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A STUDY ON IMPROVED VERSION OF AUTOMATED FIRE FIGHTING ROBOT

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ABSTRACT

In today's scenario, due to rapid growth of environmental temperature and other critical work initiatives inside the factories, there are many possibilities that a fire can start in any industry or at remote areas. This paper examines that how we extinguish the fire whether it will be at small or large scale. So instead of using human beings we can go through some engineering applications which can be better suited for the conditions and what can be better than a Fire Fighting Robot. Robot is the emerging and effective solution to protect human lives and their surroundings as well as wealth. Our main aim is to develop a Fire Fighting Robot using embedded system. On doing so we not only control over the critical situations but also we can save humans who work inside these critical situations for extinguishing the fire.

In past there were many fire fighting robots developed. But in our research we are trying to innovate the existing one. Hence we are implementing AVG (Automated Guided Vehicle) concept in our fire fighting robot along with the programming code which is generated through ARDUINO software. In this research we generate an advanced model of fire fighting robot which can extinguish the fire by going through itself. The robot has automated sensing features with the help of which it can come back to its original place after extinguishing the fire. Hence we do not need any human support system.

Keywords: Robotics, AGV (Automated Guided Vehicle), Fire-extinguisher, Automation, ARDUINO

I. INTRODUCTION

Robot is a simple mechanical design which is capable of performing human task in the way of human manner. On building a robot it requires complex and expertise programming module. This programming module is use for putting together motors, flame sensors and wires, among other important components. In this research we implement the following concepts:-

- 1) Environmental Sensing Techniques.
- 2) Proportional Controlling of Motors.

In this robot the information is processed from various sensors and hardware elements through microcontroller. For detection of fire accident we use thermistors or visible sensors. In this prototype the thermistors/flame sensors will detect the flame. Once the flame is detected, the robot sounds the alarm with the help of buzzer provided in it, the robot actuates the valve of electronic device and then extinguish the fire through sprinkling of water on flame.

For extinguishing the fire and rescuing victims from the risky situations, fire fighters face many problems, and not only they face problems but sometimes they lose their lives too. So, for suppressing these conditions we introduce an Automated Fire Fighting Robot in which a robot can function and controlled by itself. In other words we say that Automated Fire Fighting Robot will decreasing the need of fire fighters to get into dangerous situations. This robot extinguish or gives the fire protection when the fire will take place in any industry or in a tunnel way by using automation concept by the use of microcontroller in order to reduce the damage of property and loss of life.

There is requirement of professionals who have high technical skills along with training so that they deals various situations very easily. Some of the major specialised areas through them fire and rescue operation includes are:-

- 1) Aircraft rescue.
- 2) Suppression of wild land fire.
- 3) Fire done in the toxic environment created by combusting materials.

Now a days the major/critical hazard is to catch up fire in some toxic or chemical substances. They not only damage the places but also affects the surrounding environment. So, to deal with such type of fire we definitely not use human being for extinguish fire. So, at that place Automated Fire Fighting Robot is the best tool we use for extinguish the fire.

- **Type of fire:** In the world, fire has been classified into five classes and the fire extinguishers is made for each class of fire.

Table-1

Name	Fuel
Class A	Wood, paper, cloth, trash and plastic
Class B	Flammable liquids, gasoline, and flammable gases, butane
Class C	Energized electrical equipment, motor, appliance
Class D	Combustible metals, sodium, aluminium
Class K	Cooking oils and greases

II. REVIEW LITRATURE

Earlier studies show that there are various types of fire fighting robots, which are very important for every industry. Some of them which are mostly used in today's environment are:-

- 1) **LUF60:** This is a diesel power fire fighting robot, this robot is mostly used in tunnels of railways, aircraft hangers, chemical plants etc. in this robot the water flow rate is 800GPM and it can blow the water beam as far as 80m. It will work under 400°F.
- 2) **FIRE ROB:** This is a remote controlled mobile robot that is used to fight fires by search and inspect the fire scene. This robot is protected from heat with the heat shield technology along with high pressure water mist extinguisher for controlling fire. Beside this it also equipped with thermal imaging sensors and cameras for the observation of fire scene.
- 3) **FIRE MOTE 4800:** It is a ground vehicle equipped with spray nozzle, high pressure water equipment, navigation and thermal imaging camera, roll-flat hose inlet. All of these equipment's are put under the stainless steel insulated body which reflect radiant heat.
- 4) **MVF-5:** This is a multifunction fire fighting robot which was manufactured by Croatian manufacturer DOK-ING. This robot was developed to extinguish fire in unreachable areas and life threatening conditions. This vehicle is operated by a single operator and control by using remote control with the remote controlled technology GPS-INS (Global Position System-Initial Navigation System) and its range of control is 1500m.

As we see from above inventions there are some disadvantages and some of them are:-

- 1) They all need human help whether it is in direct or indirect manner.
- 2) The fire extinguisher needs an unrestrictedly supply of water from the water supply system.
- 3) During spraying of water, the water spray system cannot move away from the location of water supply system.

So, in our research we are trying to reduce the above problems. In our Automated Fire Fighting Robot we do not need any type of human intervention, the tank of water is fully attached to the chassis of vehicle and there is also refuelling system we give in our primary tanker from the outside. And along with water we also introduce air control mechanism and oxygen control mechanism in Automated Fire Fighting Robot.

III. WORKING MECHANISM

In Automated Fire Fighting Robot we are use D.C motors, castor wheels, microcontroller, sensors, pump and sprinkler. Microcontroller is the heart of project. Microcontroller controls all the parts of the robot by the use of programming. In this robot as the fire sensor senses the fire, it sends the signal to the microcontroller; since the

signal of the sensor is very weak, the amplifier is used so that it can amplify the signal and send it to the microcontroller. As soon as microcontroller receives the signal a buzzer sounds, the buzzer sound is to intimate the occurrence of fire accident. After the sound of buzzer microcontroller actuates the driver circuit and it drives the robot towards the fire place, as the robot reaches near the fire microcontroller actuates the relay and pump switch is made 'ON' and water is sprinkled on the fire through sprinkler and along with it parallelly air control and oxygen control mechanism is also switch 'ON'.

But due to inefficiency and problem occurred by microcontroller AT89C51. We use compilation software ARDUINO along with motherboard ARDUINO Pro Mini (AT mega 168).

This ARDUINO system is more user friendly and through it we modify our program very easily. So, for seeing the future problems we use ARDUINO, so that we took changes in it.

IV. COMPONENTS ALONG WITH SPECIFICATION

1) Power Motors:

Two D.C motors are used of 16 Kilogram-force meter of torque and 100 rpm rating. D.C motors are generally more powerful than servo motor in terms of speed and torque. Microcontroller could not accurately control D.C motors without a motor controller. Therefore we use ARDUINO Pro Mini along with encoder use to get feedback from D.C motors.

2) Chassis:

It is the whole body frame of Automated Fire Fighting Robot. All the component of the robot are attached directly to the chassis. Different types of material we use for chassis are aluminium, steel, acrylate, high density polymer, along with high temperature thermal shield layer of approx. 1700°C.

3) Wheels:

In Automated Fire Fighting Robot we use four cluster wheels for the motion of robot having 14 cm diameter.

4) Water Pump:

The robot is equipped with the extinguisher devices such as air jet which blows tremendous amount of air and water tank of 500 ml. Which throws water with the help of water pump and nozzle on the class-A type of the fire in the robot model.

5) Nozzle:

It is used to control the direction or characteristics of flood flow (especially to increase velocity) as it exists (or enters) an enclosed chamber or pipe.

We use various type of nozzle according to the situations, some of them are:-

- a) High velocity
- b) Propelling
- c) Magnetic
- d) Spray
- e) Atomizer nozzle
- f) Swirl nozzle
- g) Air-Aspirating nozzle
- h) Vacuum
- i) Shaping

But in general we use brass nozzle connected to fire hose.

6) Mother Board:

The ARDUINO Pro Mini is a microcontroller board base on ATmega168. It has 14 digital input/output pins, 8 analogous inputs, on board resonator, reset button and holes for mounting the pin headers. A 6 pin header can be connected to a FIDI cable or spark fun breakout board to provide USB power and communication to the board.

Summary:

Microcontroller	ATmega168
Operating Voltage	5V
Input Voltage	5 - 12 V
Digital I/O Pins	14
Analogue Input Pins	8
DC Current per I/O Pin	40 mA
Flash Memory	16 KB
SRAM	1 KB
EEPROM	512 bytes
Clock Speed	16 MHz

Power:

The ARDUINO Pro Mini can be powered with a FIDI cable or breakout board connected to its 6 pin header, or with a regulated 5V supply on the V_{cc} pin.

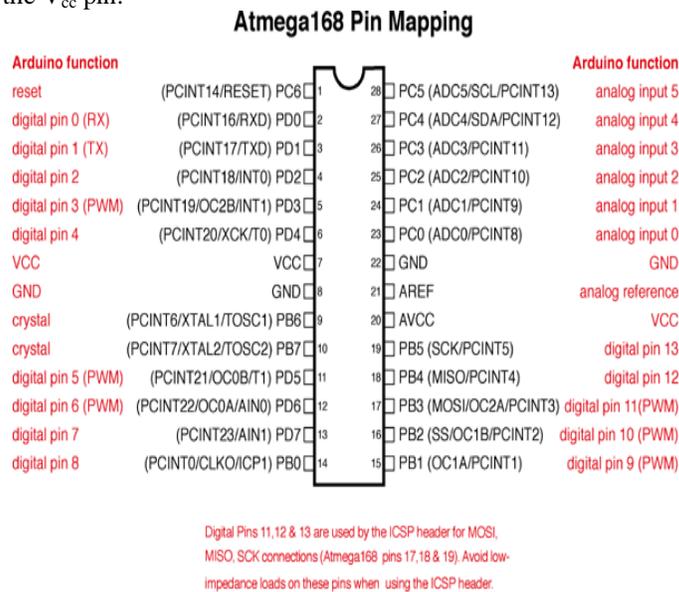


Fig.1-AT mega 168 Pin Mapping

Programming:

The ARDUINO Pro Mini can only be programmed with the ARDUINO software. The ATmega168 on the ARDUINO Pro Mini comes pre-burned with a boot ladder that allows you to upload new code into it without the use of an external hardware programmer. It communicates using the original STK500 protocol (C header files).

Automatic software reset:

Rather than requiring a physical press of the reset button before an upload, the ARDUINO Pro Mini is designed in a way that allow it to be reset by software running on a connected computer. One of the pin on the 6 pin header is connected to the reset line of the ATmega168 via a 100 nano farad capacitor. This pin connects to one of the hardware flow control lines of the USB-to-serial converter connected to the connector.

Physical dimension:

The dimension of the Pro Mini PCB are approx. 0.7”x1.3”.

7) 5V Simple power supply for digital circuit:

Summary of circuit features:

- 5V brief description of operation- It gives +5V output along with the capability of 100mA output current.
- Circuit protection- When the regulator IC gets too hot it will auto shutdown.
- Power supply voltage- Unregulated D.C 8V-18V power supply.
- Power supply current- Needed output current +5mA.

The circuit we use in Automated Fire Fighting Robot gives +5V output at about 150mA current, but it can be increased to 1A when good cooling is added to 7805 regulator chip.

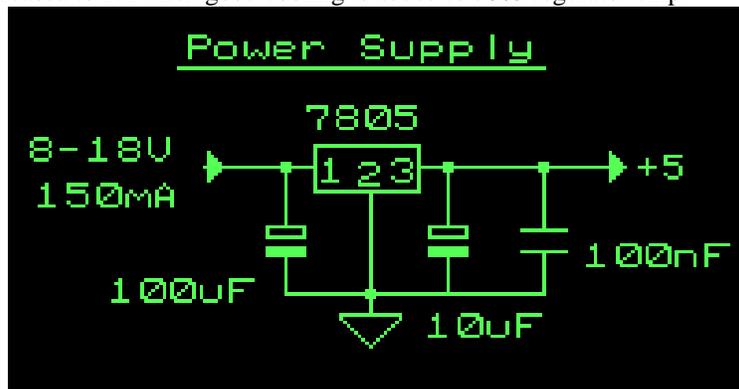


Fig.2-Circuit diagram of the power supply

The capacitor must have enough high voltage rating to safely handle the input voltage feed to circuit.



Pinout of the 7805 regulator IC

Fig.3

- Unregulated voltage IN.
- Ground
- Regulated voltage OUT.

Component List:

- 7805 regulator IC
- 100µF electrolytic capacitor, at least 25V voltage rating

- 10 μ F electrolytic capacitor, at least 6V voltage rating
- 100nF ceramic or polyester capacitor.

8) RF Module (transmitter and receiver):

In Automated Fire Fighting Robot we use Amplitude Shift Keying (ASK) based. Transmitter and receiver pair operated at 433MHz. The encoder IC takes in parallel data which is to be transmitted, packages it into a serial format and then transmits it with help of RF transmitter model. At the receiver end, the decoder IC receives the signal via the RF receiver model, decodes the serial data and reproduces the original data in the parallel format.

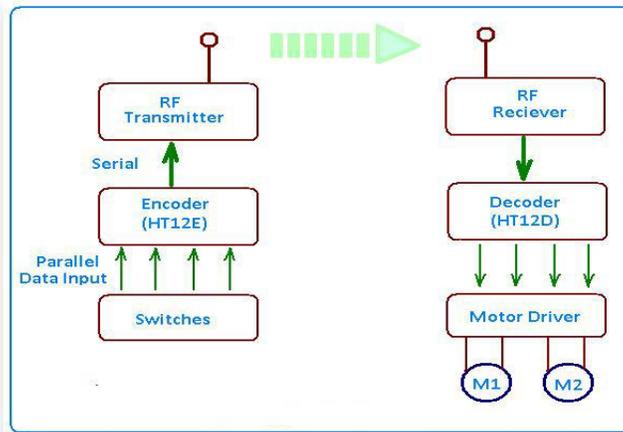


Fig.4-Block Diagram of RF Module

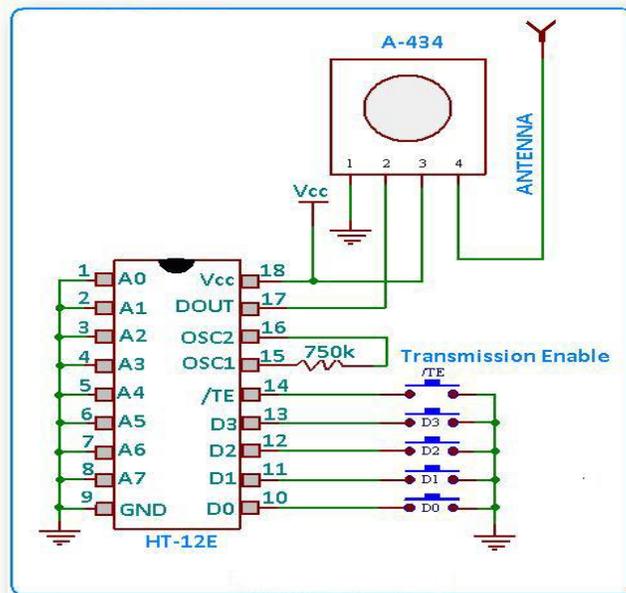


Fig.5-Block Diagram of IC-Encoder

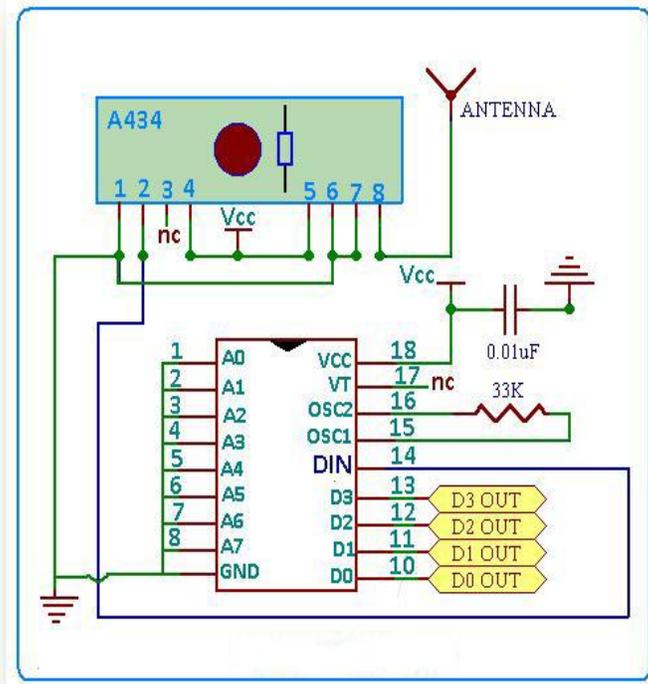


Fig.6-Block Diagram of IC-Decoder

Summary of encoder with DIP switch:

- 18 PIN DIP
- Operating Voltage : 2.4V ~ 12V
- Low Power and High Noise Immunity CMOS Technology
- Low Standby Current and Minimum Transmission Word
- Built-in Oscillator needs only 5% Resistor
- Easy Interface with and RF or an Infrared transmission Medium.
- Minimal External Components

Summary of decoder with DIP switch:

- Compatible with RF Modules 433 MHz Link :RF Modules (TX + Rx Pair) 433 MHz ASK
- 18 PIN DIP, Operating Voltage : 2.4V ~ 12.0V
- Low Power and High Noise Immunity, CMOS Technology
- Low Stand by Current, Ternary address setting
- Capable of Decoding 12 bits of Information
- 8 ~ 12 Address Pins and 0 ~ 4 Data Pins
- Received Data are checked 2 times, Built in Oscillator needs only 5% resistor
- VT goes high during a valid transmission
- Easy Interface with an RF of IR transmission medium
- Minimal External Components

9) H-Bridge:

H-Bridge is an electronic circuit that enables a voltage which applied across a load in either direction.

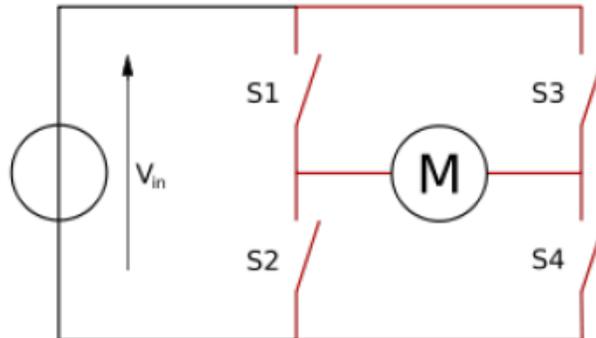


Fig.7-Structure of an H bridge (highlighted in red)

10) Relay:

In Automated Fire Fighting Robot we use four relays according to two motors, air jet, and pump respectively. It is an electrically operated switch. Relay is used where it is necessary to control a circuit by a low power signal or where several circuits must be controlled by one signal.

Upgrade From Previous Year Models:

In upgraded version we did coding process on ARDUINO which is very simple, compatible and also user friendly too. Along with these properties the most advantageous thing that robot express is, time saving Automated Fire Fighting Robot (i.e.; it directly went to effected area). In this upgraded version we don't need any manpower putting eagle eye on this robot. The whole process of extinguishing fire will do by this upgraded version of robot itself.

V. CONCLUSION

From my research it can be concluded that the today's era is the era of technology and what can be a better use of technology if with the help of it, we can save human lives. In the country like India we still suffer from various hazardous activities where the human worker are taking risk of life every day at their working places. Many factories are there which are not even maintaining the standards to be followed in order to save human life. Just to save some money.

Hence our research is going to help them a lot as it can be a cheaper alternative available for factories to fight with those fire situations without taking the risk of human life. This project therefore has a unique version in robotic field. It aims to promote technology with innovation to achieve a reliable and effective outcome and cheaper cost.

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