A Novel Approach for the Design of Raspberry-Pi mounted on DIY Quadcopter for Flood Surveillance.

Prof. Suneetha.V[1], Dr. Salini Suresh[2], Mr. Abhishek V[3], Ms. Gowda Deepa Narasimha[4]
Head-MCA Dept[1], Associate Prof[2], Post Graduate Scholar[3], Post Graduate Scholar[4]
Master of Computer Applications, Dayananda Sagar College of Arts, Science and Commerce[1,2,3,4]

Abstract: **Floods are one of the most unpredictable and devastating natural disasters on Earth. It often results in unprecedented inundation of human habitat leading to large scale destruction and loss of many human lives and livestock. Even after flood subsides, it leaves behind trail of epidemic making situation worst. The Government and many other Non-Government Organisations (NGO) come forward to mitigate the situation and contain damage by deploying multiple Disaster Recovery teams. Flood relief camps are set up and teams are on vigil to rescue the stranded and isolated. It is therefore, imperative to develop a effective flood control system to predict and its onset reduce contain the damages caused. Efficient aerial survey of flood affected area is mandatory pre-requisite to realize the same. Traditional survey using fixed wing planes and rotary helicopters tend to be costly and provide high-level view of the situation. As a alternate solution, this paper proposes a system that captures the images of the affected areas through low cost-effective micro-controller (raspberry-pi). Here, our UAV (Unmanned Aerial Vehicles) is based on KK2.1.5 flight controller which is connected to 4 ESC (Electronic Speed Controller) and each Esc is connected to its brushless motor. Apart from the flight controller we use a raspberry -pi 3 cameras and a NOIR Pi 3 camera to get the images from the surface. This camera records images from the area and data is intern stored and analysed.**

Keywords: Floods, Raspberry-Pi, cost-effective, UAV, NOIR Pi camera.

I. INTRODUCTION

Flood prediction and warning aims to reduce risk of lives and economic impact. A flood alert system supports data collection, analysis, monitor and warning. Wireless sensor nodes are used to collect site information whereas a controller is used to analyze those collected site information and thereby generates flood warning Flood prediction and warning aims to reduce risk of lives and economic impact. A flood alert system supports data collection, analysis, monitor and warning. Wireless sensor nodes are used to collect site information whereas a controller is used to analyze those collected site information and thereby generates flood warning Flood prediction and warning aims to reduce risk of lives and economic impact. A flood alert system supports data collection, analysis, monitor and warning. Wireless sensor nodes are used to collect site information whereas a controller is used to analyze those collected site information and thereby generates flood warning Flood prediction and warning aims to reduce risk of lives and economic impact. A flood alert system supports data collection, analysis, monitor and warning. Wireless sensor nodes are used to collect site information whereas a controller is used to analyze those collected site information and thereby generates flood warning Flood prediction and warning aims to reduce risk of lives and economic impact. A flood alert system supports data collection, analysis, monitor and warning. Wireless sensor nodes are used to collect site information whereas a controller is used to analyze those collected site information and thereby generates flood warning Flood prediction and warning aims to reduce risk of lives and economic impact. A flood alert system supports data collection, analysis, monitor and warning. Wireless sensor nodes are used to collect site information whereas a controller is used to analyze those collected site information and thereby generates flood warning

Flood detection and warning results in decreasing the damage caused to the economy and lives of people. Flood monitoring system contributes to handle data

collection, analysis and warning. Natural calamities change the scenario of the stillness of the environment. These disturb the flow of the living and the economical conditions. The effects are worse than the calamity itself. Natural calamities are major concerns throughout the globe. Every reiteration of these makes lives of the poor vulnerable. Floods have become very common phenomenon across the world. Due to drastic changes in the climate the occurrences of these calamities also have increased in these years.

There are many monitoring systems available but none of the system gives clarity about what is the actual situation of the flooded area. These kinds of scenarios make difficult for the government and army rescue team to plan and proceed to review the affected area. For such cases, we need a technique which gives us the live view of the affected area without even going or visiting the actual area. This makes the task of the rescue team easier, to plan and to take required raw materials for the people around the flooded area. In this paper, we have proposed a method which streams the live scenario of the affected area using a Raspberry Pi NOIR Camera that is mounted on a quadcopter. A USB Dongle is required as the Raspberry-Pi needs Internet connectivity to steam the data to a remote location.

II. LITERATURE REVIEW

Even though many existing research works exits. most it requires lots of capital/investment and a clear idea about the subject like machine learning and IOT algorithms whereas the proposed methodology tries to achieve the same without much capital and knowledge about these technologies

In the methodology proposed by the author in [6], there are no of fixed cameras in the flood prone areas to monitor the flooding. it is noticeable that multiple cameras are required for the surveillance for the affected areas which requires a lot of investment and capital though the camera is trained for recognising objects into different groups based on predefined k-means algorithm where the machine learns to solve the clustering problem.

The second paper the research work proposed in[7] gives a real understanding of how an IOT application works although Real issue is addressed i.e. women faces these situations in the most unexpected places where there's hardly any scope for help however a similar solution could be implementing the GPS through an android application that will transmit live location.

There are many Smart solution implemented for women safety like a device are known as "watch me". This has been introduced that has a biometric sensor to detect the heart rate of a person. During emergencies this sensor will generate an alarm to grab the attention of nearby people. The device also automatically makes a call to registered contacts and also supports GPS tracking to track the victim's location. Similarly, suraksha, hear me, abhaya app are some implementation of the same idea. The paper proposed by [8] intends a system where we need a deep understanding about hydraulic engineering. The concept emphasis on remote monitoring, which is similar to the proposed methodology, where digital image processing used as a core technology using a photo electric sensor

III. BACKGROUND

A quad copter seems like a difficult piece of machinery and it may look like an intimidating prospect to modify or fix such thing at home. But in reality, if you have an understanding of the parts, it becomes much easier and quicker. Quadcopter components are designed to build together pretty easily, and if directions are followed, you can actually build a DIY quad-copter at home! So, let's get into it…. What makes a quad copter?

- **Chassis/Frame**
- **Motor**
- **Propellers**
- **Flight Controller**
- **ESC (Electronic Speed Controller)**
- **Radio Transmitter & Radio Receiver**
- **Battery & Battery Charger**
- **Jumper Wires**

Fig.1. Hardware Module

A. *QUADCOPTER*

A quadcopter is also known as quadrotor or multirotor that generates an upward lift using 4 motors. As the name suggests quad means 4, which implies it works on 4 motors. similarly, there are Bicopter (only 2 motors), Tricopter (Three motors), Quadcopter (4 motors), V-Tail (3motors), A-Tail (3 motors)), Penta copter (5 motors). Hex copter (6 motors), Octocopter (8 motors)

Fig. 2 Quadcopter

The backbone of a quadcopter is the frame (chassis), some motors and propellers attached to the chassis. Chassis come in a different sizes and weight. The appearance of the frame is mostly a vague X shape. For hobbyist's desire to mount something with excess weight such as a camera, a frame is recommended. There's always a delicate balance played by the manufacturers between flight speed, manoeuvrability, and flight.

Fig 3: Chassis

B. *MOTOR*

The Hardware module which is a second most important component is a Motor. Motors are measured in kilovolts units, which is equal to the number of cycles per minute a motor can establish when a 1v current is introduced. More the kilovolts, the faster the motor can spin. However, more speed is not recommended.

Fig 4: Motor

The next component required is an propeller which are used to generate upward lift which also keeps the quad in flying However, to keep the quadcopter flying at a hover, the upward thrust needs to equal the weight of your quadcopter.

Fig 5: Propellers

C. *FLIGHT CONTROLLER (KK2.1.5)*

A Flight Controller (FC) is a small circuit board which differs in difficulty. There are multiple flight controllers in the market like KK2.1.5, Pixhawk PX4 2.4.6, Open Pilot etc. In this we are using a KK2.1.5

FC. The job of the FC is to direct the RPM of each motors in response to input.

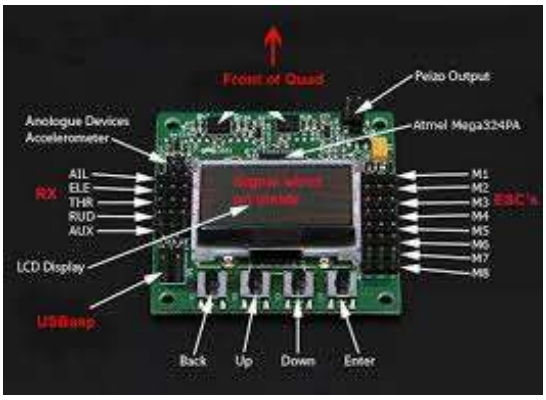

Fig 6: KK2.1.5 Flight Controller

D. *ELECTRONIC SPEED CONTROLLER (ESC)*

The term ESC stands for an "Electronic Speed Controller ESC is an electronic instrument that is responsible for changing the speed of the motors. These are frequently used on RC i.e. radio-controlled models which are electrically powered through battery. The ESC is the bridge between the flight controller and the motor. Given that each brushless motor requires a ESC, the quadcopter will require 4 ESC. The ESC signals the flight controller and takes power from the battery and makes the brushless motor spin.[2][3]

Fig 7: Electronic Speed Controllers

E. *TRANSMITTER AND RECEIVER*

One of the important parts required to fly a quadcopter is a Transmitter (Tx) and Receiver (Rx). An FPV Drone Radio Transmitter is a device that uses radio signals to transmit data through air with a set frequency over a receiver. The Tx is controlled by the drone pilot and Rx is connected to the drone.

Fig 8: Transmitter and receiver

F. *LITHIUM POLYMER BATTERY*

The power source in a Quadcopter is a LiPo battery known as "Lithium Polymer" battery. They have high energy capacity, high discharge rate and also, they ae very light weight. The LIPO battery average voltage with respect to quadcopter is from the range 40kv to 10000kv are connected in series to form a single battery. LiPo battery is designed to work within a safe voltage range, from **3V to 4.2V**. Discharging under 3V may cause performance lost and even damage to the battery. Over-charging above 4.2V is dangerous which may even lead to fire or burst. LiPo batteries for quadcopters in recent days come with a C rating. C Rating is an indicator of the continuous discharge rate of a LiPo battery.

Fig 9: Lithium Polymer Battery

G. *RASPBERRY-PI*

The Raspberry Pi 3 Model B is a very small PAN card size personal computer. To work has a computer you just need to add a component like keyboard, mouse, micro SD card etc. It supports operating system like Linux Ubuntu windows 10 core for IOT etc.

The Raspberry-Pi 3 is much faster than Raspberry-Pi 2 and 1. The Pi 3 supports Built-in Wi-Fi and Bluetooth that are very handy in these situations.

Fig 10: Raspberry Pi

H. *RASPBERRY PI NOIR CAMERA V2*

It is the official "Night vision" camera board released by the Raspberry Pi foundation. It is a high quality 8-megapixel Sony IMX219 image sensor custom designed add-on board for Raspberry Pi. The NOIR camera has no infrared filter on the lens which makes it perfect for Capturing low light photography.

Fig 11: Raspberry –Pi NOIR Camera

I. *DONGLE*

A dongle is a tiny piece of computer hardware that connects to a port on another device to provide it with additional functionality, or enable a pass-through to such a device that adds functionality. [4]

Fig12: Dongle

IV. METHODOLOGY

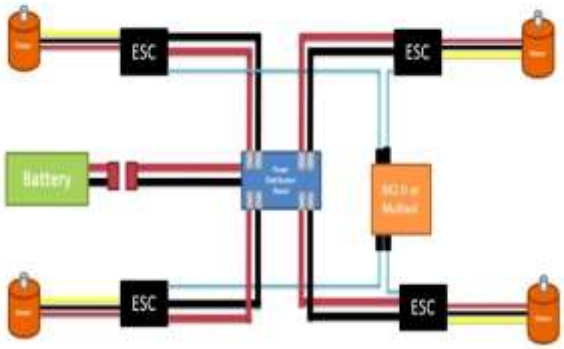

Fig 13: Block diagram of Quadcopter

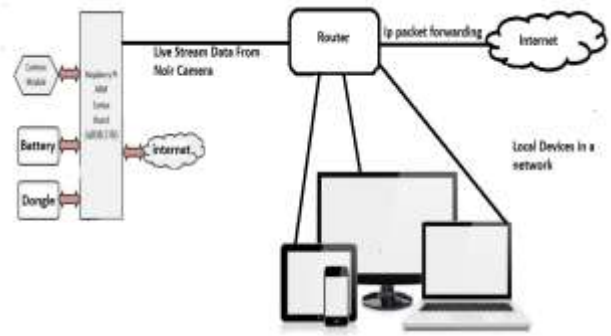

Fig 14: Block Diagram of Raspberry-Pi connected to Camera

Part-1: Stream to pi

Here, in this procedure we are going to demonstrate how to stream videos directly from Raspberry-Pi to any pc or host anywhere around the world. We are going to use a tool names Motion here where it is a camera signal monitoring software which has motion detection features. Before that we want to make sure our Raspberry-Pi is up to date.

The below steps are done for streaming in our local network:

Step 1: Run this command in the Linux terminal.

- **Sudo apt-get update**
- **Sudo apt-get upgrade**

Step 2: Now we install motion software.

- Sudo apt-get install motion

Step 3: Activate the Camera and reboot it.

- **sudo nano /etc/default/motion**

Step 4: Now, search for start_motion_daemon and activate it

- **# start_motion_daemon=yes**

Step 5: View the camera stream on your Pi.

- **http://localhost:8081**

Next step to stream to all devices in our network is given below:

Firstly, Configure the WI-FI connection on Terminal

Step 1: Open the network configuration file

- **#sudo nano /etc/network/interfaces**

Step 2: Place your own Wi-Fi SSID and password

```
auto lo
iface lo inet loopback
iface eth0 inet dhcp
allow-hotplug wlan0
auto wlan0
iface wlan0 inet dhcp
wpa-ssid "Your Network SSID"
wpa-psk "Your Password"
```

Step 3: Reboot the network interface

- sudo service networking reload

Step 4: Camera server test from your phone/laptops

- **http://<Our ip address >:8081**

Till now we did stream within the network, but now we must stream it to the devices outside our network. For this we use dynamic DNS service to access Raspberry-Pi camera from anywhere**.**

Step 1: Choose a name for our network to redirect http request to an IP-address on a no IP-Server.

- http://mochi.ddns.net

Step 2: Install no IP script in Raspberry-Pi which keeps the IP-address stored always updated.

Fig 15: Create a Hostname keeping the default options

1] Create the directory, step into, and download the script
mkdir/home/pi/noip
cd/home/pi/noip
***wget:http://www.no-ip.com/client/linux/noip-duc-linux.tar.gz*tar**
vzxf noip-duc-linux.tar.gz
This should have created another directory with a folder name by the last version of no-IP script.

2] Install no-IP script!
cd noip-<the_version_you_have_downloaded>
sudo make install

3] Now, we login to our no-IP account and it will ask ho often the updates to be triggered here. We speci approximately 15 mins and launch the service.

- **sudo /usr/local/bin/noip2**

4] To confirm the service is running properly.

- **sudo noip2 -S**

5] The last step involves automating the service launch. Open t boot file

- sudo nano /etc/rc.local

Add this line at the bottom of the file (just exit 0)

- **/usr/local/bin/noip2**

A. *CONFIGURING YOUR ROUTER*

After the streaming setup is done, we have a domain name that always redirects requests to our home network. However, your router doesn't know how to deal with the incoming requests. To solve that issue, we use port forwarding. Port forwarding is a technique through which a device transmits all incoming communication/traffic of a specific port to the same port of another network node. Port forwarding is also known as port mapping or tunnelling.

Connect to your router administration panel

On a browser, type your router IP address/gateway in the URL bar. Typically, it's 192.168.1.1 or 192.168.1.254. If not, it should be somewhere in your router manual. Login: By default, credentials are often admin & admin or 0000.

B. *FORWARDING TO YOUR PI*

After finding the port forwarding, you'll need to add a new rule. Here's an example with the parameters and their meaning.

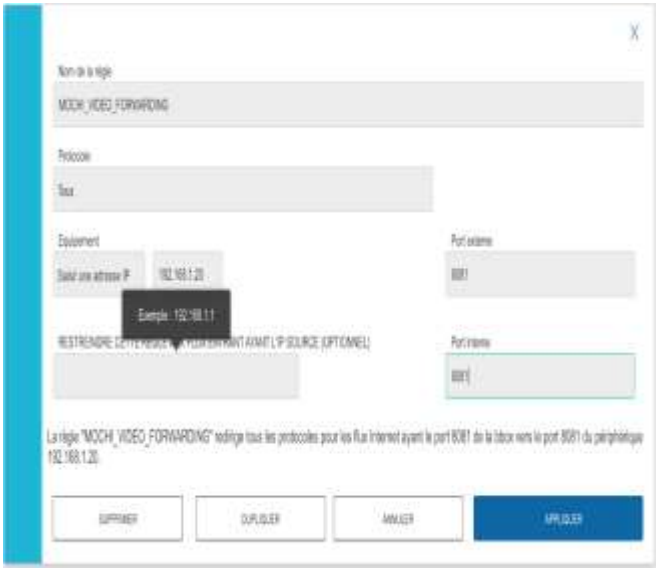

Fig 16: Router Port forwarding configuration

Internal Port: The port on the Pi where requests should be redirected to. In our case, the video stream server is at 8081 if you followed the first tutorial. [5]

External Port: We don't want every requests redirect to our PI. Only those that are targeting the camera server. Since we are going to use a browser, or an app to access our Pi, we can request our home network with any port we want. (for example we will use http://mochi.ddns.net:XXXX). To make it simple, I used the same as the video stream server: 8081[5].

Fig 17: Port forwarding Configuration with additional rule for web server (port 80)

Protocol: Set this to ALL.

IP Address / Device: The IP of the Pi in your home network. That's where we are going to redirect the incoming requests so they can reach our Pi. To find it, type the following command (on your Pi):

- **ifconfig**

By typing this command, we find out the ip address (inet address) of out raspberry pi.[5]

- **wlan0 Link: Gives the Ethernet Hardware address that looks like (80:1f:02: aa: 12:58)**

inet addr: 192.168.0.10 //ip address of pi

After this the Raspberry-Pi and the router are all set, we can use these to see the live view or scenario of the affected area due to flood which makes it easier for the government and the army rescue team to take action.

Part 2: analysis on images

Now since our part 1 is complete its now time for us to do analysis of the data on the pi.

We are going to use a tool MATLAB for processing the data.

MATLAB

MATLAB is a language for technical and mathematical computing. It integrates computation, visualization, and programming in an easy environment where problems and solutions are expressed in mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modelling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development with GUI

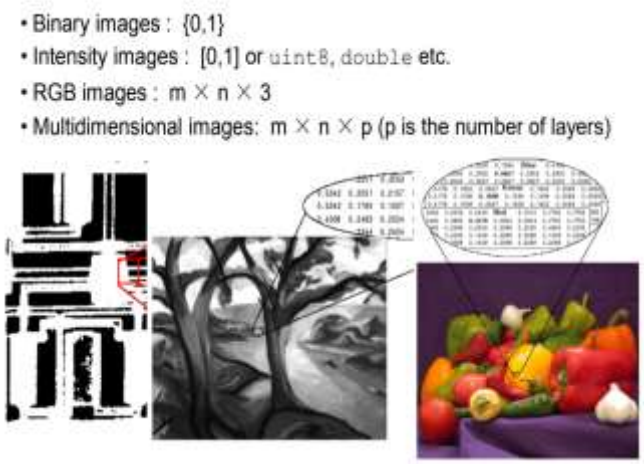

Fig 18: Images in MATLAB

Fig 19: Initial Configuration of raspberry pi

MATLAB is a system whose basic data element is an array that does not require any dimension. This allows you to solve many technical computing problems, especially those with matrix, vector etc.

The name MATLAB stands for matrix laboratory

Image Processing means processing digital image by means of a computer. We can also say it's a process of getting enhanced image either to extract some useful information using computer algorithms,

Image processing mainly include the following steps:

1. Importing the image via image acquisition tools;
2. Analysing and manipulating the image;

3. Output in which result can be altered image or a report which is based on analysing that image.

Image as a Matrix

Since images are represented in rows and columns, we have the following syntax in which images are represented:

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & f(0,2) & \dots & f(0,N-1) \\ f(1,0) & f(1,1) & f(1,2) & \dots & f(1,N-1) \\ . & . & . & & . \\ . & . & . & & . \\ . & . & . & & . \\ f(M-1,0) & f(M-1,1) & f(M-1,2) & \dots & f(M-1,N-1) \end{bmatrix}$$

DIGITAL IMAGE REPRESENTATION IN MATLAB:

$$f = \begin{bmatrix} f(1,1) & f(1,2) & \cdots & f(1,N) \\ f(2,1) & f(2,2) & \cdots & f(2,N) \\ \vdots & \vdots & & \vdots \\ f(M,1) & f(M,2) & \cdots & f(M,N) \end{bmatrix}$$

In MATLAB the start index or the initial index is from 1 instead of 0. Therefore, f(1,1) = f(0,0). Flood-Fill Operations imfill is a function in MATLAB that performs a *flood-fill* operation on binary and grayscale images. This operation can be useful in removing irrelevant artefacts from images.

For binary images, imfill changes background pixels (0s) to foreground pixels (1s),

For grayscale images, imfill changes the intensity of darker areas surrounded by lighter areas.

Fill in the background of a binary image from a specified starting location:

```
BW1 = [1 0 0 0 0 0 0 0
       1 1 1 1 1 0 0 0
       1 0 0 0 1 0 1 0
       1 0 0 0 1 1 1 0
       1 1 1 1 0 1 1 1
       1 0 0 1 1 0 1 0
       1 0 0 0 1 0 1 0
       1 0 0 0 1 1 1 0]
```

BW2 = imfill (BW1, [3 3],8)

BW2 = 8x8 logical array

```
1 0 0 0 0 0 0 0
1 1 1 1 1 0 0 0
1 1 1 1 1 0 1 0
1 1 1 1 1 1 1 0
1 1 1 1 1 1 1 1
1 0 0 1 1 1 1 0
1 0 0 0 1 1 1 0
1 0 0 0 1 1 1 0
```

Algorithm imfill uses an algorithm based on morphological reconstruction [1].

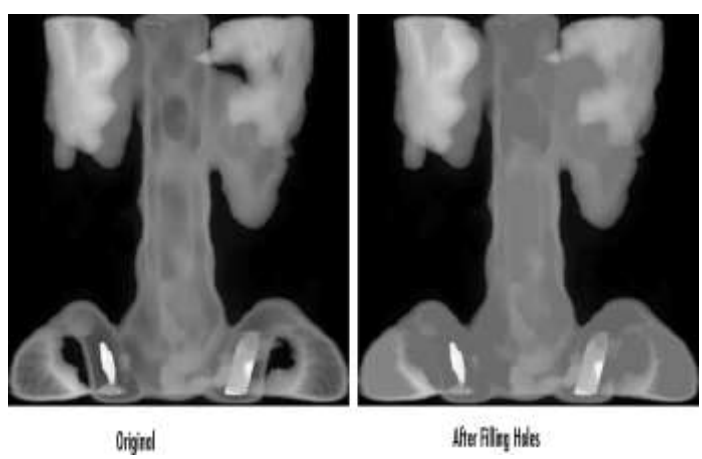

Fig 20: Before and after image of imfill operation in

MATLAB
SYNTAX

```
BW2 = imfill (BW, locations)
BW2 = imfill (BW, locations, conn)
BW2 = imfill (BW,'holes')
BW2 = imfill (BW, conn, 'holes')
I2 = imfill(I)
I2 = imfill (I, conn)
BW2 = imfill (BW)
BW2 = imfill (BW,0, conn)
[BW2, locations out] = imfill (BW)
```

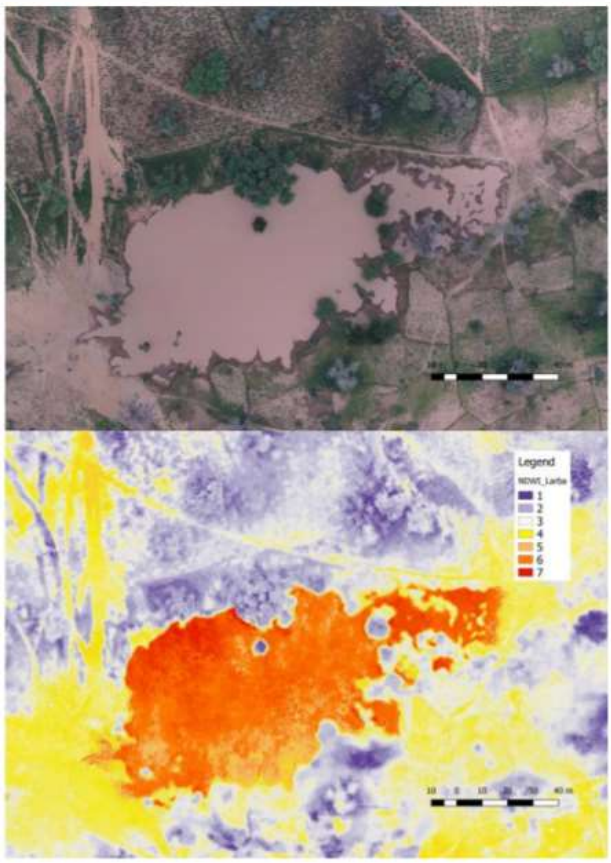

Fig21: Shows the images captures by the quad copter and the analysis done on the image using

V. CONCLUSION AND FUTURE SCOPE

We would like to conclude by saying raspberry-Pi is a very powerful credit card size hardware which is capable of computing and processing large number of operations. Although, we are not utilizing the full potential of the Raspberry- Pi, this enhances the future scope and implementation that can be done using this micro-computer

The only issue we might face is concerned with the weight of the Quadcopter. Lifting the components along with Raspberry-Pi and the battery may cause an imbalance during the flight of the drone.

Since, we already mentioned Raspberry-Pi is a powerful computing machine, we can further increase its efficiency by converting Raspberry-Pi into a custom programmed flight controller. This will save us a lot of money as we need not buy a separate flight controller, Transmitter and Receiver to control the drone. This will also reduce the weight of the drone which will resolve the balancing issue caused before.

REFERENCES

[1] https://grabcad.com/library/quadcopter-drone-12
[2] https://slideplayer.com/slide/13171860/.
[3] https://www.getfpv.com/learn/new-to-fpv/all-about-multirotor-fpv-drone-electronic-speed-controller.
[4] https://en.wikipedia.org/wiki/Dongle.
[5] https://hackernoon.com/how-to-access-your-raspberry-pi-camera-from-anywhere-544ab9e5bacc
[6] Flooded area detection using UAV images A. Sumalan ; D. Popescu ; L. Ichim 2016 24th Telecommunications Forum (TELFOR) Year: 2016 | Conference Paper | Publisher: IEEE.
[7]SMARISA:A Raspberry Pi Based Smart Ring fo r Women S afety Using IoT Navya R Sogi ; Priya Chatterjee ; U Nethra ; V Suma,2018 International Conference on Inventive Research in Computing Applications (ICIRCA)Year: 2018 | Conference Paper | Publisher: IEEE.
[8]Design of flood control and video surveillance s ystem of water resources,Feng Xu | Wentao Wang 2010 6th International Conference on Advanced Information Management and Service (IMS) Year: 2010 | Conference Paper | Publisher: IEEE