"Autonomous Fire Fighting Robot"

PROJECT REPORT

Submitted for CAL B.Tech Introduction to Innovative Projects (PHY1999)

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May, 2017

CERTIFICATE

This is to certify that the Project work entitled "Autonomous Fire Fighting Robot" that is being submitted by "*William C Francis*"," *Abhiroop Bansal*"," *Siddharth Singh*" for CAL in B.Tech Introduction to Innovative Projects (PHY1999) is a record of bona fide work done under my supervision. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted for any other CAL course.

Place : Chennai

Date : 6/5/2017

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ACKNOWLEDGEMENTS

I would like take this opportunity, to thank my faculty for helping us out in this project with their support. I would also like to thank my team members for successfully complete the project's working model in time and carry out the necessary tasks. Without them this project couldn't have been completed. THANK YOU.

I would also like to thank VIT University Chennai Campus for giving the opportunity to complete my project.

ABSTRACT

In our project, we develop a robot that is able to locate and extinguish fire in a given environment. The robot moves through its surroundings and scans throughout till it finds a fire.

It is a robot that autonomously detect and extinguish fire. It uses flame sensor for detection and Arduino board for processing. Fire extinguisher along with electronic valve (actuator) is used to extinguish the detected fire. The robot rotates while actively scanning for fire. This scanning is performed by sensors placed on the sides. When a fire is detected, it moves in the direction of fire an stops 30 cm in front of it and trigger the extinguisher to turn out the fire. This project aims to provide a solution to put out any fire with minimum human casualty.

INTRODUCTION

The field of firefighting has long been a dangerous one, and there have been numerous and devastating losses because of a lack in technological advancement. Additionally, the current methods applied in firefighting are inadequate and inefficient relying heavily on humans who are prone to error, no matter how extensively they have been trained. A recent trend that has become popular is to use robots instead of humans to handle fire hazards. This is mainly because they can be used in situations that are too dangerous for any individual to involve themselves in. In our project, we develop a robot that is able to locate and extinguish fire in a given environment. The robot navigates the arena and avoids any obstacles it faces in its excursion.

COMPONENTS USED

- Arduino Board - 1

- Flame sensor modules - 3

- DC Motor Driver - 2

- Electronic Valve (or linear actuator) - 1

- DC Gear Motor - 4

- Fire Extinguisher - 1

- Wheels - 4

- Motor Clamps - 4

- Switch, Wire, Screws etc.

FLAME SENSOR

A flame sensor typically responds to the presence of fire. It can either produce sound, deactivate a fuel line or activate a fire suppression system as a response to mitigate fire.

Flame sensor modules do not cost much, and the efficiently detect flame.

In this project we used laser to detect the flame. The sensor then sends a signal to the Arduino which computes and takes effective control measures. Only digital output is used in this project.
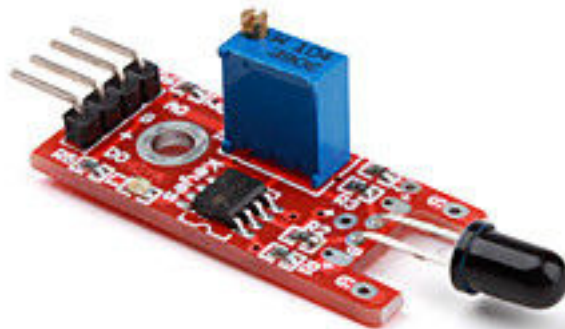
CHASSIS

The chassis is made of steel. It consists of a rectangular base and a cylinder holder to keep the fire extinguisher intact
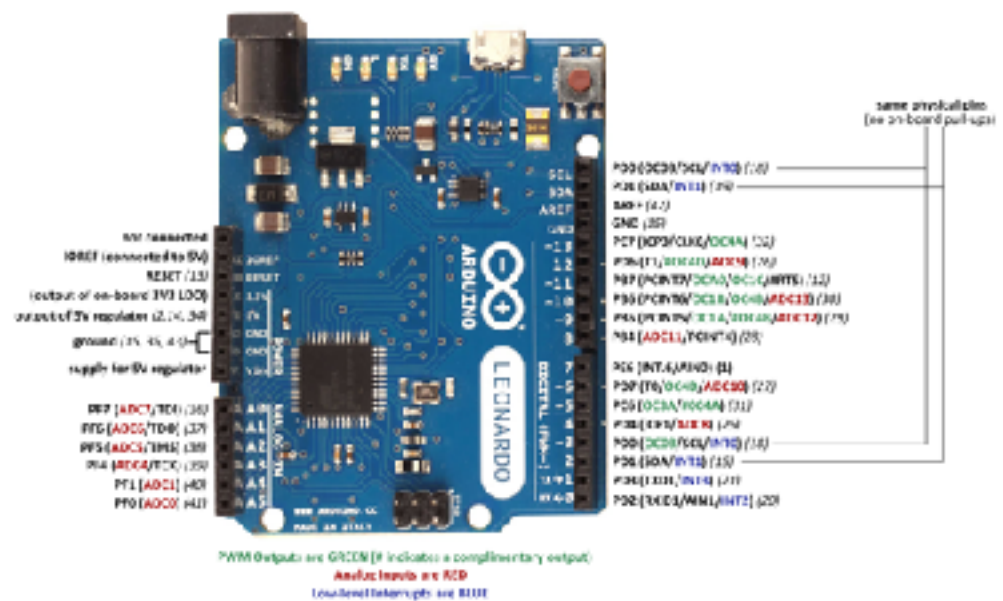
ARDUINO

Arduino is a software that helps to manufacture digital devices which can sense and control objects in the physical world.

In this project, Arduino Leonardo board is used.

Arduino acts as the brain of the machine and helps integrate the various processes being carried out.

MOTOR DRIVER

Since the Arduino board can supply only 5v which is insufficient for driving motor, motor driver is used.

With the help of motor driver, clockwise and anticlockwise rotation of motor can be easily achieved. Motor driver must be supplied with a supply voltage of 5v -9v. Ground must be connected to the ground pin of Arduino board.

Since this robot needs to carry a fire extinguisher, dc gear motor having enough torque must be selected. Here a metallic gear motor with 60rpm, having 10-12kg/cm torque has been used.

FIRE EXTINGUISHER

General fire extinguishers are heavier and difficult to be transported or triggered. A spray type one will be most convenient and affordable. In case of general type, an electronic valve should be used to release the gas or foam.

For the spray type, electronic actuator can be used. In this project, we have used spray type extinguisher an instead of actuator, a cam mechanism is used to apply pressure on the nozzle. Cam mechanism consist of a metallic cam connected to a gear motor. It presses the nozzle knob as it rotates. A separate motor driver is used to drive this motor.

WORKING PRINCIPLE

The robot keeps moves towards the fire when it is detected. When the robot reaches near the proximity of the fire, it stops and starts the extinguishing process. A motor on top of the extinguisher pushes the nozzle down till it stop detecting the fire. After the fire is extinguished, it moves back and continues scanning for any more fires in its vicinity.

ARDUINO CODE

```
int d1 = 2;
int d2 = 3;
int d3 = 4;
int led = 10;
int motora1 = 5;
int motora2 = 6;
int motorb1 = 7;
int motorb2 = 8;
int cam_motor1 = 11; /* use same in case of valve */
int cam_motor2 = 12;
int enable = 9;  /* enable for cam motor driver */

void setup(){
 pinMode(led,OUTPUT);
 pinMode(d1,INPUT);
 pinMode(d2,INPUT);
 pinMode(d3,INPUT);
 pinMode(motora1,OUTPUT);
 pinMode(motora2,OUTPUT);
 pinMode(motorb1,OUTPUT);
 pinMode(motorb2,OUTPUT);
 pinMode(cam_motor1,OUTPUT);
 pinMode(cam_motor2,OUTPUT);
}
 void brake()
 {    digitalWrite(motora1,HIGH);
     digitalWrite(motora2,HIGH);
     digitalWrite(motorb1,HIGH);
     digitalWrite(motorb2,HIGH);
 }
 void rotate()
 {
   digitalWrite(motora1,HIGH);
    digitalWrite(motora2,LOW);
    digitalWrite(motorb2,HIGH);
    digitalWrite(motorb1,LOW);

 }
   void left()
```

```
{
  digitalWrite(motora2,HIGH);
  digitalWrite(motora1,LOW);
  digitalWrite(motorb1,HIGH);
  digitalWrite(motorb2,LOW);
}

void forward()
{
  digitalWrite(motora1,HIGH);
  digitalWrite(motora2,LOW);
  digitalWrite(motorb1,HIGH);
  digitalWrite(motorb2,LOW);

}
void backward()
{
  digitalWrite(motora2,HIGH);
  digitalWrite(motora1,LOW);
  digitalWrite(motorb2,HIGH);
  digitalWrite(motorb1,LOW);

}
void start()
{    digitalWrite(cam_motor1,HIGH);
     digitalWrite(cam_motor2,LOW);
}
void spray_stop()
{
  digitalWrite(cam_motor1,LOW);
  digitalWrite(cam_motor2,HIGH);
}
void normal()
{
  digitalWrite(cam_motor1,LOW);
  digitalWrite(cam_motor2,LOW);
 }


  void loop(){
   rotate();
    while(digitalRead(d1)==HIGH&&digitalRead(d3)==HIGH&&
digitalRead(d2)==LOW)
```

```
{
  digitalWrite(led,HIGH);
  forward();
}
  while(digitalRead(d2)==HIGH)
  {
    digitalWrite(led,HIGH);
    digitalWrite(enable,HIGH);
    start();
    brake();
    delay(5000);
    normal();
    backward();
    delay(700);
    forward();
    delay(1000);
  }
  spray_stop();
  digitalWrite(led,LOW);
  delay(500);
  normal();
  digitalWrite(enable,LOW);

}
```

RELEVANCE IN PRESENT SCENARIO

- 1/6th of all the deaths caused by accidental fires in India are due to exploding cooking gas cylinders and stoves

- As many as 121,325 accidental fires injured 13,721 people over the past 5 years in India.

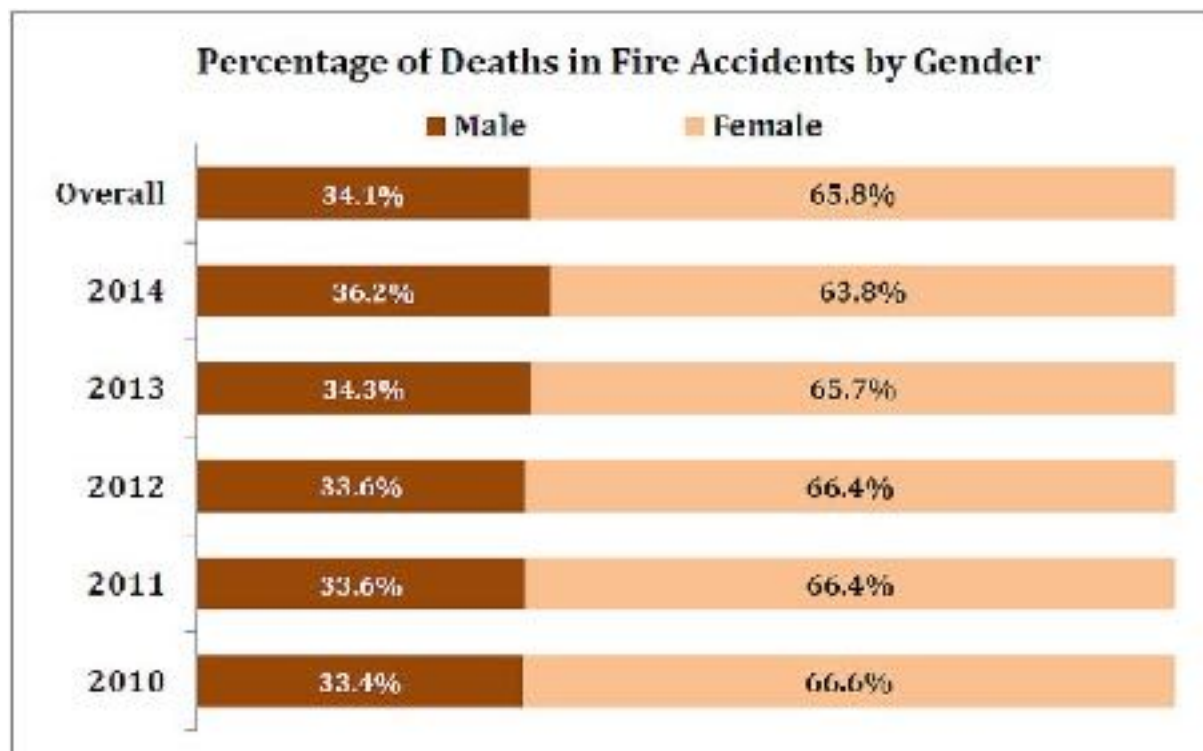- 6% of all unnatural deaths are caused by accidental fires

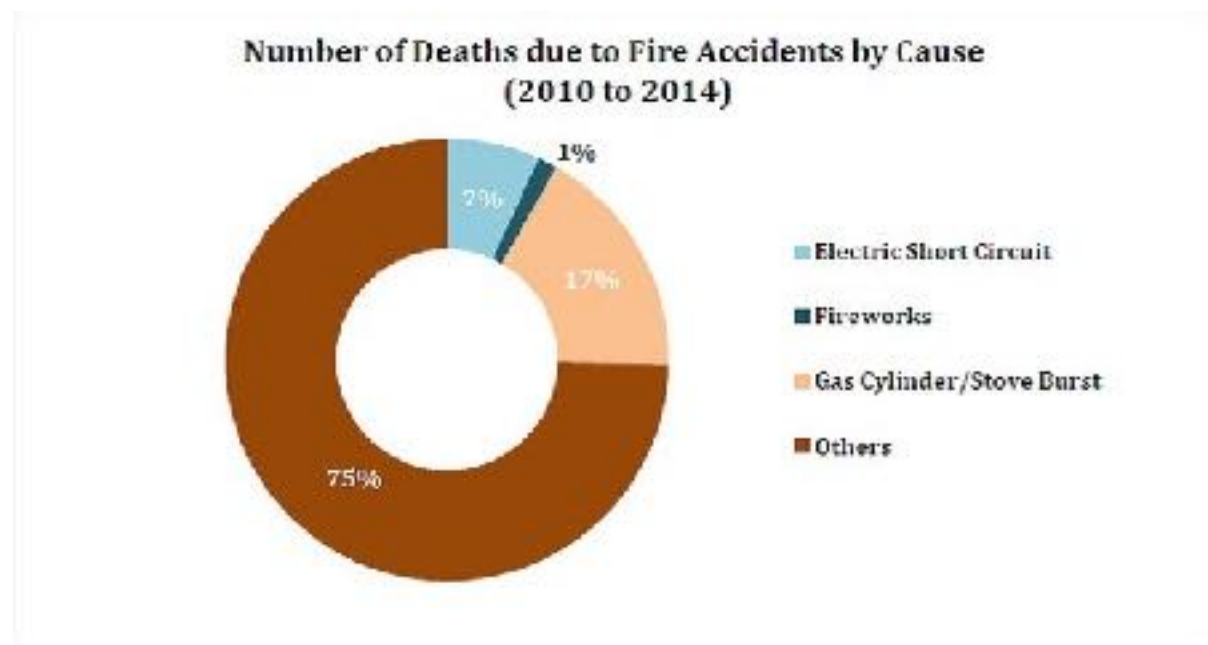Number of Fire Accidents & Deaths in India
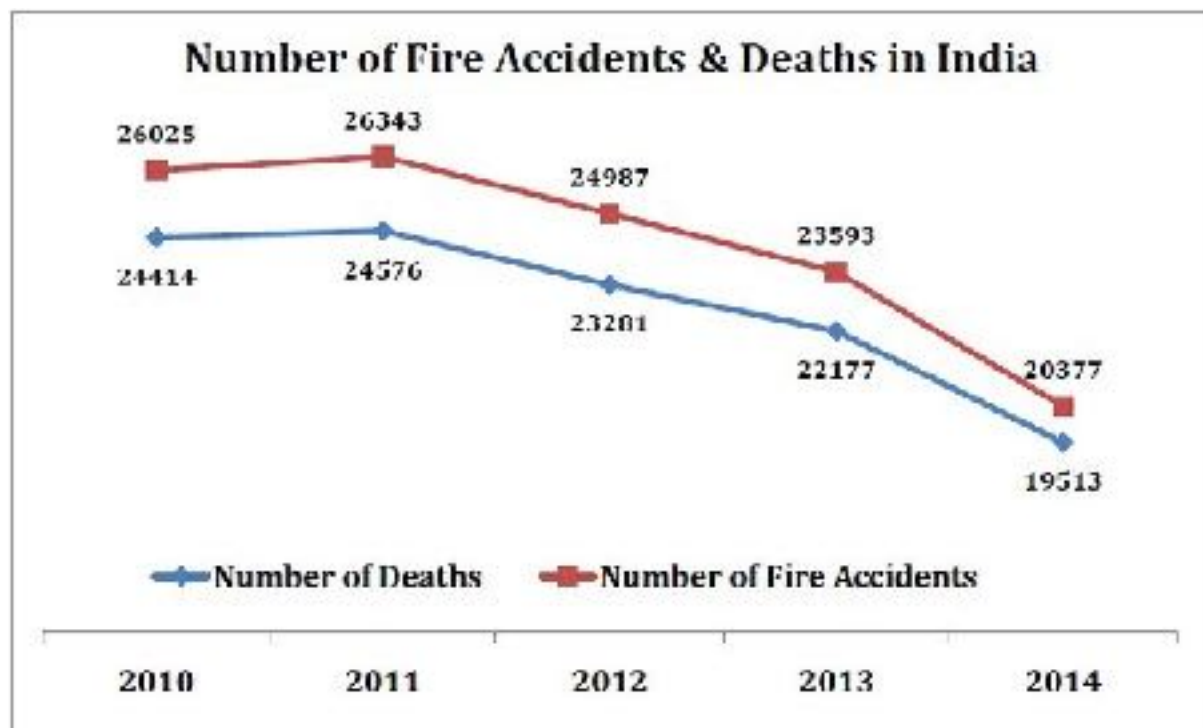
APPLICATIONS

HOUSEHOLD

- A small model of the fire extinguishing robot can be implemented in a household kitchen. For, in such an environment, the possibility of a severe fire can arise out of a leaking LPG cylinder, a gas knob left on or oven left operating for too long or any such malfunction of household appliances.

- It is important to modernise the fire fighting mitigation techniques and technology in the kitchen environment because more than 65% (75,039) of the victims of accidental fires are women.

- From this histogram we can conclude that the scenario has not changed much since 2010.

Percentage of Deaths in Fire Accidents by Gender

	Male	Female
Overall	34.1%	65.8%
2014	36.2%	63.8%
2013	34.3%	65.7%
2012	33.6%	66.4%
2011	33.6%	66.4%
2010	33.4%	66.6%

INDUSTRIAL

• Industries such as coal mines, small and medium electric component manufacturers as well as polyester makers are very prone to fire safety breaches as involve inflatable materials.

• For the industrial purpose, the model can be upgraded by increasing the cylinder size to handle class B fires as well as electrical fires.

• The inherent feature here is that the robot can quickly identify the source of fire and send an alert signal to the evacuation and response team, consequently the processes can be put on a hold until the situation is neutralised.

• Each sector of the factory can have its own robot placed in a suitable location from where it can detect fire.

Number of Deaths due to Fire Accidents by Cause (2010 to 2014)

1%
2%
17%
75%

■ Electric Short Circuit
■ Fireworks
■ Gas Cylinder/Stove Burst
■ Others

DURING EVACUATION AND RESCUE

- During evacuation and rescue missions the critical time to save a life is limited and the fire fighters often need to traverse through a building effectively.

- For this purpose, the fire fighter can take the assistance of our robot to easily navigate through the obstacles and reach the civilians trapped inside as fast as possible.

- Also it can drastically reduce the risk to the fire fighters' lives as any falling debris or surrounding fire will be neutralised.

SWOT Analysis

Strengths

- It is a mobile design.

- It can easily access and navigate through small openings to reach the source of fire which may otherwise be difficult to control manually.

- It is fireproof

- The model uses powerful 60 rpm motors

- Fire can be easily detected using inexpensive flame detector

WEAKNESSES

- Small range of operation

- The Arduino board is delicate and it can be damaged during operation

- Power supply can get depleted easily

OPPORTUNITIES

- This project has the potential to be developed as a successful startup

- It has a huge potential for commercial viability as it has a ready market

- The make-in-India scheme by the government will make the production process efficient due to cheap labour cost and raw materials

- This will ultimately bring down the over all cost of the model

- A few modifications can also make it viable for industrial and evacuation scenarios that cause class a and b fires.

THREATS

- The attitude of the consumers especially at the domestic level should be in line with the idea of fire safety mitigation

- Realty developers and architects should be transparent with the residents about the fire safety situation of a building

- Industrialists and companies being insensitive towards fire safety posing a barrier to the implementation for industries

CONCLUSION

After developing the working model and carrying out SWOT analysis for our project - Autonomous Fire Fighting Robot (AFFR), we come to the conclusion that given its features, ease of production and reliability, the AFFR model can be easily applied to our everyday household environment. Further with some modifications and upgradations, its scope can be extended to an industrial scenario.

We intend to take this project even further by developing the model with wider applications and wider range of operations. This project has indeed provided us with the motivation to think innovatively and creatively.

REFERENCES

The following sites helped us gather information

- http://www.engineersgallery.com/tag/fire-fighting-robot-wikipedia/

- http://www.instructables.com/id/Arduino-Modules-Flame-Sensor/

- http://plfr.org/public-education/seasonal-safety-tips/fall-winter/fire-extinguisher-tips-techniques.php

- https://en.wikipedia.org/wiki/Main_Page

And many more.