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**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****SMART FIRE FIGHTING ROBOT****Dr. G. Sekar^{*1} & Mr. S. Munaf²**

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ABSTRACT

This paper aims to design a vehicle capable of detecting and extinguishing the fire. Various sensors such as smoke sensor, ultrasonic range finder and temperature sensors are installed on the vehicle to understand the environment. By implementing an autonomous firefighting vehicle disasters can be avoided with minimal risk to human life. In this paper, an autonomous vehicle which is capable of detecting fires in indoors and move towards the flame to extinguish it with the help of water and carbon dioxide is proposed.

KEYWORDS: Arduino Uno, Fire extinguisher and Smoke sensor.**1. INTRODUCTION**

As Robotic technologies, have progressed and turned out to be essential, people have attempted to substitute human work with mechanical autonomy advances, predominantly where people can put at risk while doing their job. This makes a scope for robots to apply their capabilities to substitute human's day-to-day actions, allowing them to put their mind on difficult tasks. Frequently, humans work in complex teams to resolve difficult scenarios result of some disaster; however, it would be more favorable if we allow robots to prevent from severe fire hazards, than to react after the occurrence of fire disaster. The need for fire detection system in an urban environment is mandatory and this robot is designed to match those vital civic environment needs.

Using Four-wheeled differential drive vehicle, temperature sensor, smoke sensor, ultrasonic sensor and Arduino UNO, an autonomous vehicle is designed to detect fire, extinguish and avoid obstacles. In the industrial sector, the application of the project is gigantic, particularly in the fire department. The main operation of the vehicle is to sense and extinguish the fire source with the input from the temperature sensor, smoke sensor and extinguish the fire with water. Three temperature sensors are fixed in three different directions in the vehicle. The spacing between the temperature sensors is 90°. The smoke sensor is used to confirm the fire. The vehicle is built upon an obstacle avoidance vehicle. The ultrasonic sensor is used in order to design an obstacle avoidance vehicle and to find an alternative path to reach the destination.

2. PROPOSED METHOD

The proposed fire fighting vehicle consists of five integral components viz., 1) structure 2) Temperature Detection, this vehicle compares the temperature in three sides from the vehicle and moves accordingly. 3) Obstacle avoidance & Driver system, this vehicle stops automatically when there is any obstacle in its path and reroutes itself in the alternate possible shortest path, reaching its target. 4) Smoke detection, is used to confirm whether it is fire or not. 5) Fire detection system, it not only distinguishes fire in determined path, but has the capability to identify fire in the field outside its defined path 6) Pumping, after reaching the destination water is sprayed to extinguish the fire. The functional requirements are assembled and connected to arduino uno as depicted in the block diagram. The assembly of the system consists of temperature sensor, smoke sensor, obstacle avoidance module, fire extinguishing module and motor driver module. The extinguisher module contains water storage and it can hold maximum 1 liter of water. The storage is fixed permanently in the vehicle and it can be refilled



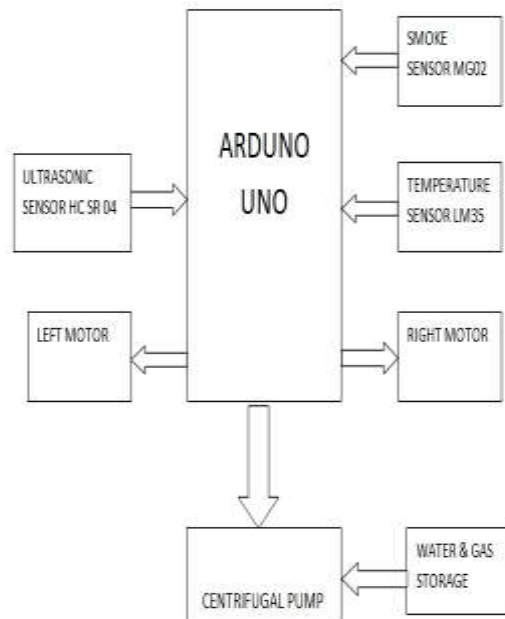


Figure 1. Structural diagram

3. EXPERIMENTAL SETUP

All the materials used in the fabrication of the vehicle were found locally. It is the purpose of the design to demonstrate a fabrication process of fire extinguisher vehicle that can perform safely.

Mobility of the vehicle

This is a high functioning mobile vehicle. For the mobility of the vehicle, two wheels made of Nylon and a caster ball is used. This is mainly a rear wheel drive type of vehicle. Two motors are mounted with the nylon wheel by two separate shafts. The wheels are of 3 inch diameter and 0.8 inch thickness. The motors' movement is controlled by a motor driver (L293D) which responds to the signal from arduino. The motors have high torque and speed. These are locally made motor which do not give the same speed even when unloaded. The vehicle also seems not to have uniformly distributed weight. An extreme calibration is then done to match the speed of both motors so that they can go straight in a specific direction. The use of caster ball is made for simplicity and its low cost. The vehicle movement is mainly controlled by rear wheels. Caster ball is used for front support providing a flexible mobility.

Water spreading mechanism

The water container has the capacity to contain at least 1L water. It is made of strong cardboard which has water resistant property. The pump is set with the container by screw and glue mechanism. The glue used here is water proof. A long aluminum pipe is fitted with the pump. The pipe is about 2 feet long because water should be thrown by keeping a safe distance from fire. A locally made water spreader is used at the front of the pipe to spread the water. The use of the spreader reduces the velocity of water from the pump greatly but spreads the water effectively for extinguishment purpose. So a safe distance from the source is maintained by making the pipe long.

4. HARDWARE IMPLEMENTATION

The modules used in the proposed vehicle are discussed in this section.

Temperature sensor module

In automation mode, the LM35 temperature sensors are fixed on the top frame in three different directions. It produces the analog output which is processed by the arduino and it is used to navigate the vehicle towards the fire location.

Obstacle avoidance module

In automation mode, the HC-SR04 ultrasonic sensor is fixed on the top frame front end. It produces the analog output which is processed by the arduino and it is used to avoid obstacles in the path of the vehicle towards the destination.

Smoke sensor module

In automation mode, the MG02 smoke sensor is fixed on the top frame front end. In some cases, places like industries, workshop, welding etc the room temperature is high due to the machineries so it is used to confirm in case of fire. Once the fire is confirmed the extinguish process takes place.

Fire extinguishing model

The Vehicle is stopped at 7-10 inches from the fire to extinguish it. Solenoid pump is used to pump the water from the storage to extinguish the fire. The sprinkler is attached to the end of the pipe to sprinkle the water from the storage with the help of solenoid pump. The pipe is extended 15cm from the storage to extinguish the fire.

5. SOFTWARE MODULE

The system software was developed using the Arduino software. This was very complex and plays the major role in the whole vehicle operation.

Main Program

The vehicle has mainly two phases. First phase is dedicated to navigate the vehicle towards the fire and extinguish it and second phase is dedicated to navigate the vehicle towards the smoke. The vehicle was programmed to operate in automated mode once it detects the fire, it self-navigates itself towards the fire using the values received from the temperature sensor. On reaching the destination, it enters the second phase, where the smoke sensor plays a prominent role of detecting the fire. If there is fire, it stops moving and starts the fire extinguishing process.

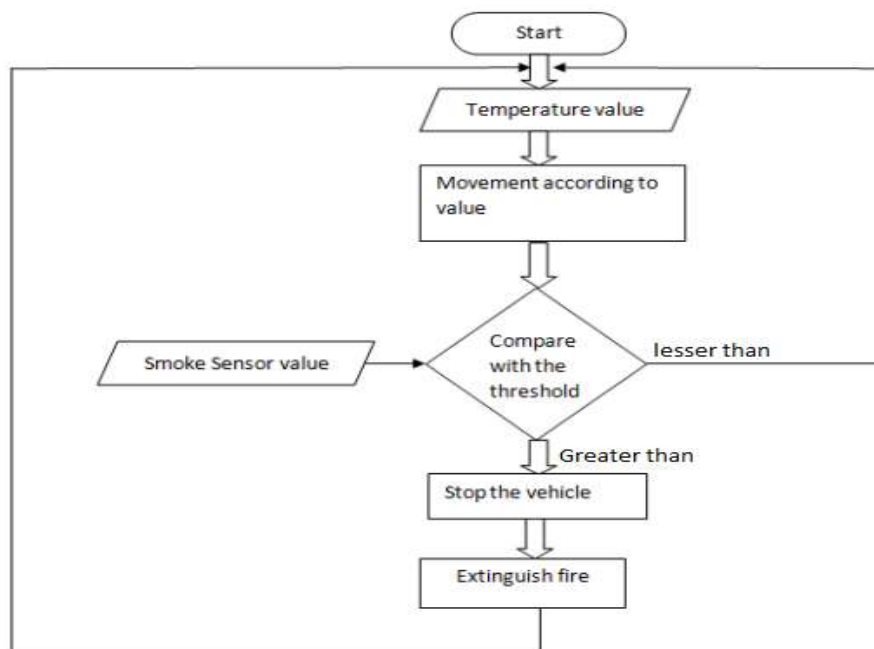


Figure 2. Proposed flow diagram



6. WORKING MODEL

The working principle is very simple. At the beginning of operation, the vehicle moves straight. Arduino will control the motor through the motor driver. To turn left, left motor will remain off and other one will move, thus resulting in left turn of the body. To turn right, the right motor will remain off and the other one will move, thus resulting in right turn of the body. Eventually temperature sensor will detect the fire if there is any.

The three temperature sensors are mounted in front and both sides of the vehicle, which is used to detect the fire in every direction. After getting three analog values from the temperature sensors the arduino will compare the value and decide the direction of the vehicle. Then the vehicle will move forward to the fire slowly. Here, algorithm is needed to make a slow approach of the vehicle towards fire. Because the vehicle needs to stop at a certain limit and it definitely does not want to mess up with the fire. The LM35 sensor senses the heat. If it finds a remarkable increase in the temperature and the temperature reaches the threshold temperature the vehicle is stopped to extinguish. The ultrasonic sensor is used to move the vehicle to the destiny without any obstacles in the path. The ultrasonic sensor is fixed in front of the vehicle. The analog output of the ultrasonic sensor is processed by arduino. If any obstacle present in the path the vehicle is made to find the alternate shortest path.

The ultrasonic sensor is used to find the distance between the vehicle and the obstacle if there is any. If the distance is greater than the programmed value the vehicle is moved forward else the vehicle needs to find the alternate path. The ultrasonic sensor HC-SR 04, the trigger pin is used to send the high frequency signal of ultrasonic range and the echo pin is used to receive the sent ultrasonic signal reflected from the obstacle. Then a solenoid pump is used to pump the water to extinguish fire. It throws water which is stored in the container. The tube which is attached to the container inclined at 45 degree and extended by 15cm. A container can store maximum 1 liter of water to extinguish fire. A small water sprinkler at the end of the tube is fixed for effective extinguishing of fire.

7. CONCLUSION AND FUTURE WORK

The Fire Fighting Vehicle is effective enough to fight against fire on a small scale. It is made as a preventer vehicle. Because it can detect fire instantly and can extinguish it before spreading. This multisensory based vehicle may be a solution to all fire hazards in most of the industries. With enough funding and scope, this design of vehicle can also fight against large fire with larger reserving capacity and an improved sensing unit can provide even an earlier detection of fire at all circumstances.

GSM can be implemented to send alert messages to the nearest fire station when the vehicle fails to extinguish the fire. The camera can be added to the vehicle in order to distinguish between ambient sun light and fire source. This will help set a variable threshold for comparing the sensor value to decide whether there is a fire or not. The motions of the robot can be made smooth by implementing PID control.

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