

# UAVs for Thermal Imaging and Long E

Shruthi N<sup>1</sup>, Rakesh Yali<sup>2</sup>, Bhuvana P S<sup>3</sup>, Pooja G R<sup>4</sup>, Pavana K<sup>5</sup>

<sup>1,2,3,4</sup> Student, Department of Aeronautical Engineering, SIT, Mangaluru

<sup>5</sup> Assistant professor, Department of Aeronautical Engineering, SIT, Mangaluru

**Abstract-** Unmanned Aerial Vehicle (UAV) technology is classified as being disruptive since it has the potential to radically change the utilization of airspace. Most unmanned vehicles are aimed at military applications, yet civilian applications of unmanned aerial vehicle technology could benefit in many areas.

There is an increased interest on the use of Unmanned Aerial Vehicles (UAVs) with thermal sensing in many areas such as military, disaster, fire protection, wildlife and feral animal monitoring around the world. The thermal sensing describes a novel system which uses a predictive dynamic application that places the UAV ahead of a user, with a low cost thermal camera, a small on board computer that identifies heat signatures of a target animal from a predetermined altitude and transmits that target's GPS coordinates. These UAVs are equipped variety of sensors that can be used for various applications. The signals from sensors are processed by using arduino and raspberry pi module. LTE, which is a wireless communication, has been used in order to provide controlling for wide ranges.

The ability to generate quantitative remote sensing products by means of a UAV equipped with raspberry inexpensive thermal and multispectral imaging sensors. The low cost and operational flexibility, along with the high spatial, spectral, and temporal resolutions provided at high turnaround times, make this platform suitable for a number of applications, including precision farming or military, where time-critical management is required.

These use independent variation of speed of each rotor to achieve control. By changing the speed of each rotor it is possible to specifically generate a desired total thrust; to locate for the centre of thrust both laterally and longitudinally; and to create a desired total torque, or turning force. These are differing from conventional helicopters, which use rotors that are able to vary the pitch of the blades. At small size quadcopters are with guards that enclose the rotors further, due to their ease of construction and control, quadcopter aircraft are frequently used as amateur.

The use of Unmanned Aerial Vehicles (UAV) for tasks that have been done by manned aircraft is becoming more common. Unfortunately, the use of UAVs in civil airspace has been decreased because of the lack of processes to allow their operation. To determine the reasons for this, it is necessary to look into the historical use of UAVs, their progress, developments in military technology, and their applications. The development of the mini-drones, officially called unmanned air vehicles (UAVs) have captured the attention of many researchers and as well as many students. Drones have endless commercial applications, due to their relatively small size and ability to fly without an on-board pilot such as in military, agriculture, photography, surveillance, and numerous public services.

A quadcopter is a type of UAV which consists of four arms on which the rotors are mounted. They are also called as quadrotor helicopter or quadrotor. Usually they consist of two pairs of propellers; two clockwise and two counter clockwise. These use independent variation of the speed of each rotor to achieve control. The speeds of each rotor can be varied in order to obtain the desired total thrust. These vehicles are among the successful heavier than air vertical takeoff and landing vehicles. These quadcopters are cheaper and more durable due to their mechanical simplicity. These are used to test and evaluate new ideas in different fields, including flight control theory, navigation, robotics and so on.

- The use of LTE network providing an unlimited range and low latency video.
- The flight control system communicates with PC assistant through a micro USB cable.
- The use of extend range of communication between the smart phone and the drones in an open unobstructed area.

## I. INTRODUCTION

- Use of thermal cameras which can enhance the visibility with night vision and the use of GPS provide the location of the desired area.
- Maintain kinetic and potential energy levels above a minimum threshold by flying in such a way as to harvest energy from wind.
- Plan informative flight paths that yield high-gain observations to minimize uncertainty in the probabilistic model.

## II THERMAL SENSING UAVs

The process of monitoring wildlife and feral animals is a complex and expensive task which require careful planning and execution. Remote sensors (thermal camera), advanced path planning and image processing algorithms can be placed on unmanned aerial vehicles (UAVs) to provide a low cost approaches to determine critical requirements for spatial and spectral distribution of wildlife. For example use of thermal camera with UAV for detection objects in the ocean surface. Now a days for various applications thermal sensing UAVs are using such as construction, electrical, mining, surveillance, fire fighting, rescue and search operation. Thermal drones or thermal UAVs are those which use vision imaging cameras by detecting heat coming from most of the objects and materials converting them into form of images and videos. Thermal imaging cameras or thermal vision cameras are also called heat detecting sensors.



Thermal vision camera

Thermal vision cameras make pictures and videos from heat that is infrared thermal radiation and both are the parts of electromagnetic spectrum but the thing is the camera which can detect visible light will not see thermal radiation and vice versa. The objects which are at room temperature radiate energy as infrared waves. When we see thermal photographs or videos of a person or an object the energy radiated

will be in the range of wavelengths. This is called emission spectrum. As the temperature increased the wavelength within the spectra of radiation get decreases means hotter the object emits shorter wavelength and high frequency radiation.

Heat is the discharge of electromagnetic waves from every bit of matter in which temperature is greater than absolute temperature that is zero (-273.15°C). This converts thermal energy into electromagnetic energy. All matters tend to radiate energy in the form of electromagnetic waves.

## III. OBJECTIVES

- To provide thermal sensing at low cost.
- To a single camera for video streaming, thermal imaging and night vision.
- To the use of Thermal imaging can be used in military, agriculture, wildlife, disasters and so on.
- To assure LTE advantage over transmitter to provide controlling for longer distances.
- To provides GPS location requirements.

## IV. METHODOLOGY

- To obtain the thermal sensing at low cost there is a use of raspberry pi board in combination with raspberry pi camera. The pi camera is interfaced in order to obtain the thermal, night visions. Software is created in order to run the camera for various applications. Software is accessible with the IP address 192.163.43.101:5000. This software enables to download the videos and images in the form of zip file. Various settings can be obtained in this software. With this camera not only the night and thermal imaging but it can be used as a normal camera for taking images, video recording.
- Controlling of quadcopter is done with the arduino which is programmed with multiwii software. For controlling a web page is designed through which the quadcopter is controlled. The entire esc is connected to the arduino and is configured through the software. The web page is accessed after connecting the arduino to raspberry pi with the use of software known as

putty. Through this we obtain the LTE communication for controlling.

- If a dongle is connected to the raspberry pi a server needs to be created in the chrome through which the signal transmission can take place and also controlling of the quadcopter. This provides us the longer range controlling of the quadcopter.

#### V. ASSEMBLING OF THE COMPONENTS

The UAV needs all the components mentioned above in order to be complete. The type of UAV that is being done is quad X. it is a structure where the four arms will be arranged in the design of X. At first the frame is arranged which consists of a power distribution board and the four arms. They are joined with the help of screws. Next the escs are soldered to the board at the required slots and also a battery connecting wire is soldered. The motors are mounted on the frames and the connection for esc and motors will be given. The connection should be such that consecutive motors should be of opposite spin. These connections for spin can be obtained by interchanging the wires that come from the esc. The esc consists of ground, live and neutral wires which are further connected to arduino board.

The arduino board is used in order to control the motors of the quad copter. The arduino board is programmed using multiwii program. The arduino is programmed such that when the

Program is executed it first controls the esc and these esc further control the motors. The pitching, yawing and rolling motion of the quad is controlled by the arduino. The esc are of 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> arms are connected to the pins 2, 3, 5 and 6 of the arduino respectively. Then the ground is connected to the ground pin. The complete quad copter is powered by a 2200mah battery which is of 20-30C discharge rate that can fly about 15 min. the arduino is further powered by the battery power of 5V and 250mA.

The arduino will be connected to the raspberry pi. This raspberry pi controls the complete assembly of the quad copter. This is powered by the same battery with 5V and 250A of power. The raspberry pi is a small computer which can be used to run any of the programs. The programs for the pi are done using the python software. A raspberry pi camera is fitted on the raspberry in order to obtain the video and imaging from the drone. A GPS is connected to the arduino in

order to obtain the locations. The arduino, raspberry pi, GPS are mounted on the frame using the nuts and bolts and gumtapes.

#### VI. WORKING

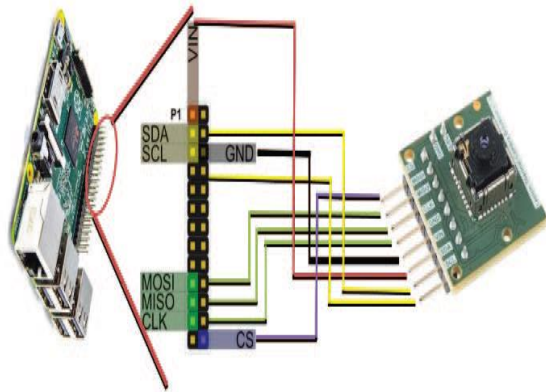
A thermo graphic camera (also called an infrared camera or thermal imaging camera) is a device that forms an image using infrared radiation, similar to a common camera that forms an image using visible light. Instead of the 400–700 nano meter range of the visible light camera, infrared cameras operate in wavelengths as long as 14,000 nm (14  $\mu$ m). Their use is called thermography. Infrared energy is just one part of the electromagnetic spectrum, which encompasses radiation from gamma rays, x-rays, ultra violet, a thin region of visible light, infrared, terahertz waves, microwaves, and radio waves. These are all related and differentiated in the length of their wave. All objects emit a certain amount of black body radiation as a function of their temperatures.

Generally speaking, the higher an object's temperature, the more infrared radiation is emitted as black-body radiation. A special camera can detect this radiation in a way similar an ordinary camera detects visible light. It works even in total darkness because ambient light level does not matter. This makes it useful for rescue operations in smoke-filled buildings and underground.

A major difference with optical cameras is that the focusing lenses cannot be made of glass. Special materials such as Germanium or Sapphire crystals must be used. Germanium lenses are also quite fragile, so often have a hard coating to protect against accidental contact. The higher cost of these special lenses is one reason why thermographic cameras are more costly.

In this project we are using a raspberry pi camera that can be used as a normal light sensing camera and also a thermal camera. An interface for the pi camera is done in order to obtain the thermal sensing. This camera is of pixels 5MP. A higher MP camera can be used to get better quality images. This pi camera is mounted on the slot that is provided on the raspberry pi. A filter is provided to this camera through programming in order to obtain the thermal imaging. This thermal imaging may be used for greater application. But the camera used in this project is of

lesser pixels so the application can be limited. Use of higher pixels may provide better clarity and as well as better thermal imaging. The connection of the camera to the raspberry is as shown in the below figure.



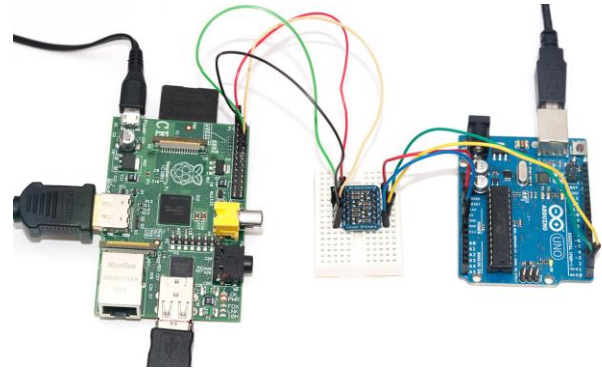
#### Raspberry pi with camera connection

Advanced optics and sophisticated software interfaces continue to enhance the versatility of IR cameras.

- Night vision
- Building inspection
- Energy auditing of building insulation etc..

The algorithm is designed to automatically detect objects and is written using Python and a pixel based object detection algorithm. This algorithm makes use of the thermal camera and OpenCV, an open source computer vision library wrapped for Python. During the first step the system uses the prediction algorithm. The system scans the area using thermal camera takes one image every second. Then the image is loaded into a program with colour intensities representing each pixel. The image is then displayed in greyscale in the two dimensional matrix. The image is stamped with GPS coordinates in order to know the location of each image and blob detection is applied. If there is detection of some objects the image the code will go back. The code will find the correct pixel coordinates of the detection in the image and send them to the GCS.

The GPS is connected to the arduino in order to find the location of the UAV. Further this arduino is connected to the raspberry pi. The pi commands the arduino for the operation.



Raspberry pi with arduino

## VII. RESULTS AND DISCUSSION

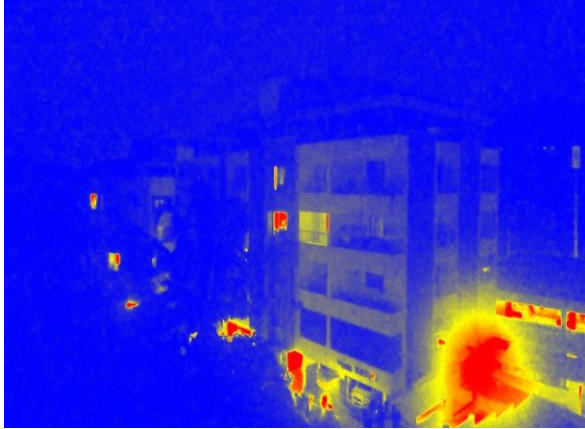
The results obtained by the raspberry pi imaging is as shown in the below diagrams.



Normal image obtained from pi



Night vision mode



Thermal sensing

The images from the raspberry pi are obtained through the web server. As represented in the above figures it not only gives the thermal and night vision but also can be used to get normal images and videos. The endurance level of that is used in this project is of 2200mAh, 3S battery with a discharge rate of 20-30C. This can power the quadcopter with four motors of 2200kv for about 13-15 minutes. With the use of higher mAh with the same discharge rate with even more number of cells can give longer flight.

### VIII. CONCLUSION

Thermal sensing for UAVs are becoming the most used ones for various applications in military, surveillance etc. these UAVs are controlled by a transmitter and a receiver which allows it move only for limited distances. The thermal cameras used in these are also costlier. In this project we used a raspberry pi cam instead of a thermal camera. This pi camera is interfaces that is a filter is introduces in between the processing of the image so that obtained image becomes a thermal one. These images are taken by the use of programs that are fed into the computer and as well as the raspberry pi. Not only the imaging can be done but also the video streaming can also be done and recorded. There is also the use of arduino for controlling the motors. The gps allows knowing the location.

This project suggests a model where thermal sensing can be done with lesser expenditure. The controlling via LTE gives a wide range of application such as in military operations, disaster managements, etc. In this project we have an approach of a method where these

UAVs are controlled by an wireless LTE communication and also use a gsm module which allows it to move it to far distances. There is also the use of lithium batteries which are lighter and have high energy density which gives better endurance for the UAV.

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