An Analytic Study on Fire Fighting Robot

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Abstract - *Expanding human population and growing industrialization, has led to a manifold increase in the number of fire accidents. There are many possibilities that a fire can start in an industry or in any remote area. For example, in cotton mills, garments, fuel storages, etc., electric leakages can lead to huge damage. The physical limitations of humans to deal with these kinds of destructive fires combined with the adverse conditions, makes fire extinguishing an arduous task. The research and development in the field of Artificial Intelligence has given rise to Robotics. Robots are implemented in various areas like Manufacturing, Industries etc. Hence, Robotics can be used to assist fire fighters to perform the task of firefighting and so reduces the risk of their lives. The use of firefighting robots can reduce the errors and the limitations that are faced by human fire fighters. This paper will talk about each component of the robot from fire monitoring to fire extinguishing.*

***Key Words*:   Fire Fighting, Fire Monitoring, Fire Extinguish, NodeMCU, Robot, WiFi.**

1. INTRODUCTION

Accidents that involve fire have been a cause of concern to mankind for a long time now. Fires are known to cause destruction on a small as well as a large scale. Fire requires three basic components to get ignited; this is known as FIRE TRIANGLE. The Fire Triangle also known as Combustion Triangle is a simple model for understanding the necessary ingredients for most fires. The triangle illustrates the three elements a fire needs to ignite: heat, fuel, and an oxidizing agent (Oxygen). Fig. i. illustrates the Fire Triangle and its three basic components.
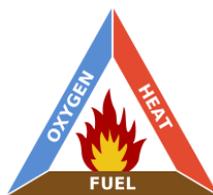
Fig- 1: Fire Triangle

In spite of the best attempts made by human fire in the process of extinguishing fires, it is not always possible for them to tackle fires in the most efficient manner.

Our task an Instrumentation Engineers was to design and build a prototype system that could monitor and extinguish a fire. It is the Robot that can move through a structure, find a lit candle, monitor the temperature and then extinguish it with help of a water spraying technique.
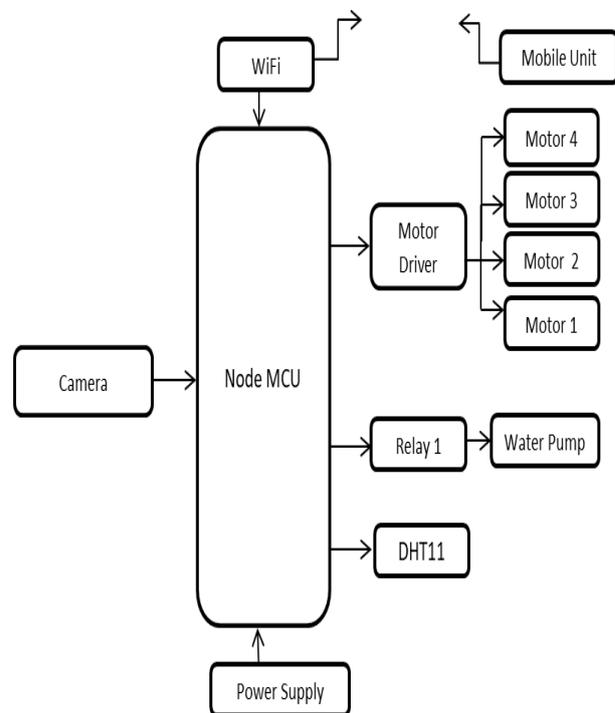
Previously Fire Fighting Robots were controlled by using different electronics devices but this reduces the scope of control of fire fighting robot. However, with the advanced techniques we can build the same robot by using android application to control the actions of the robot. With the help of such robots, a fire fighter's work gets decreased and a movement of robot is much effective. By using an android app fireman man detect the fire and can be able to extinguish it.

Our research paper describes the design of a small Fire Fighting Robot. We have worked on the same project at our college presenting a synopsis showing its basic construction and working. The Fire Fighting Robot is designed to search for a fire in a small floor plan of a house, extinguish the fire with the help of the water pump.

2. BLOCK DIAGRAM

Dia No-1: Block diagram of Fire Fighting Robot.

The block diagram consists of NodeMCU microcontroller along with ESP8266 WiFi module in-built in it. Also the robot consists of 4 motors connected through motor driver and a

humidity and temperature sensor for monitoring the environment. The robot also consists of third party Camera for visually observing the surrounding. For extinguishing the fire the robot consist of a water pump operated through mobile commands.

3. CIRCUIT DIAGRAM AND SYSTEM WORKING.

The circuit implemented consists mainly of two different sub-circuits.
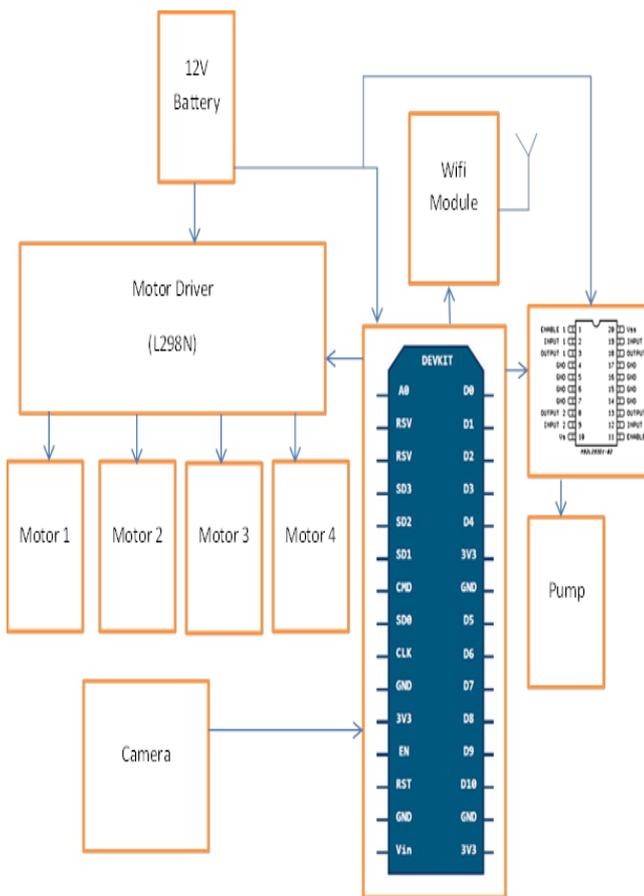
Dia No-2: Circuit diagram of Fire Fighting Robot.

The first part comprises of making the robot to follow the instruction that are given to it by the user using Android App through WiFi. This was done using a WiFi module circuit. This was based on the phenomenon that with the router receiving information from the Internet, translating it into a radio signal and sending it to the computer's wireless adapter. In our case, the user watches the surrounding through the robot's eye and then through mobile we send the command to the robot. Therefore, the voltage across terminal of the controller gets high as long as the robot is receiving the signal. As the pin gets high the motor corresponding to it starts. The sensor ahead keeps on measuring the temperature and humidity and informs us continuously. As the command stops, the voltage across pin gets low and the motor stops.

The second part comprises of detecting the fire, monitoring the temperature and humidity and extinguishing the fire. When the user handling and giving commands to the robot monitoring the temperature and detects fire, the user command s robot to start the water sprinkler.

3.1. Components

3.1.1. Microcontroller

A microcontroller is a computer on a single integrated circuit containing memory, a processor core and programmable input/output peripherals. It is designed for embedded applications.

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 WiFi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.[1][2] The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. Node MCU has 128kB internal RAM and 4MB external flash. It works on 80-160MHz clock frequency.
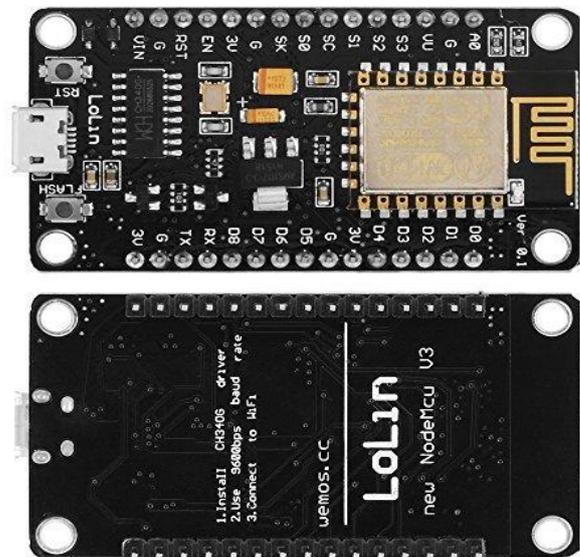

Fig No-2: NodeMCU Front and Back Side

3.1.2. Mechanical Part

The robot is based on the four wheel drive system which provides more stability to the robot. The chassis is made of metal so that it can bear the weight of all the components.

3.1.3. Motors

Four 100 rpm motors have been used to run the robot. The motors give high torque due to which robot is able to maintain balance between speed and weight.

3.1.4. Power

A 12V battery is been used as power source.

3.1.5. Pumping System

The pumping system consists of a mini submersible type water pump that works on 9 V D.C. and a water tank. It is extremely simple and easy to use. A small pipe is used to carry water from pump outlet.

4. MODULES

4.1. Fire Detection Module:

a) The user controlling the robot will move it into the room and monitors the fire if there is any.
b) If the temperature at certain place is more than the threshold set then the user start the water sprinkler.
c) Else detect and monitor only the temperature inside the room.

4.2. Temperature Monitoring Module:

a) When the user directs the robot into a room, the robot analysis the room and monitors as well as displays the temperature in the room.

4.3. Fireman Module:

a) When the robot will be moving inside the room it can be controlled by the fireman using android phone.
b) The camera on the robot will allow fireman to analyze the situation and turn the pipe of water sprinkler.

4.4. Fire Monitoring Module:

a) The user controlling the robot will move it into the room and monitors the fire if there is any.
b) If the temperature at certain place is more than the threshold set then the user start the water sprinkler.

When the fire is extinguished the temperature is monitored and displayed as well the camera shows the after result of the fire and can be used to control it.

5. RESULTS AND OBSERVATION

Whenever a flame gets detected, the robot's motion is stopped by the user and the pumping mechanism of the robot gets turned on to extinguish the fire with the help of water. Since a small amount of water can also decrease the intensity of flames coming out of fire, therefore the pumping mechanism will work for a definite amount of time to ensure that the fire is completely extinguished. There is no doubt that different kind of fires need different type of fire extinguishing material. Therefore every material should be tested. But for now we will be considering water as our major extinguishing material which can be later on replaced by best suited extinguishing material for a particular type of industry.

6. APPLICATION AND FUTURE DEVELOPMENT

Some of the advantages of industrial firefighting robot are:-

i. Can be used as a mobile surveillance system.
ii. Can be used as a fire extinguisher at places out of human reach.
iii. Can be used in security system.

The present work can be extended in several ways and some of them are given below:

i. For detecting fire with 100% accuracy so that the robot can differentiate between industrial fire and an ordinary flame, we can add some more type of sensors i.e. smoke sensor and thermal sensor.
ii. To save people who get trapped in the fire, we will again use transmission of wireless signals to the firefighting person so that they can easily locate the people and hence save a lot of precious time.
iii. We can replace water in pumping system with pressurized carbon dioxide to fight with fires caused due to electric short circuits.
iv. For domestic use, we will try to implement motion planning using neural networks so that the errors can be minimized in mapping of the house.

In this paper, the robot is limited to work in an environment which allows it to move on a particular path instructed by the user. This path can be laid only in industries which offer other equipment's which are non-mobile. But since every industry doesn't offer this type of environment, therefore the robot cannot be used in every industry. Therefore to use the robot in every industry, we can upgrade the robot and use the SLAM (Simultaneous Localization and Mapping) technique so that the robot moves in directions having no obstacles and thus explore each and every corner of an industry. Moreover for obstacle detection we need to use a sonar sensor and an infrared sensor.

7. CONCLUSION

This paper has presented a unique vision of the concepts which are used in this particular field. It aims to promote technology innovation to achieve a reliable and efficient

outcome from the various instruments. Experimental work has been carried out carefully. With a common digitalized platform, these latest instruments will enable increased flexibility in control, operation, and expansion.

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