Fire Detection and Prevention Using UAV By Machine Learning and OpenCV Implementation.

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This project report has been submitted in fulfillment of the requirements for the Degree of Bachelor of Science in Software Engineering.

Fall – 2022

APPROVAL

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This thesis titled on "**Fire Detection and Prevention Using UAV By Machine Learning and OpenCV Implementation**", submitted by **Abu Nokib Kamran (ID: 191-35-2634)** to the Department of Software Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Software Engineering and approval as to its style and contents.

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DECLARATION

I hereby declare that I have done this project under the supervision of **Kaushik Sarker**, Associate Professor & Associate Head, Department of Software Engineering, Daffodil International University. I also declare that this project is my original work for the degree of B.Sc. in Software Engineering and that neither the whole work nor any part has been submitted for another degree in this or any other university.

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Finally, I must acknowledge with due respect the constant support and patients of our parent.

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ABSTRACT

At present, the world has changed a lot with the help of new technology. At present different countries are using new technologies. In keeping pace with the world, we will present our country to the world. Currently, various companies or organizations in our country are using new technologies to increase their capabilities. In addition, these technologies have to be bought from different countries at much higher prices. Therefore, we plan to build a fire detector UAV. Which different companies or organizations of our country have had to buy from different countries by spending a lot of money. Again, many companies or organizations are doing a lot of risky work by using workers because it is expensive. As a result, the death rate of workers in the country is also increasing and the amount of damage is increasing. Our goal was to create a fire detector UAV. It will fly autonomously and detect fire quickly and will assist in informing the authorities about the fire. We have been able to show 80% of the work in the demo project so far. The problem with our program part is that all the modules are done separately. I have uploaded the code to nodemcu. Add different modules to the nodemcu such as:- Flame sensor, 5V buzzer. Raspberry Pi is also used so the Pi camera can detect fire with it. The work of the demo prototype is finished.

Currently it can detect the fire and sent a notification to the authority and alarm sounds. In addition, the flame sensor help to detect fire and sounds through the buzzer. We will continue to work in the future to extinguishing fire.

Keywords: UAV, Raspberry Pi, Pi Camera, NodeMCU(ESP8266), Flame Sensor.

1. INTRODUCTION

1.1) Background

Our university is established with around 165 acres of land. There are many buildings and many plants throughout the university area. Now, if there is a fire in any part of the university it will take a long time for a man to reach there so I am thinking of making a drone, which can detect fire and help control fire. Therefore, I want to develop a drone that can quickly spot a fire and help put it out. The UAV will detect the location of the fire and immediately inform the university authorities about the location of the fire and provide information to the emergency helpline 999 for the assistance of the fire service, thereby avoiding a lot of damage and identifying the location of the fire at an early stage.

1.2) Motivation of the Research

A drone is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAVs) or unmanned aircraft systems. Essentially, a drone is a flying robot that can be remotely controlled or fly autonomously using software-controlled flight plans in its embedded systems, that work in conjunction with onboard sensors and a global positioning system (GPS). Forest and urban fires have been and still are serious problem for many countries in the world. Currently, there are many different solutions to fight forest fires. These solutions mainly aim to mitigate the damage caused by the fires, using methods for their early detection. Many countries in the world have good mid-range drones but we want to build a drone that is affordable to people and helps in detection and firefighting.

1.3) Objective

- It can make human work easier.
- A lot of hard work in different industries can make it easier.
- This UAV is more useful in places where people are in danger.
- It can do the job much faster.
- It is very useful for detect fire easily.
- This UAV is very helpful to detect fire quickly.

1.4) Scope of the UAV

- Autonomous Movement.
- GS Controlling.
- Take & Drop Operation.
- Low Cost , High Mobility.

Raspberry Pi controlled drone can detect fire with pi camera. It also detects fire with flame sensor and buzzes with nodemcu (ESP8266). This drone is designed to be used in various fields. Here we used a drone to detect fire. This project involves programming Raspberry Pi and nodemcu (ESP8266) for fire detection. It will move independently and be controlled from the ground station. The drones detect the fire, immediately notify the authorities and help extinguish the fire. It is very cheap to make and very easy to sense the fire. The result is much less damage and faster fire localization.

1.5) Methodology

The components used in the design and construction of fire detectors are raspberry pi 3 model b+, pi camera, nodemcu (ESP8266), flame sensor, 5V buzzer and most importantly the programming of the raspberry pi and nodemcu (ESP8266).

1.6) Block Diagram

The block diagram of our work is as shown in Figure

1.6.1

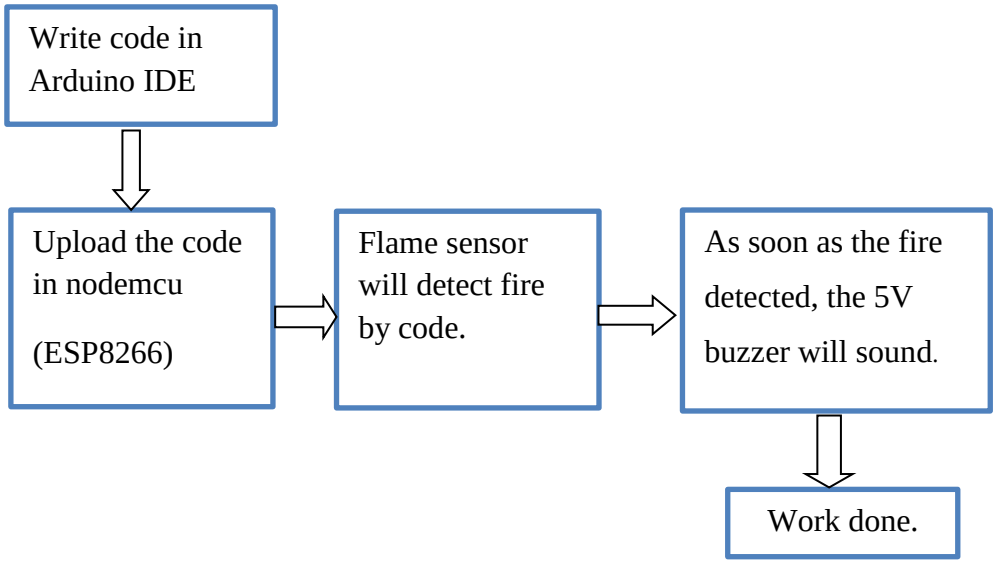


Fig. 1.1 Block diagram of Nodemcu (ESP8266)

1.6.2

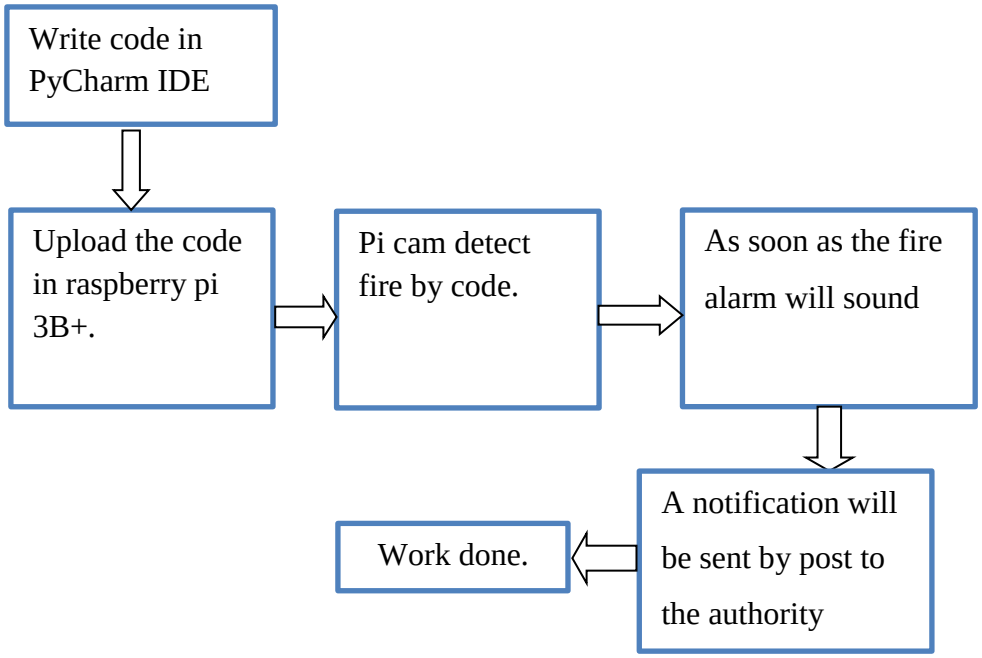


Fig. 1.2 Block diagram of Raspberry pi.

1.7) Working of the Fire Detector UAV

This work is able to successfully accomplish the defined functionality. A UAV controlled by raspberry pi can detect fire with pi camera also detect fire with flame sensor and sound buzzer by nodemcu (ESP8266). Soldered Flame Sensor and Buzzer with nodemcu (ESP8266) and pi camera with raspberry pi and procedures required for proper operation of fire detection. Firstly, the raspberry pi is placed in the middle of the UAV with the pi camera. As a result, the pi camera can detect fire very easily. Again the nodemcu (ESP8266) module is placed in the middle of the UAV and the flame sensor is also placed vertically so that it can easily detect fire. When the pi camera detects fire then a mail will be sent to the authorities with the help of raspberry pi and an alarm will sound immediately and when the flame sensor detects the fire the buzzer will sound with the help of nodemcu (ESP8266).

1.8) Purpose of the Fire Detector UAV

This is a unmanned aerial vehicle, this UAV is designed to be used in various fields. Here we used UAV to detect fire. This project involves programming raspberry pi and nodemcu (ESP8266) for fire detection. This UAV can detect fire anywhere. For example, if there is a fire somewhere in our university, then university authority can get immediate information through it. Various types of UAV are available in many countries of the world and now this thing has become very popular and our country is no exception. Our country has a lot of factories and densely populated areas, so if there is a fire somewhere, it takes a long time to find the source of the fire. This UAV will immediately detect the fire and notify the authorities about the fire.

2. LITERATURE REVIEW

2.1) Background

In this cutting-edge world, robotics is a modern field of advanced innovation that pushes the traditional engineering boundaries toward the modern era of automation. Learning about robots and their applications in daily life requires learning electrical, mechanical engineering, basic science and software. Used in fire detection, area mapping, videography, rescue operations, special operations of armed forces. The reason for reading thesis paper is how to make our project more relevant and effective.

3. COMPONENTS ASSEMBLING

3.1) Approach

We were able to study UAV, raspberry pi, nodemcu(ESP8266) in detail. We tested while building fire detection UAV. We used python code and c ++ code. After uploading the code we checked that our components can detect fire.

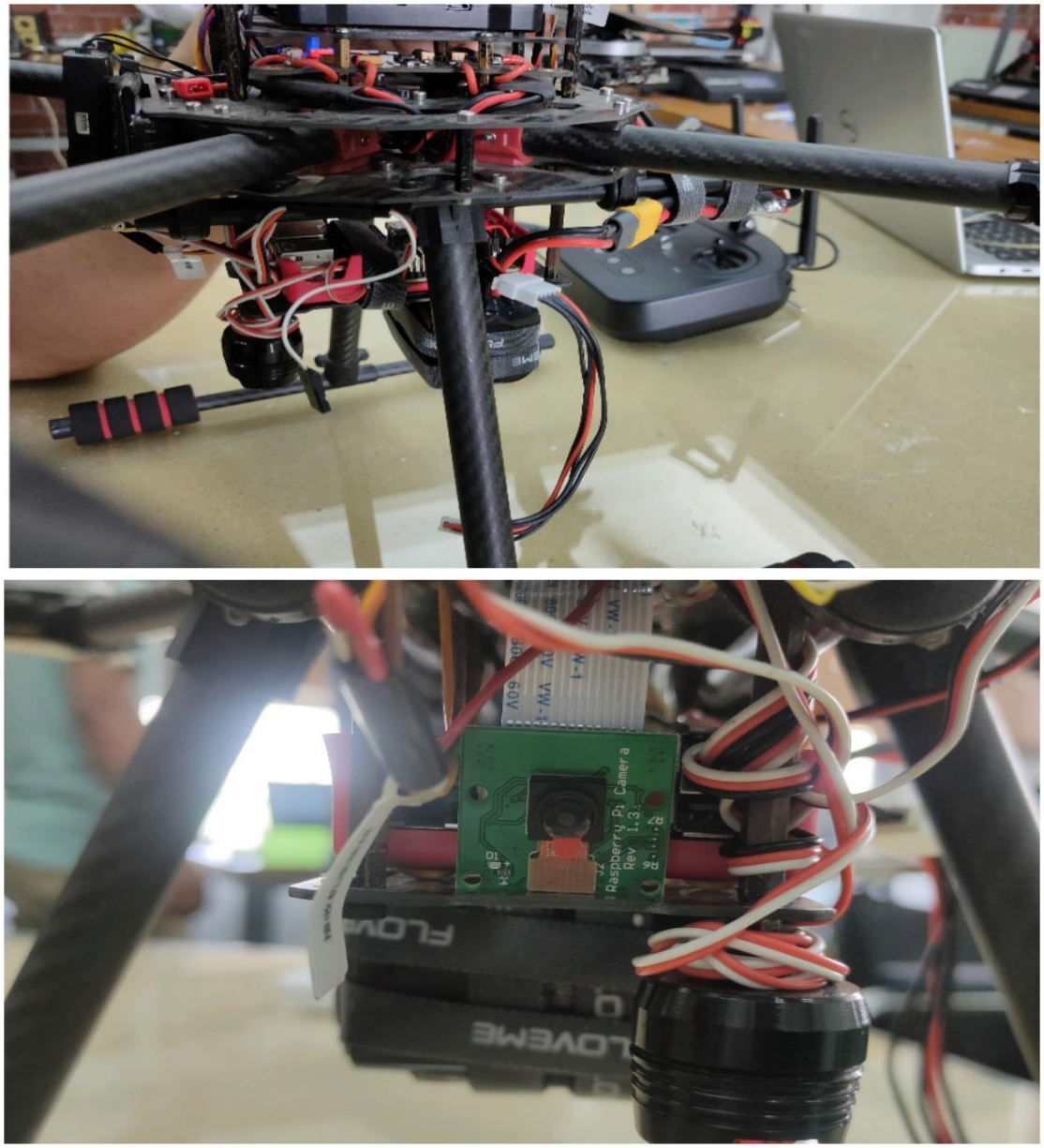


Fig. 3-1.Hole UAV.

3.2) Part of the UAV

3.2.1 Raspberry Pi (3 model B+)

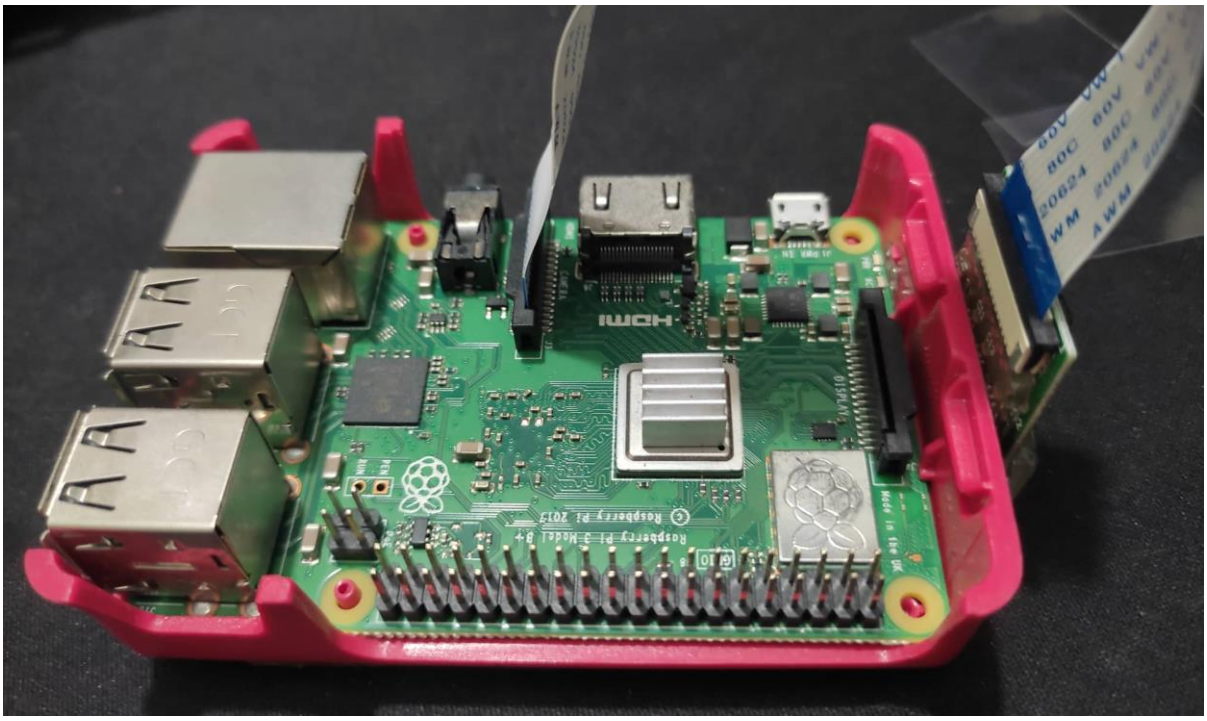


Fig. 3-2. Raspberry pi.

We use raspberry pi 3B+ to detect fire through pi cam. This component are very lightweight and work effectively.

3.2.2 Pi Camera

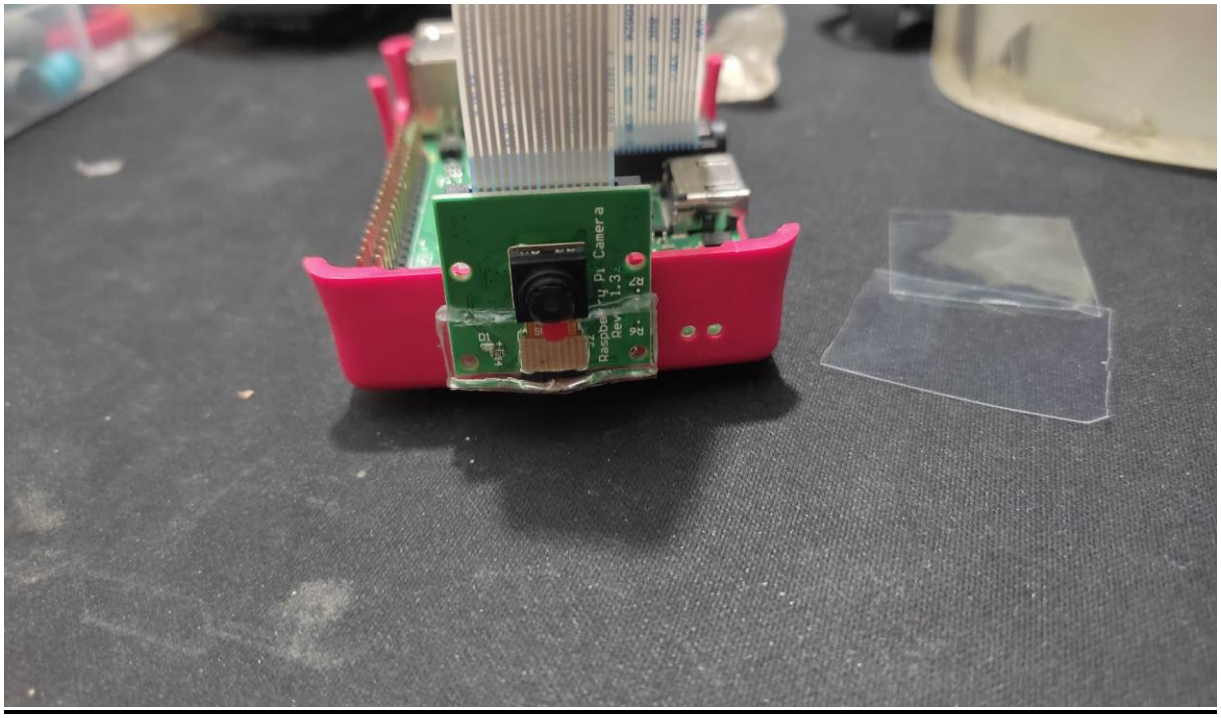


Fig. 3-3 Pi camera.

These pi camera are used suitable position of the UAV. It will help to detect fire. This module attached by the screw on the UAV.

3.2.3 Flame Sensor

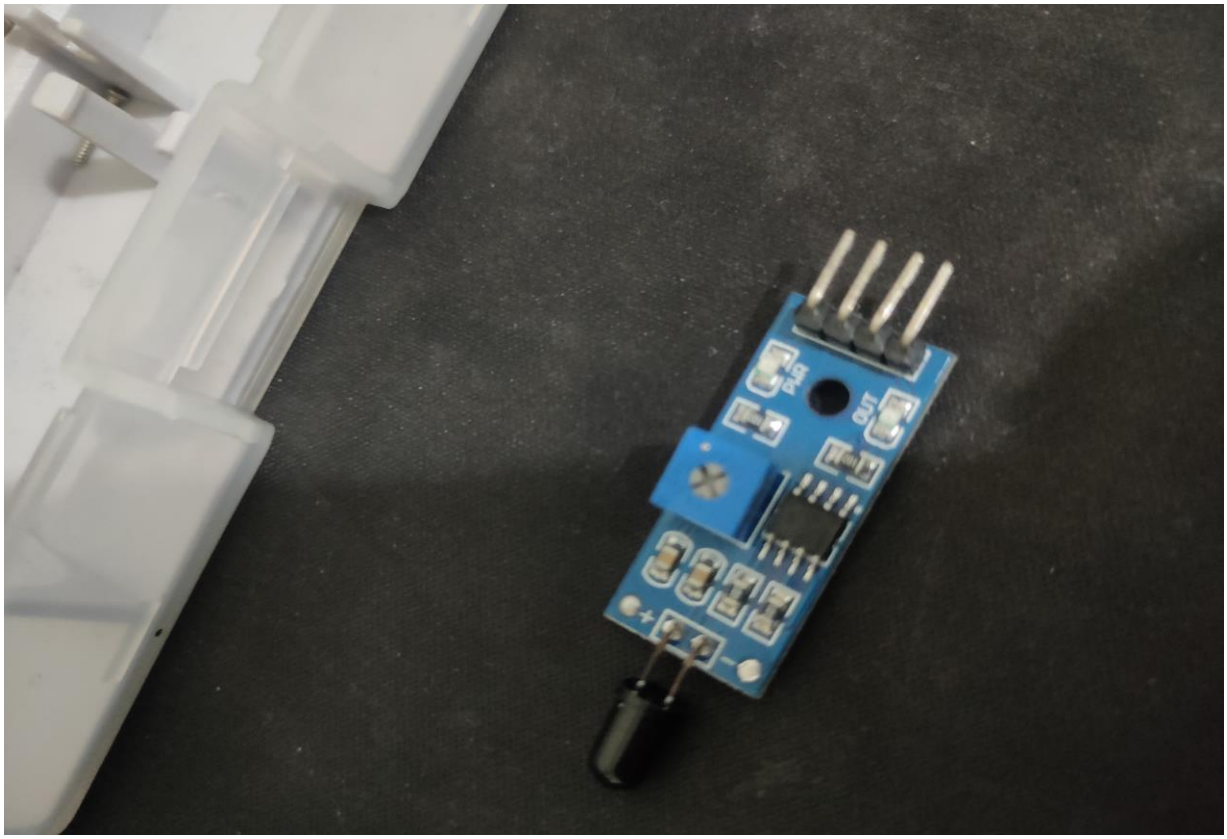


Fig. 3-4.Flame sensor.

This flame sensor helps to detect the fire easily. This flame sensor is set in the middle of the UAV. It is very effective sensor.

3.2.4 5V Buzzer

Fig. 3-5.5V buzzer.

5V buzzer is used for alarm.

3.2.5 Nodemcu (ESP8266)

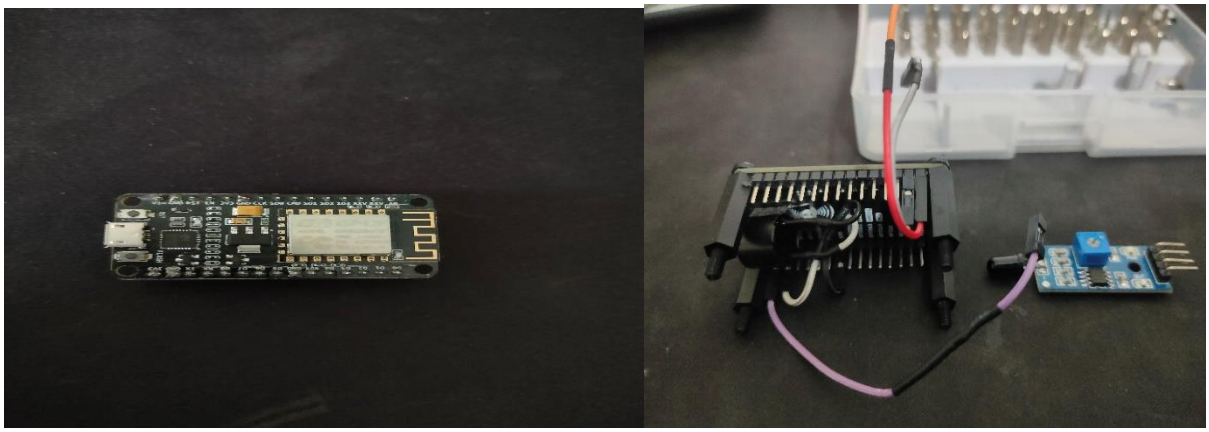


Fig. 3-6.Nodemcu(ESP8266).

Nodemcu(ESP8266) is a programmable wifi module. It is very popular now. With this module we make a fire detector using flame sensor. When flame sensor are detect the fire the 5v buzzer will give alarm.

3.3) Working of the UAV

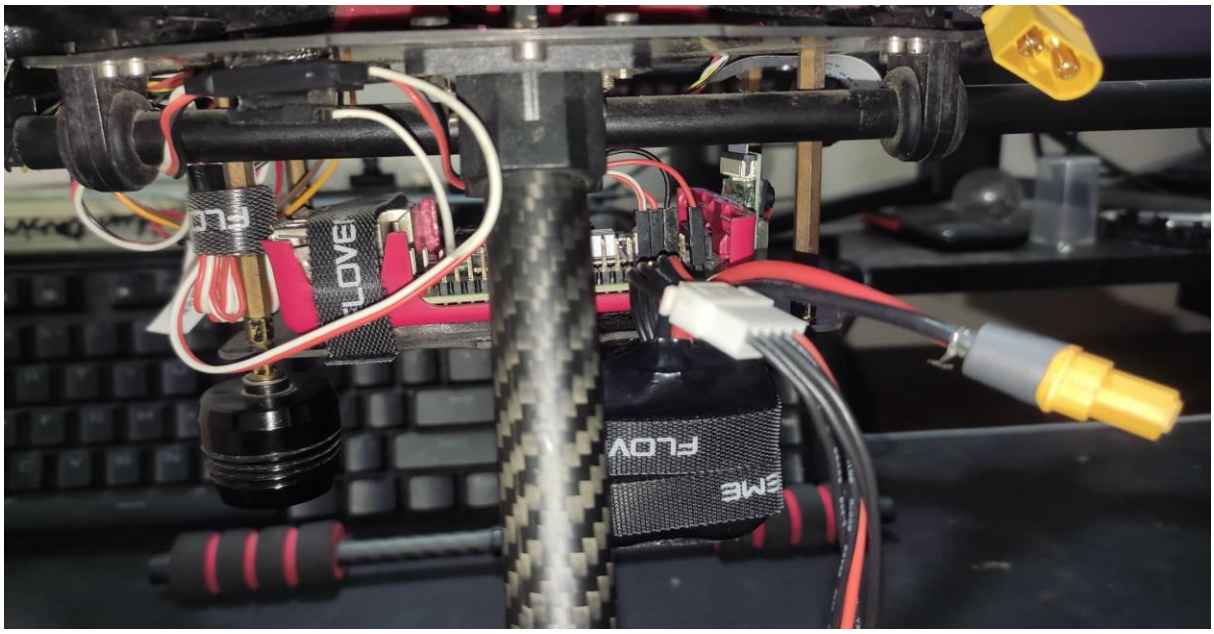


Fig. 3-7.Raspberry pi.

Connecting UAV to raspberry pi.

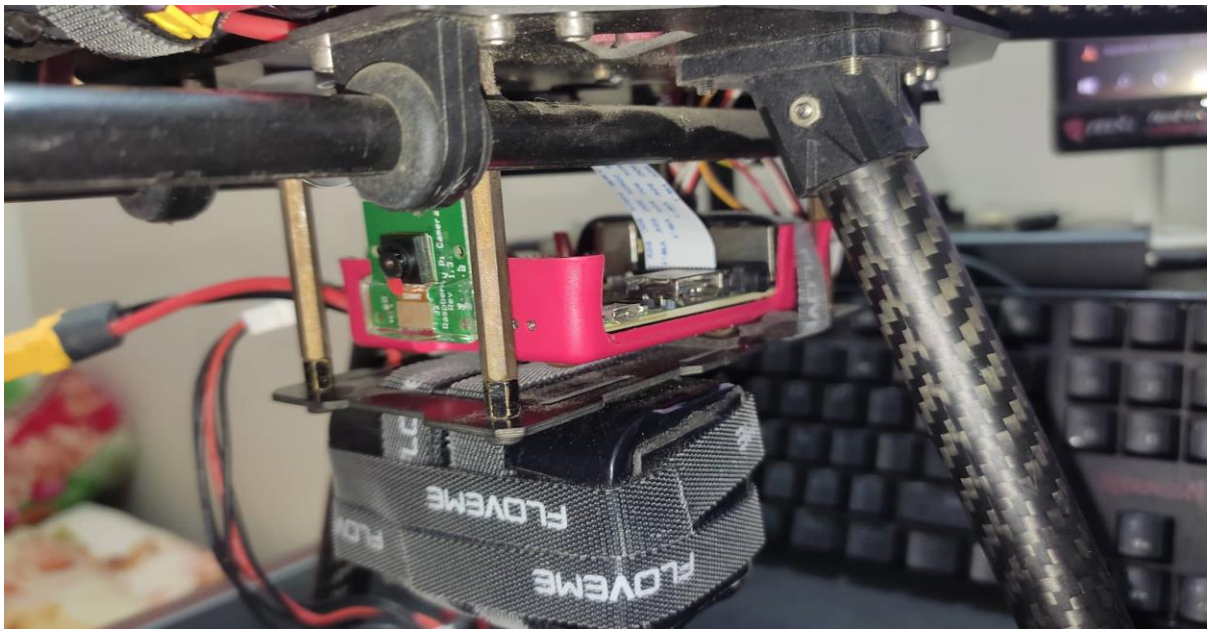


Fig. 3-8.Raspberry pi with pi camera.

Pi camera set on the UAV.

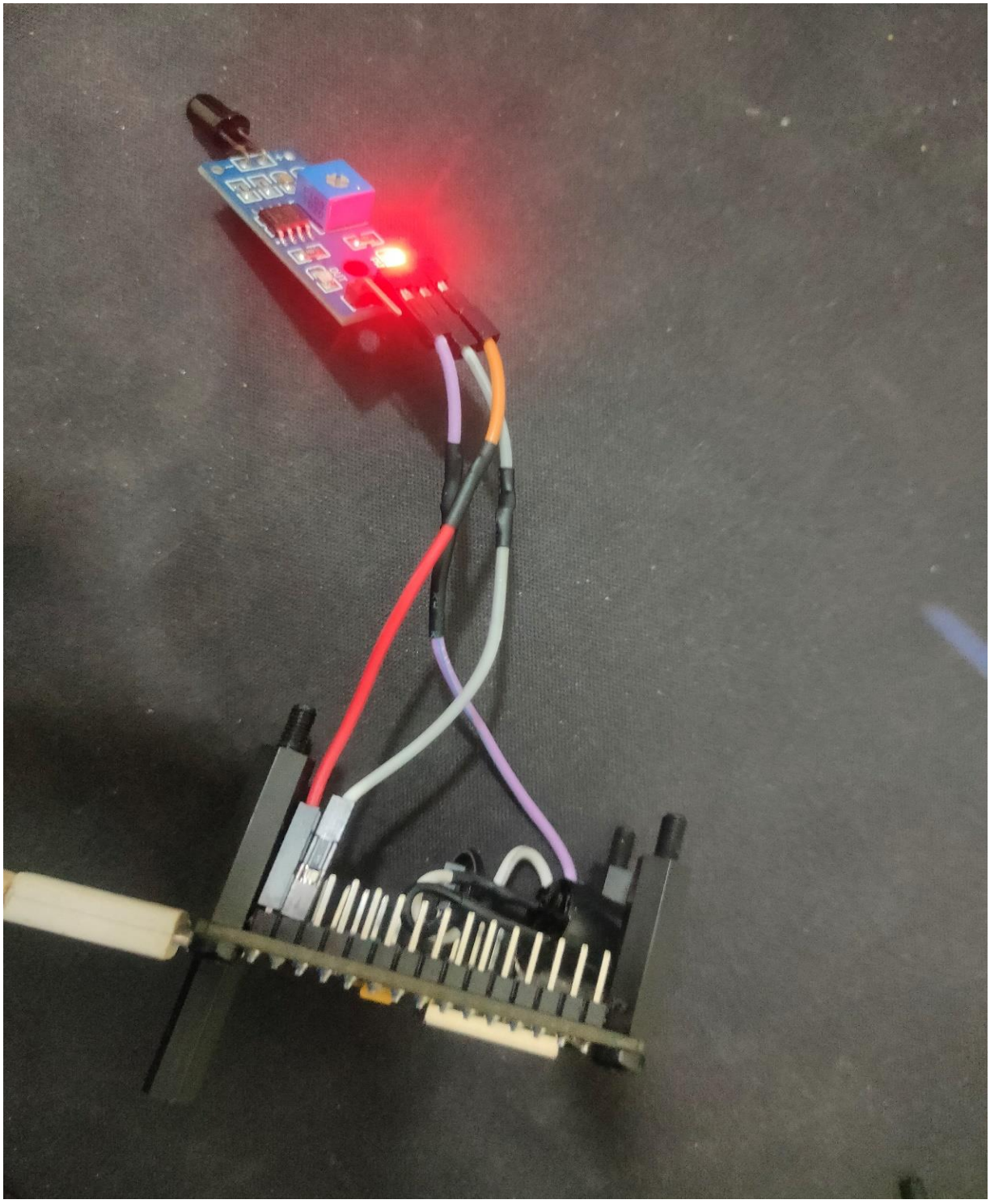


Fig. 3-9.connecting the nodemcu(ESP8266) with buzzer and flame sensor.

Flame sensor and 5v buzzer connecting with nodemcu (ESP8266) .

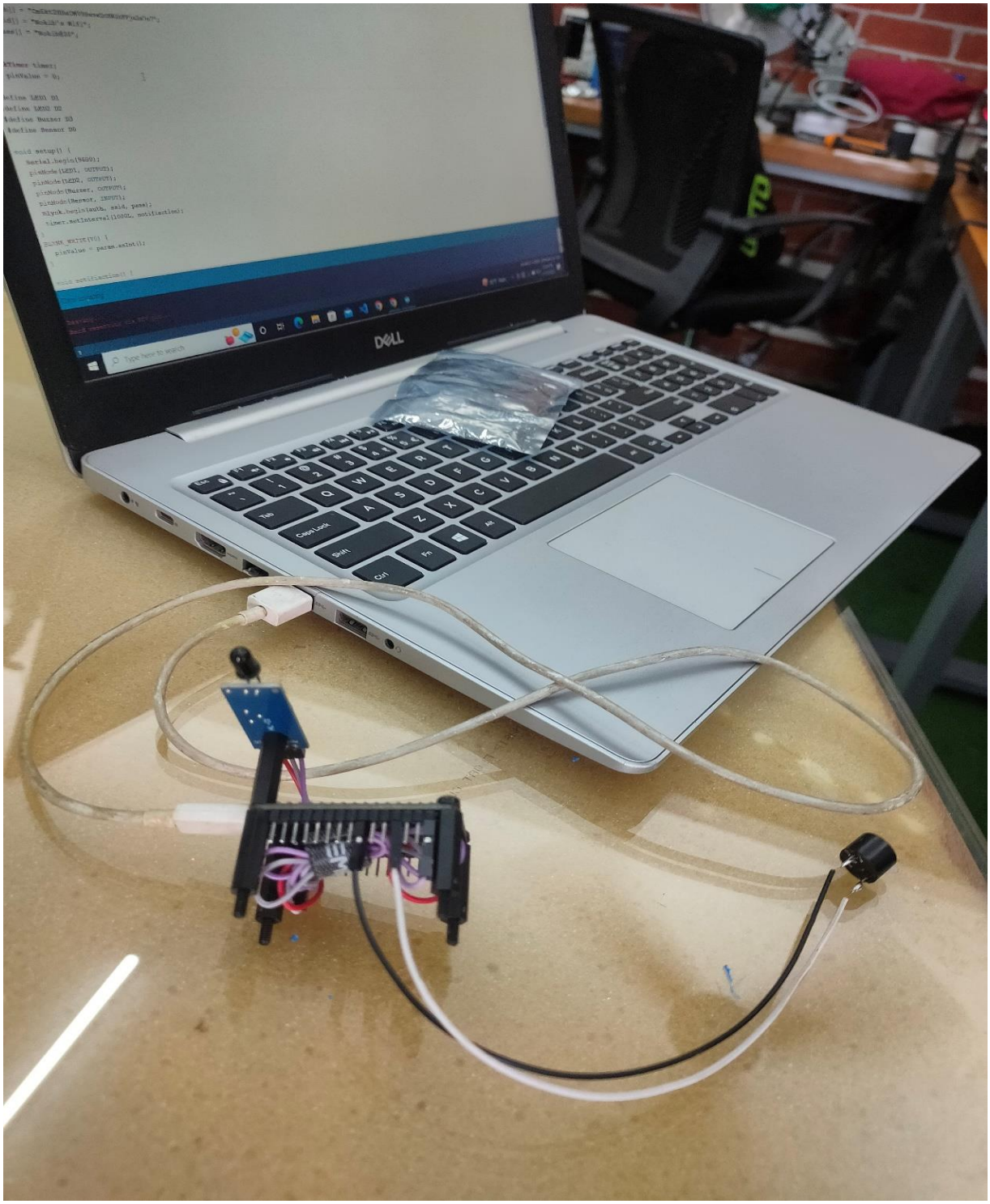


Fig. 3-10.Upload the code on nodemcu (ESP8266).

Using Arduino ide for upload the program on nodemcu (ESP8266) .

3.4) Mechanical Structure of the UAV

To build our fire detection UAV, we used a raspberry pi, a pi camera, a nodemcu(ESP8266), a flame sensor and a 5v buzzer because we can detect fire in two ways. A typical prototype that we employed is as shown in figure. There is raspberry pi that can detect fire using pi camera. Secondly the nodemcu(ESP8266) detect the fire using flame sensor and 5v buzzer will sound. These two modules are placed in the middle position under the UAV so that fire detection is easy and there is no problem in flying the UAV.

3.5) Component Study

(i) Mechanical Part

(ii) Programmable Part

3.5.1 Mechanical Parts

a. Pi camera

b. Flame sensor

c. 5v Buzzer

3.5.1.a Pi Camera(V2)

	Camera Module v1	Camera Module v2	HQ Camera
Net price	$25	$25	$50
Size	Around 25 × 24 × 9 mm		38 x 38 x 18.4mm (excluding lens)
Weight	3g	3g	
Still resolution	5 Megapixels	8 Megapixels	12.3 Megapixels
Video modes	1080p30, 720p60 and 640 × 480p60/90	1080p47, 1640 × 1232p41 and 640 × 480p206	2028 × 1080p50, 2028 × 1520p40 and 1332 × 990p120
Sensor	OmniVision OV5647	Sony IMX219	Sony IMX477
Sensor resolution	2592 × 1944 pixels	3280 × 2464 pixels	4056 x 3040 pixels
Sensor image area	3.76 × 2.74 mm	3.68 x 2.76 mm (4.6 mm diagonal)	6.287mm x 4.712 mm (7.9mm diagonal)
Pixel size	1.4 µm × 1.4 µm	1.12 µm x 1.12 µm	1.55 µm x 1.55 µm
Optical size	1/4"	1/4"	1/2.3"
Full-frame SLR lens equivalent	35 mm		
S/N ratio	36 dB		
Dynamic range	67 dB @ 8x gain		
Sensitivity	680 mV/lux-sec		
Dark current	16 mV/sec @ 60 C		
Well capacity	4.3 Ke-		
Depth of field	approx. 1 m to infinity	adjustable with supplied tool	N/A
Focal length	3.60 mm +/- 0.01	3.04 mm	Depends on lens
Horizontal field of view	53.50 +/- 0.13 degrees	62.2 degrees	Depends on lens
Vertical field of view	41.41 +/- 0.11 degrees	48.8 degrees	Depends on lens
Focal ratio (F-Stop)	2.9	2.0	Depends on lens
Maximum exposure times (seconds)	6	11.76	670.74

Fig. 3-11.Pi Camera details (V2).

3.5.1.b Flame Sensor

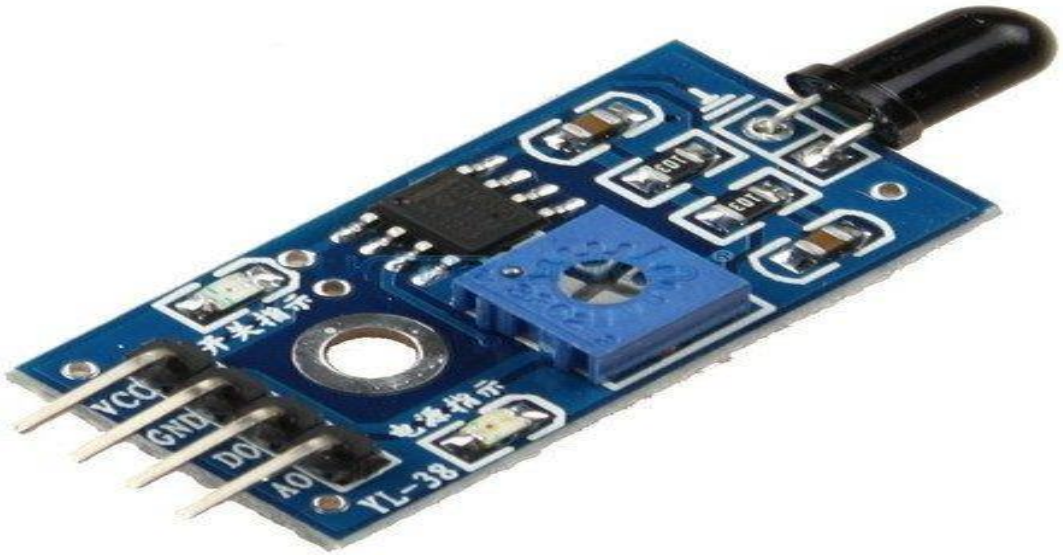


Fig. 3 12.Flame Sensor

One type of detector that is primarily made for both detecting and responding to the occurrence of a fire or flame is a flame-sensor. Its fitment may affect the flame detection reaction. It has a fire suppression system, a propane line, a natural gas line, and an alarm system. In commercial boilers, this sensor is utilized. This has the primary purpose of providing verification of the boiler's proper operation. Because of their technique for detecting the flame, these sensors respond more quickly and accurately than a heat or smoke detector. The sensor's pin configuration is displayed below. It has four pins, including the four listed below. The pins are connected when this module is used with a microcontroller unit.

3.5.1.c 5V Buzzer

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

Fig. 3-13. 5V Buzzer

3.5.2 Programmable Parts

a. Raspberry pi(3 model B+)
b. Nodemcu (ESP8266)

3.5.2.a Raspberry Pi(3 model B+)

- Broadcom BCM2837B0, Cortex-A53 64-bit SoC @ 1.4GHz.
- 1GB LPDDR2 SDRAM
- 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE
- Gigabit Ethernet over USB 2.0 (maximum throughput 300Mbps)
- Extended 40-pin GPIO header
- 1 × full size HDMI
- 5V/2.5A DC via micro USB connector
- Operating temperature, 0–50°C

Fig. 3-14.Raspberry Pi.

3.5.2.b Nodemcu (ESP8266):

The nodemcu (Node Micro Controller Unit) is an open-source software and hardware development environment built around an inexpensive system-on-a-chip called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

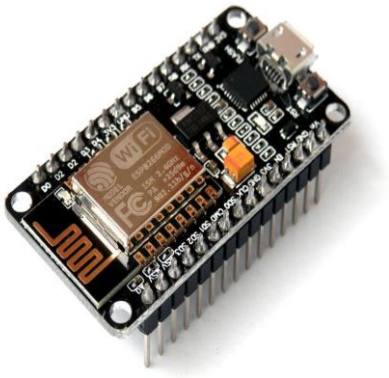


Fig. 3-15.Nodemcu(ESP8266).

3.6) PIN Description

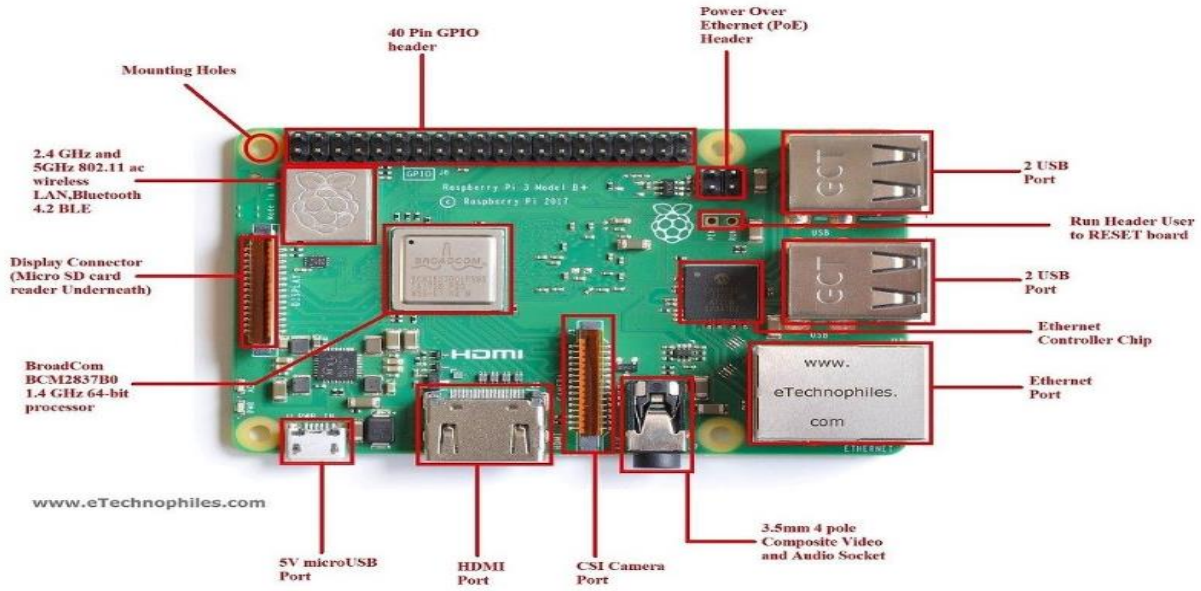


Fig. 3-16.Pin Description Diagram of Raspberry Pi.

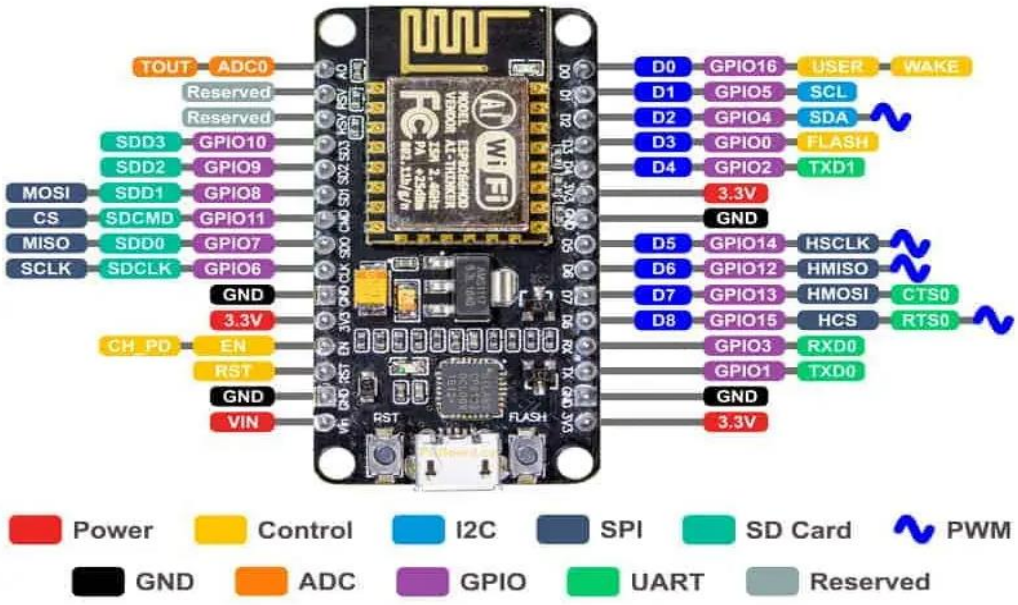


Fig. 3-17.Pin Description Diagram of Nodemcu(ESP8266).

3.7) Functional Description

Raspberry Pi is a small computer. Anything a computer can do can be done with a raspberry pi. Raspberry pi is running ubuntu operating system. Here we have used raspberry pi where we will provide the code and detect the fire through the raspberry pi camera. The raspberry pi will have a WiFi connection and provide information to the authorities. Also we used nodemcu nodemcu is a good quality iot device. It is a small device. It has built-in WiFi module. At nodemku we have uploaded code that will detect fire through flame sensor and sound the buzzer.

4. RESULTS AND DISCUSSION

4.1)Final Output

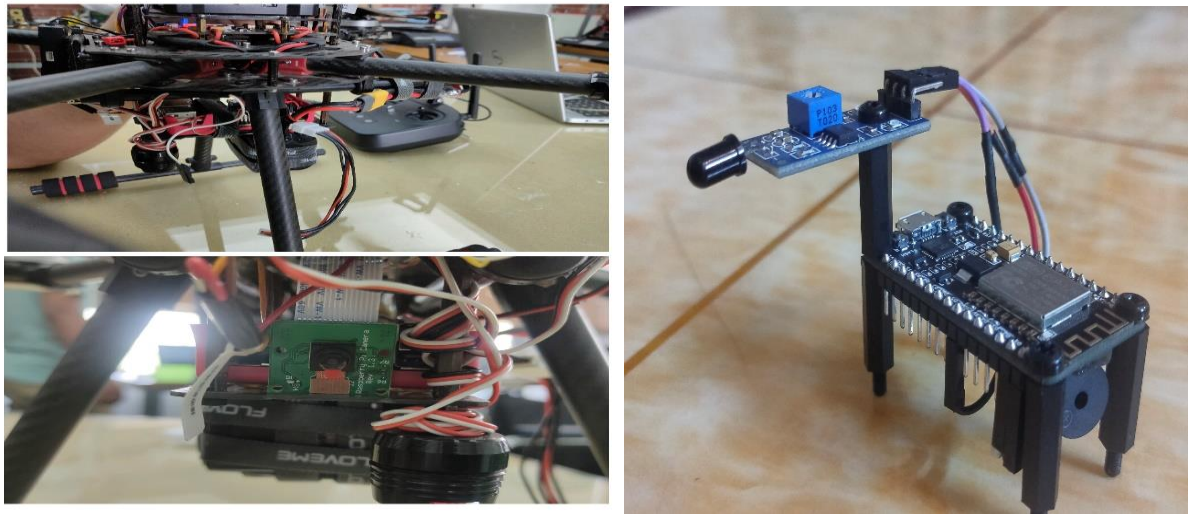
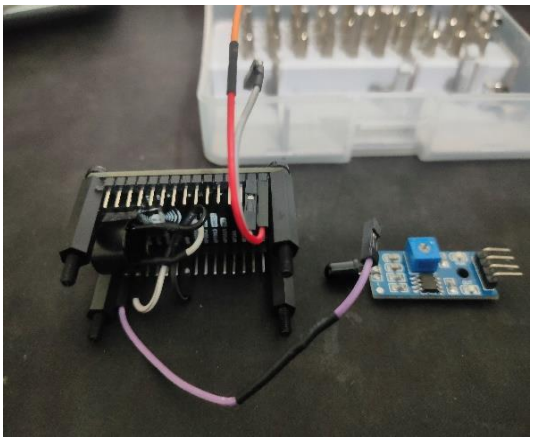


Fig. 4-1. Fire Detector Module.

This drone is easily used by the operator. Autonomous flight is possible. With this self-driving drone, fire can be detected very quickly and can be detected through pi cameras and flame sensors. As soon as the pi camera detects a fire, an email is automatically sent to the authorities and an alarm is sounded. A flame sensor is also used here, so it makes a sound when it catches fire. This will prevent many injuries and identify the fire earlier.

4.2)Learning Experience



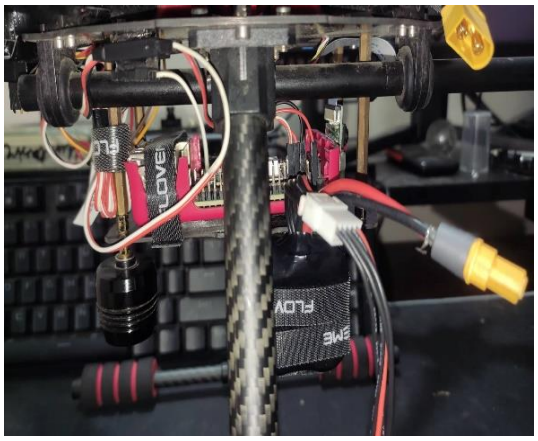


Fig. 4-2. Make the UAV and Fire Detector Module.

We faced many problems when starting this project. Because there were not enough resources on the internet to know about raspberry pi and nodemcu (ESP8266). There are many programs related to Raspberry Pi and nodemcu (ESP8266) on YouTube and Google, but none of them fit my needs. We set the program ourselves with help from various sources. We learned many new things while doing this project. we have done this project after learning a lot of new things. Much more could be done but time is running out. I encountered manyproblems using the ide to run the code. Plan to connect to blynk iot server in future. Many parts are not available in our country. Those that were not available were imported and this project became an idea of how to do it at a lower cost in the future.

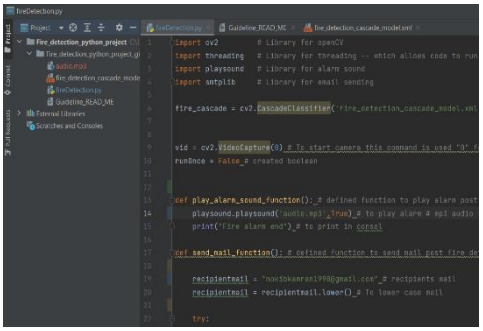


Fig. 4-3. Fire detection program for raspberry pi.

```
#include <ESP8266WiFi.h>
#define Buzzer D1
#define Sensor D0

void setup()
{
  Serial.begin(9600);
  pinMode(Buzzer, OUTPUT);
  pinMode(Sensor, INPUT);
}
void loop()
{
  int fireValue = digitalRead(Sensor);
  Serial.println(fireValue);
  if(fireValue == 0)
  {
    digitalWrite(Buzzer, HIGH);
    delay(1000);
  }
  else
  {
    digitalWrite(Buzzer, LOW);
  }
  delay(500);
}
```

Fig. 4-4. Fire detection program for nodemcu.

4.3)System Working

In the first stage, I tried to work lightly. Our goal was to plan if we could detect the fire and then increase the capacity of the drone. We did our best. We have faced many problems. One of these cases is the unavailability and high cost of suitable parts. Currently, two fire detection modules have been created and installed on the drone. This drone looks powerful. Because it can work miracles. It is very useful in many countries. These fire detector drones are most needed in industrial areas, large facilities and densely populated areas. If you want to use these drones for fire detection in your country, you have to import them from abroad. But if we can build this fire detection drone in our country, people can use it at low cost. In addition, this drone is connected to a fire extinguisher so that it can detect and extinguish the fire. I believe that the use of drones will benefit our industry, institutions and military.

5. CONCLUSION AND COMMENDATIONS

5.1) Conclusion

(1) It is possible to detect fire without any dangerous steps for fire detection.

(2) We need to learn from our errors because we made a lot of them while working on this project and fixed them.

(3) It is very easy to manage.

(4) Finding and putting out fires as soon as possible might prevent a lot of damage.

(5) It becomes trustworthy by giving the system an independent nature.

5.2) Future Works

In the future, this drone will help to identify fires and extinguish them quickly. Also, in the future, by linking with the blynk iot application, you will be able to receive fire detection notifications on your mobile phone, and this will allow you to easily receive notifications from the blynk iot application on your mobile phone.