay module and a microcontroller will control it.

Limitations:

Even though some parts of the robot can handle high temperatures to 125°C, real fires can reach temperatures from 600°C to 1000°C which could still damage the robot, even with insulation.

It is well-suited for small and medium-range fires. However, its limited water and CO2 supply makes it inadequate for larger fires.

Exposure to high heat and excessively long firefighting tasks can drain the battery faster, shortening its runtime.

Connectivity issues may arise, as Bluetooth and WiFi control's range is limited.

Future Plans:

Use better heat-resistant materials and cooling techniques to withstand higher temperatures.

Design and construct larger pumps and look for alternatives for fire-extinguishing systems which include automatic refills.

Upgrade to more powerful and better quality batteries and integrate energy-saving systems to increase runtime.

Add 4G/5G technologies and hybrid communication networks for more reliable control in challenging or rigorous environments.

Conclusion:

In summary, this fire-fighting robot is a useful and functional asset for modern-day fire safety, offering an active fire management method. By solving its current limitations and enhancing its features through thorough study and research, the robot will be even better and more effective in saving the lives of people and property. Including it in firefighting tasks will assist the firefighters do their part of the job better, making fire responses safer and more efficient. With continuous improvements and upgrades, this firefighting robot has the potential to change how fires are controlled and stopped, aiding the creation of more resilient and safer communities.