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Object identification and surveillance based ondeep learning algorithms for quadcopters

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Abstract. Drone technology is evolving for the applications like surveillance, observation, rescue and control crimes, military, agriculture, civil and many more purposes. But these surveillance systems are monitored by human interaction so there may be some negligence and malfunction may happen due to lack of observation. The objective of the work was development of unmanned aerial vehicle and implementation of the deep learning, image processing tools in the quad-copter based surveillance system. Development of the quad-copter was done by using necessary components such as Arms and power distribution board with help of fasteners. And the brushless dc motors are fitted with electronic speed controllers. And the suitable propellers are fitted to the motors, from which thrust is obtained. The Arduino Uno microcontroller is used as flight controller with MPU6050. Sensor fusion concept coding was used for accelerometer and gyroscope for stable direction orientations of Aerial vehicle. Multiwii platform was used to build the flight controller for achieving desire rotation of motors as well as proper directions and speed. The receiver was installed in the quad-copter for wireless control with transmitter of 2.4 GHz range. And IP camera was used, from which the surveillance visuals are taken for monitoring. Battery of 2200mah capacity of 3 cells was used for power supply of whole system. The visuals were obtained in raspberry pi, the live video stream/images are processed with the deep learning tools i.e., Open CV, Tensor flow, yolo for effective surveillance.

Keywords: Image Processing, UAV surveillance, Convolution neural networks, Drone design anddevelopment.

1 Introduction

The UAV (unmanned aerial vehicle) is an aircraft which can fly without a human pilot within it. UAVs are a part of an automated airplane framework. This incorporates a transceiver base station on the ground. Unmanned aerial vehicles has number of types, quad-copter is one of them which is used largely in photography, surveillance and rescue operations etc. The principal use is surveillance, which is basic for security tasks. An increase of security officers was not an optimal solution to address the problem as general civilians would feel restricted for their usual activities, leading to a drone-based surveillance system that does not indulge in the day-to-day activities of the general civilians.

State of the art drone has an appreciable influence on daily life of human beings reducing their challenges in various arena. Some of the areas of application are surveillance systems, military applications, aerial photography and agricultural sectors. The basic core

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technologies like ML, open CV, AI & Control systems are integrated for the required unmanned aerial application in hazardous and inaccessible areas.
Many researchers are trying to improve the productivity of Automations and a large number of them had made it further developed. Though the advanced automation systems have evolved but due to few constraints some real time applications demand the old manual systems. Automation innovation was utilized to screen and distinguish crimes in combat zone, wild, inborn zones and deserts.

2 Literature Survey

2.1 Review on Unmanned Aerial Vehicles

The research on unmanned airborne vehicle equipped with present day technologies for civil security applications. With miniaturization and growing capabilities of the mems devices have resulted in real time autopilot UAV systems [1]. The demand for UAV has seen a steep growth in the year 2018 in military applications in navy, air force and army and also expected to rise in the coming decade [2]. New age air traffic includes UAV's which collect the air traffic information and distribute to the controllers for efficient tracking and monitoring of the airborne machines [3,5].
UAVs normally referred as "drones" may be fully or in part autonomous however sometimes controlled remotely by the human pilot [6, 7]. Mainstream improvement started out in US military, based totally on the aircraft precept, later including helicopter-primarily based movement to growth versatility [8].
The primary and basic requirements/functions of the military applications include targeting the enemy base and bombing them or spraying of the fluids with UAV's [9]. Vulnerabilities such as hacking and spoofing of data packets sent and received by the drone is a critical issue which can be addressed with suitable firewall mechanisms inside the kernel of its operating system [10].

2.2 Unmanned Aerial Vehicle's Applications

The (UAVs) Unmanned aerial vehicles commonly called as drones, the UAV domain is known as most robust and multi-dimensional evolving technologies in present technology research fields, because they are using in the air traffic management systems, surveillance, agriculture, photography, inspection along with data collection and management [11, 13].
And coming to societal applications there are many advantages but within that many issues with privacy things so many people have published papers on primary social, legal and ethical dilemmas, in the case of automatically controlled by pilot or autonomously sensing devices [14, 15].

2.3 Review of Image processing applications

Open CV is one of the booming technologies in image processing nowadays, initially open cv was introduced by Intel with inbuilt libraries for video and image analysis. There are three approaches in open cv the first one is using specification of histogram in an image with respect to python language, second one was live edge detection of a video, which can be possible using webcam also. And third one is live face recognition [16].
Authentication & Identification has become main problem in nowadays digital world. Face recognition performs a sizable position in authentication & identification. In this paper, numerous existing face detection and recognition methods are analysed and discussed. Each

approached was discussed briefly & in comparison with the opposite in phrases of key assessment parameters [17].
Detecting and spotting objects in unstructured as well as in structured environments is tough job obligations from OpenCV and AI perspective. This paper introduced a new computer vision based totally obstacle detection technique for cell technology and its programs [18]. Each character photograph pixel is assessed as belonging either to an obstacle based on its appearance. The method uses a webcam that performs in real-time, and affords a binary obstacle photograph at excessive decision. The system has been tested successfully in a spread of environments, indoors as well as outdoors [19].

3 Methodology

 # Task 1 : Study the characteristics of the Components and Procurement of Required Components

Study the characteristics and specifications of different components used for development of Quad-copter, selection of frame, motors, batteries and controller as for the system requirements, which are efficient and availability of components in low-cost for the development of surveillance system.

#Task 2 : Assembly and subassembly of the components to build the Quad-copter

Assembly of the frame will be done by four arms and fasteners then brushless dc motors will be installed over the frame, suitable controller will be built and installed in the system with electronic speed controllers, and as per the requirements the power source will be provided.

 # Task 3 : Development of the Surveillance part

The framework comprises of the IP (Internet Protocol) Camera, which has fitted to bottom of the quad-copter so the camera is a device to get the visuals from the top view using the drone so this camera sends the visuals to another system using IP address and then the further process is done using the software tools like Open CV, Tensor flow, Yolo etc.

 # Task 4 : Using the proper codes and algorithms for accomplishing required rotations of motors for getting desired orientations of quad-copter and speed

The accelerometer is a device facilitates in analysis and motion and to be vigorous within accelerating conditions. Utilization of hardware systems associated with gyro-accelerometer and interplay with the Arduino yield sensor that keeps up quad-copter direction. Gyroscope allows balancing and maintaining of the quad-copter in steady mode with x, y, z, values. Using the standards of these sensors improvement of the algorithms can be performed.

 # Task 5 : Implementation of Image processing tools and algorithms and testing

The visuals are transferred to the Monitoring system through the Internet protocol facility of camera. Then the Open CV and Tensor flow, Yolo algorithms and codes are used for the captured visuals for feature extraction and activity detection for better surveillance.

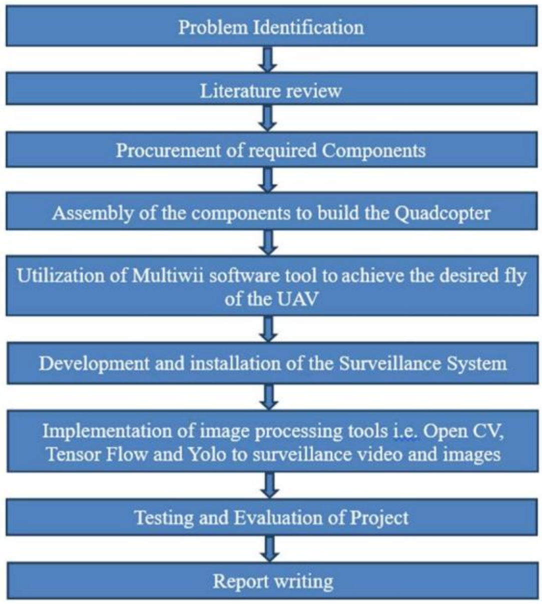

Fig. 1. Flow of the research work.

- **CNN**

The CNN (Convolution neural network) is a type of deep neural network, widely used in the applications related to the images. The networks of convolution model are inspired by the animal visual cortex which resembles connectivity pattern between neurons of animal neural network. Proposed architecture has input layer followed by a convolution layer with activation function as ReLU layer then comes pooling layer and at the end fully connected layer where architecture will give the output of visuals as shown in the Figure as well as flow chart.

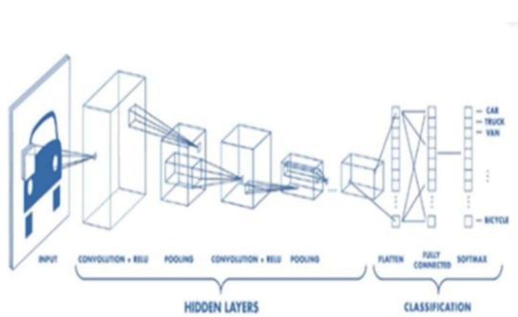

Fig. 2. CNN Architecture.

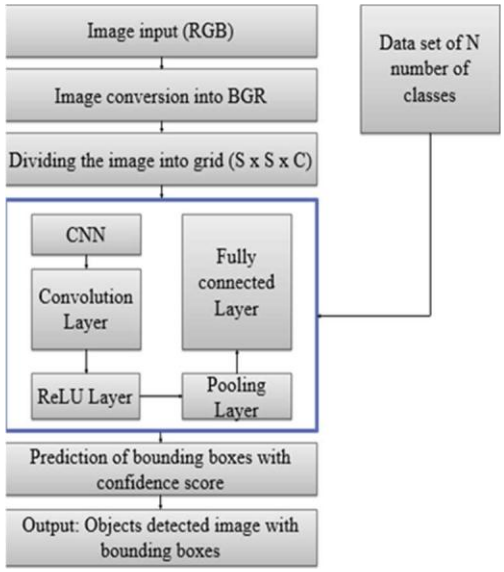

Fig. 3. CNN Flowchart.

4 Design approach

4.1 Quad-copter Architecture

The below block diagram of the quad-copter design as shown in Fig 4. Power source is connected by means of power supply system to the components of quadcopter i.e., flight controller, sensors, motor drivers (ESCs). Each motor of the quadcopter is driven by the ESCs. And the other components of the system are camera and wireless trans-receiver. The Global Positioning System which fetches the location coordinates from worldwide orbiting satellites, which is connected to Arduino flight controller for positioning. And the telemetry data is sent back to system using RF communication along with video stream.

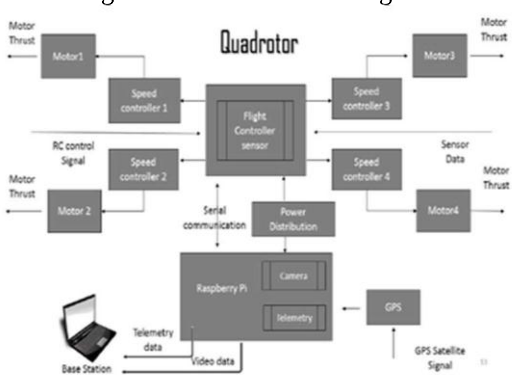

Fig. 4. Quadcopter Architecture.

4.1.1 Wireless Transmission System

The transmission system consists of Wireless receiver module in quad-copter which is programmed with Arduino. The wireless transmitter module which was controlled by operator so as to provide the commands to the flight controller through the receiver. There are many remote transmissions, which are of RF range at 900 MHz, which was allotted by ISM Band for open-source programming.

4.2 Calculations for selection of components

4.2.1 Maximum amperes rating

Electronic Speed Controllers were used to run the brushless DC motors that are used in most of the quad-copters. The maximum ampere of an ESC should be more than the motor/propeller draws. As far as ESC, recommending 25 to 45% additional Amperes can withstand by ESC.

The basic equation is,

Ampere Rating of ESCs = 1.5 x 15.6 (Motor's max ampere rating) = 23.4

According to calculations, ESC between ranges of 20A to 30A are selected.

4.2.2 Thrust calculations

Generally, the required thrust is calculated using below mentioned equation.

Thrust required = (weight of whole system) / 4.

As per the component's specifications ESCs, Motors will weigh about 1350 grams and frame weigh about 975 grams and other things like battery, RC receiver, flight controller generally weigh about 375 grams.

$$\text{Thrust required} = 1350\times2/4 = 2700/4 = 675 \text{ grams}$$

The required thrust from each motor is 675 grams, so the actual amount of thrust produced by each motor is known by the calculations done below mentioned formula. As per few sources thrust calculation equation is given below.

$$Thrust = [(eta \times P)\ 2 \times 2 \times \pi \times r2 \times air\ density]\ \wedge 1/3 \quad (1)$$

Where,

Eta = propeller hover efficiency let assume it as in range of 70 to 80 %.

P = power of shaft = current*voltage*motor efficiency

R = Propeller's radius in meters

Density of Air = 1.22 kg/m³

Required voltage = 11.1 v

Required current (amp) = 15.6 A

Efficiency of Motor is assumed 75% = 0.75

Eta = 0.8

Then, the thrust

$$\text{Thrust} = [(8/10\times10\times15.6\times0.75)^2\times2\times3.14\times(0.127)^2\times1.22]\ \wedge0.33$$
$$= [(93.6)^2\times0.1235]\ \wedge0.33$$
$$= (8760.96\times0.123)\ \wedge0.33$$
$$= 871.92\wedge0.33$$
$$= 10.016 \text{ N}$$

Therefore, Thrust calculated

$$\text{Thrust} = 10.016 \text{ N}$$

$$= 10.016 \times 0.101 \text{ kg}$$
$$= 1.0116 \text{ kg}$$
$$= 1011.65 \text{ grams}$$

Consequently, the thrust produced from one motor is 1011.65 grams.
Quad-copter has 4 motors, the all-out thrust produced, total thrust produced by four motors shown in the below calculation.

$$\text{Overall thrust} = 1011.65 \times 4$$
$$= 4046.61 \text{ grams}$$
$$\text{Thrust} = 4.0466 \text{ kg.}$$

On the off chance that if the efficiency of motor is less, at that point by taking some factor of safety is must, if the motor is of 70% proficient in the above, then 70% proficient work framework can create thrust of motors.

$$\text{Thrust} = 4.0466 \times 70/100$$
$$\text{Thrust} = 2.83 \text{ kg}$$

As per calculations the thrust required to lift the quadcopter's motors is 2.83 kg.

4.2.3 Specifications of Electrical & Mechanical Components

Below mentioned are accompanying primary electrical and mechanical modules whose determinations are portrayed.
a) Quad-copter frame
b) Brushless DC motors
c) Quad-copter Propellers
d) Li-Po battery

a) Quad-copter Frame
As per the requirements the frame of quadcopter should be flexible enough to nullify the vibrations produced by the motors during the flight. For the selection of the appropriate frame for the quadcopter the main parameters are size, weight, material used to build the frame. And the frame is built according to below mentioned parameters.

- The frame has a central power distribution board at the center to mount the electronic components and to power up the system.
- The board has four ends where four arms can be connected to build quadcopter.
- And the brackets at the end of the arms to fix the BLDC motors.

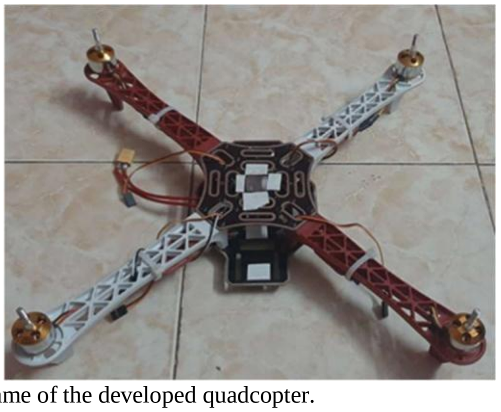

Fig. 5. Glass fibre frame of the developed quadcopter.

b) DC Motors (Brushless)

In the quadcopter, four motors drive the propellers to produce the thrust.
As per the design the motors are of 1000 RPM brushless DC motors with a 3.17 mm shaft breadth and weight of one motor is 55 grams, the maximum current drawn is 17 Amps.

Fig. 6. Brushless DC motor used for propulsion system.

c) Propellers
The propellers are sufficiently enormous to give satisfactory lift to the quad-copter, propellers are compact enough to fit into the selected frame.
The propellers selected for the quadcopter are made up of carbon fiber, suitable for selected frame with vary in size of 4 to 22 inches in length and 2 to 12 degrees of pitch.

Fig. 7. Propeller of the quadcopter.

d) Battery
The battery gives constant voltage, extreme contemporary power for all the other components at the quad-copter.

Fig. 8. Lithium Polymer battery (2200mAh).

i) Battery Selection
The decision was to use the 2300 mAh battery as per the UAV's flight time and other component's power requirements.

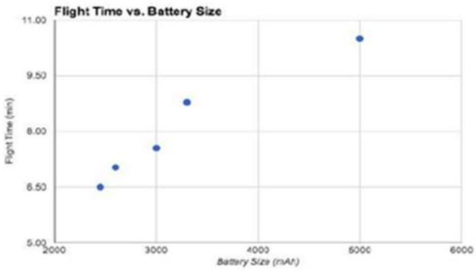

Fig. 9. Graph of variation in flight time w.r.t battery capacity.

Table 1. Battery Capacities with Flight Times.

Battery power (mAh)	Time of flight (min)
2,450	6.5
3,000	7.55
3,300	8.78
5,000	10.5
11,975	30.0

4.3 Sensor Modules

a) MPU 6050 :

The MPU-6050 is a IMU sensor which has Micro Electro Mechanical System (MEMS), which provides the Accelerometer and Gyroscope data on a single chip. The Inertial measurement unit which monitors forces acting on accelerometer and angular changes on Gyroscope and magnetic forces on Magnetometer. These are used in the self-balancing robots, planes, smart phones, UAVs for positioning, motion tracking and to control the flight.

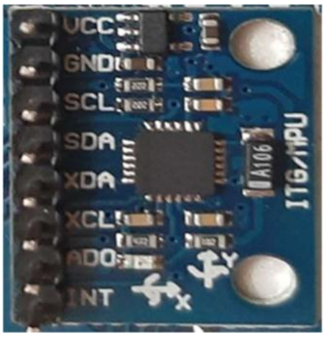

Fig. 10. MPU6050.

b) IP Camera :

Internet protocol camera which is abbreviated as IP camera, which is a sort of digital video camera that captures the visuals by its lens and sends that data by means of internet of things. These are generally used for surveillance and security purpose, similar to Closed circuit television (CCTV) cameras but IP camera doesn't require the local storage system instead these need local area network for data transmission.

4.4 Embedded Systems & Electronics Modules

4.4.1 Flight Controller Using Arduino Uno board

Arduino is an open-source software and hardware platform dedicated for microcontrollers programming. Arduino products have the General public license which permits all to design and development of Arduino boards and software distribution.

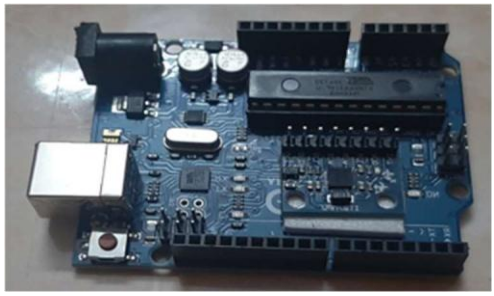

Fig. 11. Arduino Uno – Microcontroller board.

4.4.2 Electronic speed controllers

The electronic speed controller is a circuit which controls the rpm of the BLDC motors as per the instruction of receiver data. These ESCs are commonly used in electrically powered & RC controlled toys and crafts especially for brushes dc motors for generating three phase electric power from voltage source.

Fig. 12. Electronic speed controller of 30A.

4.4.3 Transmitter & Receiver

- Transmitter :

The transmitter is a device which uses radio signals to communicate its commands remotely through predetermined radio frequency to a radio receiver. The receiver will be in the copter and its being controlled remotely through the transmitter, the transmitter interprets the pilot’s commands into the motor’s rotation for desired movements of copter. In some cases, there will an option to use the required frequency of band i.e., 900MHz in a 2.4GHz radio trans-receiver. Quad-copter Radio Transmitter transmits commands by means of channels. Every channel has its own function being sent to the craft. Throttle, Yaw, Roll and Pitch are the main four parameters of the data need to control the drone.

Fig. 13. Radio Transmitter.

- Receiver :

The device which has the capability of receiving the commands or signals sent by Radio Transmitter is called as Radio Receiver. Which communicates with flight controller of the system to control the flight of aircraft.

Fig. 14. Radio receiver and binding cable.

4.4.4 Software tools

a) Arduino IDE

The Integrated development environment of Arduino IDE is an application platform for many operating systems like windows, Linux, Mac etc. which can be programmed in C as well as C++ programming languages. This platform is used to write the code for requirements of application and then to upload that code to the suitable microcontroller boards.

b) Open CV

Open CV (open-source computer vision library) is an AI programming library. On view of achieving the proper structure to computer vision applications and to enhance the use of machine learning in commercial aspects. The open cv has more than 2500 optimized algorithms, which are included with the comprehensive set of classic and state of art computer vision machine learning algorithms.

c) IP Web Cam

IP webcam tool is utilized in this work for the for short range video transmission with or without internet. IP webcam android application is used for video transmission. It gives live video transfer which can be accessed by local or global computers. For local correspondence it utilizes Wi-Fi connection. Cell phone and the on-board PC needs to connect in same Wi-Fi communication. IP Webcam helps to convert mobile device into a web cam for online stream and monitoring. To get the stream just one needs to go to browser and type the IP address that's it will give the live stream of the visuals. The IP address is provided by the application itself, which will be displayed below the stream. But system needs a flash player to watch the stream.

d) Multiwii

Multiwii is a flight control platform that is used by many if the drone developers and which is flexible to all type of UAVs i.e., Drones, planes etc. The flight controller will monitor the acceleration and gyroscope data along with roll, pitch, yaw from the MPU-6050 module. Based on the real time data fetched by motion processing unit the flight controller will controls the motors for desired flight and directions using the PID control system. Drone flight control frameworks are numerous.

4.5 Cost Estimation

The process of cost estimation done before the development, because there may be some wastage of components during or after the development of the system. The segments required for this venture are effectively accessible in the market in various sizes and expenses. Project budget estimation is given in the Table below.

Table 2. Battery Capacities with Flight Times.

Sl.No.	Components	price per unit (in rupees)	Total
1.	Quad-copter frame x 1	850	850
2.	BLDC Motors x 4	350	1,400
3.	ESCs x 4	470	1,880
4.	Propellers x 4	65	260
5.	Arduino Uno x 1	450	450
6.	MPU6050 x 1	150	200
7.	IP Camera x 1	1500	1,499
8.	2300mAh Li-Po Battery x 1	1600	1,320
9.	Transmitter and receiver x 1	3299	3,299
10.	Jumping wires x 30	90	90
11.	XT60 Connector	200	200
	Total cost		**10,128**

5 Development

5.1 Procedure for assembly of components to build the quad-copter

The components can be assembled in any manner however below listed steps are to given to do the particular sequence so that there are no other consequences occur to the process and components.

- Firstly, connect the motors to the arms of the quadcopter and fix those with screws and nuts provided with the system so that they will not get harmed during the flight.
- Later on, ESCs terminals are connected to the power distribution board by soldering the process. After the connections need to decide the front and back orientations of the

quadcopter, this step is crucial for the flight controller installation because based on the orientation it will help to flight in different directions.

• Later on, connect the ESCs to the motors with proper color coding because the connection decides the rotation of the motors in clockwise and anti-clockwise direction, the 4 motors should be numbered i.e., the left front motor is 1st one, right front motor is 2nd one, right rear motor is 3rd one and left rear motor is 4th one.

• The 1st & 3rd motors rotate in clockwise direction; 2nd & 4th motors will rotate anticlockwise clockwise direction. The motors used here are 3 phase brushless DC motors. The three wires in ESCs are connected with three wires of these motors. There is no specific order of connection with color coding so serially connect the three wires of esc to motor wires which will leads to rotation of motors in clockwise this is done for 1st & 3rd motors and for 2nd & 4th motors right end and left end wires are exchanged so that they will rotate in anticlockwise direction.

• In the next step the ESC's positive and negative terminals are soldered to the power distribution board's positive and negative terminals respectively. Then the ESCs are tied to the arms of quadcopter using the zip ties, which will help us in reduction of hanging and vibrations of ESCs during the flight.

• Next step is to fix the flight controller on the power distribution board. And insulation has to be done by a cover case.

• Then the servo connectors of ESCs are connected to the flight controller which has a specific order printed on the flight controller.

• Then place the battery exactly at the center of the drone since its bit heavy and the center of gravity should act at center of the frame.

• Then an external connector is needed to connect the battery and power distribution board called XT60.

• Later on, the receiver is to be attached system, and connect the ESC's pins to respective channels of receiver as well as flight controller pins.

• Affix a landing tripod to the bottom of the quadcopter which will be safety guard to drone while landing after flight.

• Then fix IP camera module below the quadcopter using suitable arrangements. Fix the camera in such a way that it should be easy to install and uninstall the arrangement.

• After all the above steps finally test the components working status, for that first switch on the transmitter and then switch on the drone, the feedback sound from the receiver says that they both are working well.

• Quadcopter need to armed before the flight by the transmitter. Bring down the throttle stick of transmitter to right side, drone will be armed, which means ready to take off.

• After arming is done slowly raise the throttle to check the working of motors.

5.2 Circuit connection of quad-copter

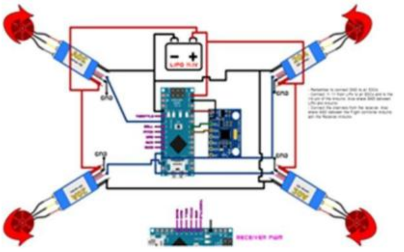

Fig. 15. Circuit diagram of quadcopter.

According to the provided blueprint of system as shown in Fig 15, did the subsequent connections, 1 : ESCs : Connected the 1st ESC’s signal Pin to Arduino Digital pin 10, 2nd ESC’s Signal Pin to Arduino Digital pin 9, 3rd ESC’s Signal Pin to Arduino Digital pin 11 and 4th ESC’s Signal Pin to Arduino Digital pin 3.

2 : MPU-6050 : Connected MPU6050’s SDA & SCL pins to Analog 4 and Analog 5 pins of Arduino respectively.

3 : Receiver : Connected receiver’s Channel 1 to Arduino Digital pin 4, Channel 2 to Arduino Digital pin 5, Channel 3 to Arduino Digital pin 2 and Channel 4 to Arduino digital pin 6.

In the last part grounded the MPU-6050, the receiver, and the ESCs. For this connected the GND pins of components to GND pins of Arduino.

4 : Battery : Connected the 2300 mAh Li-Po Battery to the system using the XT60 cable for power supply to whole system.

5.3 Configuration of Multiwii and Uploading the code to Flight controller

Multiwii is a flight control platform that is used by many if the drone developers and which is flexible to all type of UAVs i.e., Drones, planes etc. The Multiwii is available in the internet freely in zip file (open source), by unzipping it and will get the files, find the .ino format file, open it in Arduino IDE, will get the bunch of libraries within those select the config.h file to do the configuration of the quadcopter settings as shown in the Fig 17 i.e., quad X, quad +, PPM values, min and max throttle setting etc. Then select the quadcopter configuration ‘X’ and then selected the sensor type and buzzers pins and so on. Then no need to change anything in the other libraries.

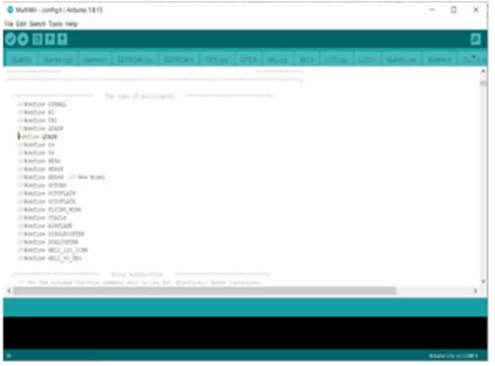

Fig. 16. Configuration of Multicopter type in Arduino IDE.

To activate any configuration, need to delete the double slashes, in which the whole line will become comment. Here the type of building drone is quad X with 4 motors.

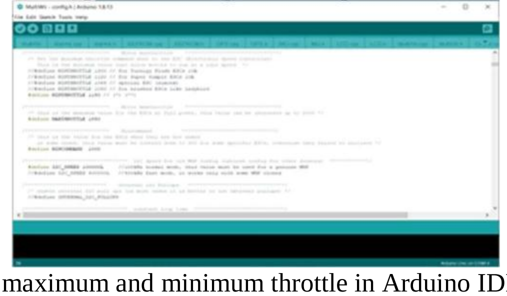

Fig. 17. Setting of maximum and minimum throttle in Arduino IDE.

Whenever the transmitter sends the PWM signals to the ESCs the motors will rotate in required direction with specific rpm according to the need. As and when signal pulse width changes the PWM signal will be modulated according to the signal’s changes. The signal pulse width is measured in terms of milli seconds. Motors used in the quad-copter are having the throttle range of 1000 µs to 2000 µs where 1000 is minimum and 2000 is maximum throttle.

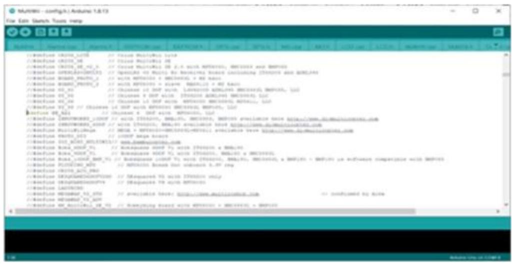

Fig. 18. Selection of IMU board in Arduino IDE.

Remove the slashes to select the MPU6050 sensor as shown in Fig 19. Then build the communication range of PPM in between transmitter & receiver with respect to flight controller. Transmitter and receiver used here is of 6 channels PPM signal which consists of parameters throttle, yaw, pitch, roll. PPM and snap found.

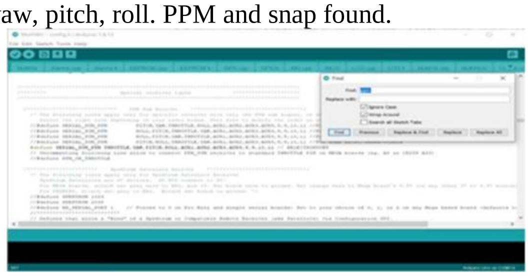

Fig. 19. Setting of PPM signal pins in Arduino IDE.

In the PPM sum receiver, added the below given instructions.
#define SERIAL_SUM_PPM THROTTLE, YAW, PITCH, ROLL, AUX1, AUX2, AUX3, AUX4, 8, 9, 10, 11
After all, above steps were done then the code is ready for uploading, later on uploaded the code by connecting the Arduino flight controller to laptop/system using cable and selected appropriate port and board.

Fig. 20. Uploading the code to flight controller using Arduino IDE.

After uploading the code, the software shows the message 'Done uploading.' keeping it connected and open the file Multiwiiconf.exe, different GUIs are available there chose according to systems using as shown in Fig 21.

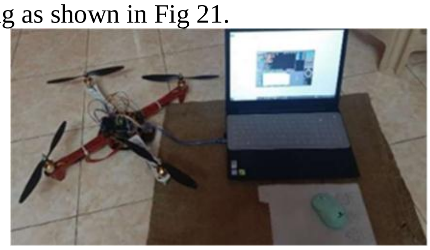

Fig. 21. Testing the working of flight controller using Multiwiiconf GUI.

After opening the Multiwiiconf.exe file the GUI showed some options like selection of port com and blocks with some readings so selected appropriate com port in the GUI and clicked on start button then the GUI showed the readings and Quadcopter orientations graphically as shown in Fig 22.

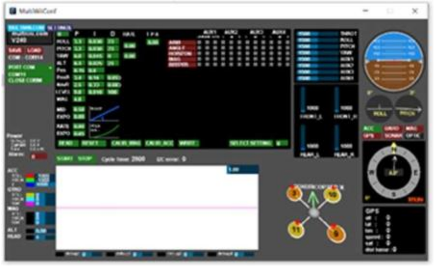

Fig. 22. Representation of quadcopter orientations and readings in Multiwiiconf.

5.4 Binding of transmitter and receiver

Sometimes the receiver won't receive the commands sent by transmitter because of binding problem, so binding of the transmitter and receiver has to be done before connecting to the system. For that, binding connector is connected to the receiver's bat port and one ESC's connector connected to one channel of the receiver where ESC connected with battery as shown in the Fig 23 then red light started blinking in the receiver so then by keep pressing on the binding key, switched on the transmitter then blinking of receiver light stopped, this is sign that the transmitter and receiver are bounded.

Fig. 23. Binding of transmitter and receiver.

5.5 Steps involved in surveillance system

The visuals captured by IP camera are used for feature extraction process where the deep learning techniques helped to get some crucial data from the images. Later on, there are series of operations has to be carried out for data extraction from the images so the if images were passed with primary layer, then they will be sent to next layer otherwise those images would have been rejected from the process so in this way many visuals were rejected and many were good in providing the needed data. The figures shown below explain the steps involved in the system.
Step 1 : Streaming the quadcopter's surveillance video on a computer/laptop using the IP address

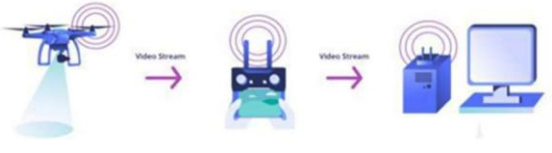

Fig. 24. Flow diagram of surveillance system.

Step 2: Displaying the results by running the object detection models on surveillance visuals

Fig. 25. Flow diagram of image processing system.

- Object Detection:

In this method work has discovered that these representations permitted to examine object location frameworks with different manners & increase new knowledge into the identifier's failures. So here an algorithm has worked to identify objects utilizing shape highlights. The accompanying algorithm dependent on discovering full item (Man and vehicles). Even though there are some variations the algorithm is robust in doing its job.

Fig. 26. Detected Objects in image.

In Fig 26 algorithms tried to distinguish thing dependent on their corresponding structure. The right-side picture showing the identified objects with green bounding box. The left-side image also showing the similar things i.e., Human and tree, stands with bounding box.

6 Results and Discussions

This part of the report explains about the testing and validation of each and every component & software tool used in the project. And all the difficulties faced during the tasks performed portrayed in detail and the safety measures taken to overcome those issues. Along with these many other suggestions are also added in the process to enhance the system efficiency.

6.1 Flight test on field

With the intention of flight, went to free surroundings. The whole system was equipped with power distribution board and a battery to power up. And 2.4 GHz Radio controlled transmitter and receiver for communication between quad-copter and pilot. So, after all the above steps before switching on the quad-copter first switch on the transmitter and then switch on the quadcopter by connecting the battery using XT60 connector, then after switching on both systems, armed the quadcopter. without arming the quadcopter motors won't spin so by keeping left stick (throttle) down and move stick to right side as shown in the Fig 27, after arming the quadcopter the yellow light switches on in the flight controller as shown in Fig 28 this showed that the quadcopter was armed and ready to fly.

Fig. 27. Arming the quadcopter by transmitter.

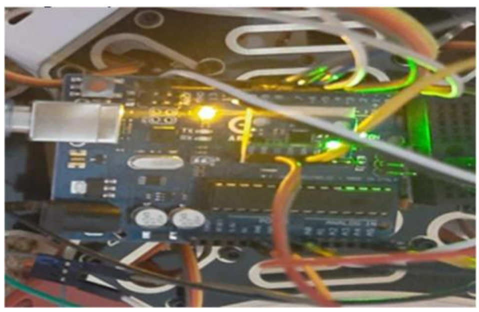

Fig. 28. Armed signal in flight controller.

Fig. 29. Flight test of quadcopter.

After taking off the quadcopter got crashed because to fly the quadcopter one need some practice so since didn’t have much practice, it got crashed by hitting to iron rod nearby as shown in Fig 30 below.

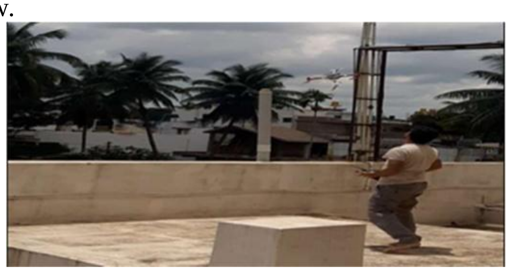

Fig. 30. Quadcopter crash during flight test.

Luckily, none of the electronic components and parts were damaged. So later on tried to fly it by tying the four arms as shown in the Fig 31 below.

Fig. 31. Tied flight test of quadcopter.

Then tried to fly it by tying the arms, so quadcopter started to work properly without any disturbances, when raised the throttle, the quadcopter started to fly within tied area as shown in Fig 32, Then tried to operate quadcopter by giving the roll, pitch and yaw operations.

Fig. 32. Tied Quadcopter flight with maximum throttle.

Then by operating the right stick in the transmitter in forward direction the quadcopter started to move forward by tilting towards frontal down as shown in Fig 33 and when did reverse the quadcopter tilted in opposite direction by operating the right stick in right direction the quadcopter tilted towards right as shown in Fig 34 and also tried for yaw movement because of tying the quadcopter was not able to show yaw movement effectively anyhow it was working.

Fig. 33. Quadcopter front pitch movement.

Fig. 34. Quadcopter Right roll movement.

6.2 Surveillance test

After the flight test and confirmation of quadcopter efficient flight, an IP camera was fixed below the quadcopter using suitable arrangements and tried for surveillance of surroundings using the quadcopter-based surveillance system and captured some pictures as shown in the figures below which were used for image processing for security purpose. Surveillance live capture streaming was planned to get done by 5.4 GHz wireless video trans-receiver but it was costly, to overcome this one, tried with android mobile with good camera as an IP Camera using an application called IP-Webcam. The figures shown below are the surveillance images captured from drone's IP Camera.

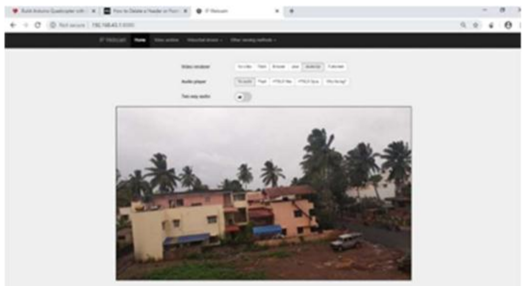

Fig. 35. Surveillance image captured from IP-Webcam live video.

Fig. 36. Captured image in browser from IP-Webcam live video.

6.3 Image processing test

Detection and tracking of moving items in a video stream were the first relevant step of facts extraction in computer vision packages together with people monitoring, video surveillance, site visitors monitoring and semantic annotation of movies The input video records were obtained from unmanned aerial automobile. Both images based and video-based performance measures were considered for analysis.

6.3.1 Implementation of object detection algorithms

The results of proposed of open CV and tensor flow, yolo techniques for object detection for different video and image data collected from the surveillance drone was shown and discussed as a comparison with the normal surveillance methods. The video data consists of a vehicle (car) as target detected in a cluttered environment. The video was a consistently low altitude angular video taken by UAV at Belagavi, India. The video was taken for the purpose of surveillance. The results of the video are shown below after implementation of algorithms of open CV and tensor flow techniques.

Fig. 37. Result image of object detection.

The Fig 37 shows the sample condition of object detection using image processing techniques between two consecutive frames. The red and blue color bounding box tracks the cars in consecutive frames. The UAV was in regular motion tracking the car was not moving. Since there was no reasonable noise due to regular motion pattern of drone, the efficiency of detection techniques was high.

6.4 Outcomes

- The use UAVs reduced the human efforts in monitoring of the intolerable activities in the society, which in turn improves the security and surveillance activities.
- During surveillance, the use of image processing and deep learning techniques minimizes the human efforts and gives efficient surveillance in absence of human interaction.
- Increase in security and quality by the use of process through image processing and deep learning tools.
- Exposure to UAVs design and development methods.
- Exposure to Mechanism of Quad-copter flight system.
- Exposure of programming language of Python and software tools like Arduino IDE, Multiwii and other deep learning tools like Open CV, Tensor flow, Yolo
- Exposure of Electronic components and Mechanical systems used in the UAV systems.
- Introduction to new methods of design and development processes which helps understand the theory better.
- Studying the design and development methods helped for better understanding of the methods and the gap between academic and actual application part.

6.5 Future Scope of This Research Work

The study was concentrated on Surveillance of surrounding for security purposes using UAV and Image processing tools where these two are separate systems in this project. However, the study may be extended in the following areas :

- The study may be extended to build drone flight completely rich with challenges that are ready to be tackled by future researches in this area and this work has taken a step towards the larger goal of fully autonomous drones.
- Using the deep learning tools system can be developed with much efficient for applications like obstacles detection and avoiding systems from attacks of enemies, which can be used in the border surveillance and war fields.
- Daily life activities can be run easily by enhancement of the surveillance application especially in crime scenes.
- The image processing can be optimized with greater efficiency by increasing the wide variety of data sets and reducing the processing time & enhancement of accuracy.

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