FABRICATION OF SURVEILLANCE QUADCOPTER

Project Report submitted in partial fulfillment of the requirements for the award of the degree

BACHELOR OF TECHNOLOGY

in

MECHANICAL ENGINEERING

Submitted by

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Under the Guidance of

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DEPARTMENT OF MECHANICAL ENGINEERING

LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institution

(Approved by AICTE & Permanently Affiliated to JNTUGV,Vizianagaram)

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Jonnada (V), Denkada (M),

Vizianagaram (Dist.)

2018 - 2023

INSTITUTE VISION AND MISSION

VISION

Producing globally competent and quality technocrats with human values for the holistic needs of industry and society.

MISSION

- an outstanding infrastructure and platform for enhancement of skills, knowledge, and behavior of students towards employment and higher studies.
- Providing a healthy environment for research, development and entrepreneurship to Creating meet the expectations of industry and society.
- Transforming the graduates to contribute to the socio-economic development and welfare of the society through value-based education.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

Envisions mechanical engineers of highly competent and skilled professionals to meet the needs of the modern society.

MISSION

- Providing a conducive and inspiring learning environment to become competent engineers.
- Providing additional skills and training to meet the current and future needs of the industry.
- Providing a unique environment towards entrepreneurship by fostering innovation, creativity, freedom and empowerment.

PROJECT – COURSE OUTCOMES

CO1 – **Outline** the basic principles and methodology to carry out the Project Work.**(Level 2)**

CO2-Evaluate the ideas and information generated by integrating different are asof knowledge to meet the project objectives.**(Level5)**

CO3- Make use of the communication skills effectively and to present ideas clearly and coherently tospecific audience in both the written and oral forms.**(Level3)**

CO4– **Develop** collaborative skills through working in a team to achieve common goals.**(Level 3)**

CO5 – **Create** fabricated model/simulated model of the system.**(Level6)**

PROGRAM OUTCOMES(POs)

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary setting

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates will have strong knowledge, skills and attitudes towards employment, higher studies and research.

PEO2: Graduates shall comprehend latest tools and techniques to analyse, design and develop novel systems and products for real life problems.

PEO3: Graduates shall have multidisciplinary approach, professional attitude, ethics, good communication, teamwork and engage in life-long learning to adapt the rapidly changing technologies

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Capable of design, develop and implement sustainable mechanical and environmental systems.

PSO2: Qualify in national and international competitive examinations for successfulhigher studies and employment.

COs VS POs MAPPING (DETAILED; HIGH:3; MEDIUM:2;LOW:1**):**

CO	CO'S mapped with PO'S(P01-P012)												CO'S mapped With PS0'S(PS01,PS02)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
C01	3		2		3		3		2		1		2	
C02		1		2		3		2		1	1		1	1
C03	2		1		1	3			2			1	1	
C04		1			2		3		1		2			
C05	1		2			2		1		2		2		
Over	3	2	3	1	2	3	2	2	3	3	3	2	3	1

DECLARATION

We hereby declare that this project entitled as **"FABRICATION OF SURVEILLANCE QUADCOPTER"** anoriginal work done by us and submitted towards fulfillment for the Award of the Degree of Bachelor of Technology in Mechanical Engineering.

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CERTIFICATE

This is to certify that this project work entitled as **"FABRICATION OF SURVEILLANCE QUADCOPTER"** is the original work done by R.SRINU(19KD1A0363),S.JAYA BHARADWAJ(19KD1A0368),SIRLA BHARATH KUMAR(19KD1A0371),TANGUDU JAIDEEP(19KD1A0377),TANGUDU SRIKAR(19KD1A0378) and submitted towards fulfilment of the requirement for the Award of Degree of Bachelor of Technology in Mechanical Engineering during Academic year.

Signature of the Guide &HOD
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Professor,Head of the department
Department of Mechanical Engineering.
Lendi Institute of Engineering andTechnology
Jonnada, Vizianagaram, A.P

Signature of the External Examiner

ACKNOWLEDGEMENT

With great solemnity and sincerity, we offer our profuse thanks to our management, for providing all the resources to complete our project successfully.

We wish to express our sense of gratitude to our guide and Head of the department **Dr. Satish Pujari** PhD**,** and Department of Mechanical for his whole hearted cooperation, unfailing inspiration and valuable guidance. Throughout the project work, his useful suggestions, constant encouragement has given a right direction and shape to our learning. Really, we areindebted to him for his excellent and enlightened guidance.

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We thank all those who contributed directly or indirectly in successfully carrying out this work

ABSTRACT

In today's world, there is a growing need for surveillance in order to maintain the decorum at a place and ensure the safety and security of its people. This project, aims at monitoring the real time environment with help of UAV like surveillance of banks, highly crowded areas, aerial traffic and Security watch etc. This project intended to fabricate a low cost, light weight surveillance UAV.

A drone in structure of quad rotor that houses a camera with a wireless transmission system is to be designed. This provides a live feed from camera to the ground station via telemetry. It is also intended to be able to carry a payload for future developments. GPS will be used to predict the location of UAV and inertial measurement unit (IMU) sensors will be used to predict proper acceleration and detection of changes in rotational attributes roll, pitch and yaw.

A surveillance quadcopter is an unmanned aerial vehicle equipped with cameras and other sensors that can be used to gather information or monitor a specific area from the air. We start by delineating the features of our aerial surveillance system and then discuss some of the technologies that we have used in building it. After that we mention how we have incorporated those technologies into a drone and have made them work together harmoniously in order to achieve our desired aerial surveillance system. This system will be a convenient and efficient alternative to current surveillance systems. It can be used in peace keeping activities and also real time monitoring of a place at any time of the day.The quadcopter's ability to navigate through difficult terrain and reach areas that are otherwise inaccessible makes it an ideal tool for surveillance and reconnaissance. The developed drone in this work can be used for a number of applications, such as policing, firefighting, monitoring flood effected areas, recording video footage from impassable areas and both military and non-military security work.

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Chapter 1

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1.1 Introduction

The Surveillance Quadcopter project is a comprehensive effort to develop an innovative and effective solution for surveillance and monitoring in a variety of industries. Traditional methods of surveillance and monitoring can be expensive, time-consuming, and often have limited capabilities. The Surveillance Quadcopter is a drone that is equipped with advanced sensors and cameras that can be used to collect high-quality data and images, making it an ideal tool for surveillance and monitoring applications.

Fig 1.1**: Surveillance quadcopter model**

The primary objective of the Surveillance Quadcopter project is to develop a cost-effective and efficient solution for surveillance and monitoring applications in various industries such as agriculture, construction, and public safety. The quadcopter is designed to be easy to operate and maintain, making it accessible to a wide range of users.The scope of the project includes the design and development of the quadcopter, as well as the sensors and cameras used to collect data. The data collected by the quadcopter is analyzed using advanced data analysis techniques to provide valuable insights and actionable information to users.The target audience for the project documentation includes potential users and stakeholders, including individuals and organizations in industries such as agriculture, construction, and public safety.

The methodology used in the project includes a rigorous design process, development process, and testing process to ensure that the quadcopter meets the needs and requirements of the target audience. The project also includes a focus on safety considerations, regulatory compliance, and ethical considerations related to the use of drones for surveillance and monitoring applications.

Fig1.2:**Parts of the quadcopter**

The surveillance quadcopter project utilizes quadcopters, which are agile and maneuverable unmanned aerial vehicles capable of hovering in place and performing complex aerial maneuvers. The quadcopters are equipped with high-resolution cameras, thermal imaging sensors, and other advanced sensors that enable them to capture and transmit real-time aerial video footage and other data to a control center or a designated device.

The project aims to address the growing need for advanced surveillance and security measures in various settings, including public spaces such as parks, stadiums, and shopping centers, as well as industrial facilities such as factories and warehouses, and critical infrastructure such as power plants and transportation hubs.

Surveillance is the monitoring of the behavior, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them. This can include observation from a distance by

means of electronic equipment (such as CCTV cameras), or interception of electronically transmitted information (such as Internet traffic or phone calls); and it can include simple, relatively no- or low-technology methods such as human intelligence agents and interception and aerial surveillance where drones are applied to relay information and gathering the required data. A quadcopter is an aerial vehicle that uses four rotors for lift, steering, and stabilization. Unlike other aerial vehicles, the quadcopter can achieve vertical flight in a more stable condition. The quadcopter is not affected by the torque issues that a helicopter experiences due to the main rotor. Furthermore, due to the quadcopter‟s cyclic design, it is easier to construct and maintain. In the project design of a quadcopter is constructed to ensure it can achieve a total flight of 10 minutes in Air with the possibility of future progress to improve in time and robustness.

A Quadcopter (UAV) is a flying vehicle which utilizes quickly turning rotors to push air downwards, subsequently making a push energy keeping the quadcopter on high. Quadcopter works according to the force or thrust generated by four rotors connected to its body. It has four input and six yield or output states (x, y, z, θ, ψ, ω).Quadcopters are small rotary crafts that can be used in various environments, where they are able to maintain hover capabilities like a conventional helicopter, but are mechanically simpler and can achieve higher maneuverability. They use four fixed propellers of pitch to control lift and a combination of propeller torques to

control roll, pitch, and yaw. Earlier designs had poor performance due to very high pilot workload. The present day control techniques and modern sensors have increased the popularity of the quadcopter as an autonomous.

Quadcopter platform.There are also several different methods of surveillance. Methods include GPS tracking, camera observation, and stake-outs, Additionally, you can use data mining, profiling, and biometric surveillance.

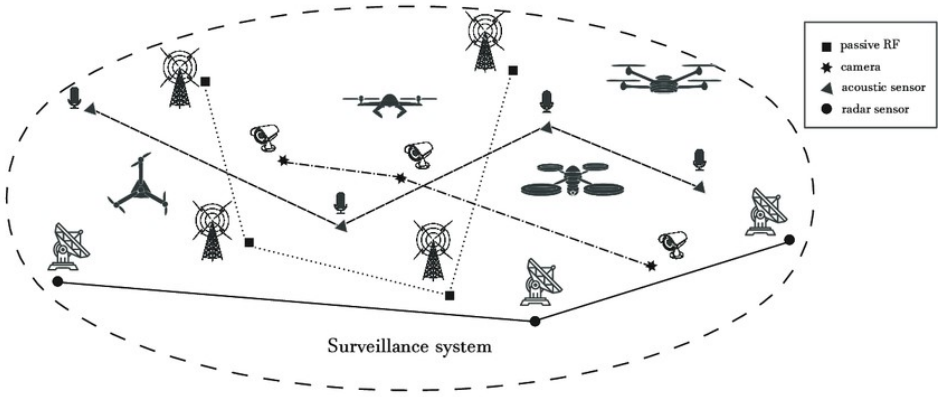

Fig1.3:**Monitoring layout**

A quad-copter is an unmanned aerial vehicle capable of flying autonomously. These can be controlled remotely via a remote-control system (RC), though controlling aircraft autonomously or semi-autonomously is constantly monitored. This movement of the aircrafts without any interference of a person inside it can be done through the pre-programmed flight, which uses global positioning system, it also depends on it and it can be achieved by combination of ultrasonic sensor. Various UAV sizes and shapes can be chosen. Most benefited application is in Military, but these unmanned aircrafts are also implemented in various applications. A unique kind of UAV's which uses four-fixed rotors is Quad-copter, per axis two rotors are used (each axis is aligned orthogonally with the other), the lift is powered by four motors and propel the aircraft. By changing the speed of the motors, the scheme of controlling a Quad-copter is done with respective to each other, also the forces of the Quad-copter wants real time movement of the motors. To obtain a balanced flight, integration of the control system is needed and a kk controller board will give the control algorithm and will be able to receive and send commands.UAV Quad-copter was used only in military applications.

When the improvement of advanced capable electronics, which ranged very powerful, very less weight microcontrollers to very small sensors with better required accuracy and precision, we can design a quad-copter with requires sizes and can be used for different applications. Several advantages are there for A

Quad-copter when compared to the other unmanned aircrafts such as its quality of moving freely even in the stiff wind and its functionalities and the power in controlling the speed of the motors for the required one. Also, these aircrafts make less harm to the humans, as we added protective frames to cover the exposed propellers. By these aircrafts we can even eliminate many fire accidents, explosions and electrical based incidents. These aircrafts also used to avoid criminal activity and others.

Traditional observational surveillance methods are typically limited by the stationary nature of the camera. The camera is therefore usually handled manually or fixed upon a tripod or other structure. Aerial surveillance with a helicopter achieves the desired result but is also very costly.

Unmanned aircraft systems provide the ideal solution to the problems and limitations faced by other surveillance methods. Drone surveillance presents an easier, faster, and cheaper method of data collection. Consequently, there are also a number of other key advantages. Drone planes can enter narrow and confined spaces, produce minimal noise, and are equipped with night-vision cameras and thermal sensors. For this reason, they provide imagery that the human eye is unable to detect. Quadcopter based surveillance system is with an automateddetection mechanism that can be used to monitor the areas by integrating the different sensors, to collect the intrusioninformation and send it to a central control station for furtherprocessing and simultaneously deploy a quadcopter to thatlocation and inform the higher authority by triggering an alarm.

The Surveillance Quadcopter project has the potential to revolutionize the way surveillance and monitoring are conducted in various industries, providing a cost-effective, efficient, and high-quality solution for collecting data and images.UAVs can quickly cover large and difficult-to-reach areas, reducing staff numbers and costs. They additionally do not require much space for their operators.The surveillance quadcopter is a versatile and highly mobile platform that offers a range of benefits for surveillance and security applications.

- **Advanced sensor capabilities:** In addition to high-resolution cameras and thermal imaging sensors, surveillance quadcopters can also be equipped with other advanced sensors, such as gas detectors, radiation sensors, and microphones, enabling them to detect a wide range of potential threats and anomalies.
- **Autonomous operation:** Surveillance quadcopters can be programmed to fly autonomously, using pre-determined flight paths and waypoints to navigate and survey an area. This reduces the need for human intervention and enables the quadcopter to cover large areas more efficiently.
- **Real-time data transmission:** Surveillance quadcopters can transmit real-time video footage and other data to a control center or mobile device, providing security personnel with instant access to critical information and enabling them to respond quickly to potential threats.
- **Mobility and agility:** Quadcopters are highly maneuverable and can fly in tight spaces and over uneven terrain, making them ideal for surveillance in urban environments or areas that are difficult to access by other means.
- **Cost-effective:** Compared to traditional surveillance methods such as manned aircraft or ground-based patrols, surveillance quadcopters are a more cost-effective solution for security and surveillance applications. They require fewer resources to operate and can cover larger areas in less time.
- **Customizable configurations:** Surveillance quadcopters can be customized with different payloads and sensors to suit different applications. For example, a quadcopter used for monitoring a wildlife reserve might be equipped with a zoom camera and environmental sensors to detect changes in temperature, humidity, and air quality, while a quadcopter used for border patrol might be equipped with thermal imaging cameras and ground-penetrating radar to detect tunnels and other underground passages.
- **Versatile applications:** The surveillance quadcopter project has a wide range of applications beyond security and surveillance. For example,

quadcopters can be used for search and rescue operations, environmental monitoring, agricultural surveys, and construction site inspections.

- **Safety considerations:** The use of quadcopters for surveillance raises some safety and privacy concerns that must be addressed. For example, quadcopters must be operated within legal and ethical guidelines, and proper training and certification are required for operators. Additionally, measures must be taken to prevent quadcopters from interfering with other aircraft or endangering people on the ground.
- **Future potential:** As the technology for surveillance quadcopters continues to evolve, there is potential for even more advanced capabilities, such as artificial intelligence and machine learning algorithms for automated threat detection, and swarm technology for coordinated surveillance and response.
- **Reducing risk to human life:** One of the main benefits of using surveillance quadcopters for security and surveillance applications is that they can reduce the risk to human life. For example, in situations such as natural disasters or hazardous material spills, quadcopters can be used to gather critical information and assess the situation without putting human responders in harm's way.
- **Enhanced situational awareness:** Surveillance quadcopters can provide security personnel with enhanced situational awareness by capturing real-time video footage and other data from vantage points that are not easily accessible by ground-based patrols. This can help them detect and respond to potential threats more quickly and effectively.
- **Integration with other systems:** Surveillance quadcopters can be integrated with other security and surveillance systems, such as CCTV cameras and perimeter sensors, to provide a more comprehensive view of a site or facility. This can help security personnel detect and respond to potential threats more quickly and effectively.

- **Minimizing false alarms:** By providing a real-time view of a site or facility, surveillance quadcopters can help reduce false alarms and unnecessary responses. For example, if an alarm is triggered, a quadcopter can be quickly deployed to assess the situation and determine whether a response is necessary.
- **Environmental benefits:** The use of surveillance quadcopters can also have environmental benefits. For example, quadcopters can be used to monitor wildlife populations, detect illegal logging or fishing activities, and assess the impact of natural disasters on the environment.
- **Flexible deployment:** Quadcopters can be deployed quickly and easily, making them an ideal solution for emergency situations where rapid response is required. They can also be deployed for short-term or long-term surveillance operations, depending on the needs of the application.
- **Remote control operation:** Surveillance quadcopters can be operated remotely, which means that security personnel can control the quadcopter from a safe distance, reducing the risk of exposure to potential threats.
- **Improved accuracy:** By providing high-resolution video footage and other data, surveillance quadcopters can help security personnel identify and track potential threats with greater accuracy. This can help reduce false alarms and improve response times.
- **Multi-functional use:** Quadcopters can be used for a variety of applications beyond surveillance and security, such as mapping, surveying, and inspection. This makes them a versatile and cost-effective solution for a range of industries and applications.
- **Improved coverage:** Quadcopters can cover a large area quickly and efficiently, providing security personnel with a comprehensive view of a site or facility. This can help detect potential threats and anomalies that may be missed by ground-based patrols.

- **Real-time monitoring:** Surveillance quadcopters can provide real-time monitoring of a site or facility, enabling security personnel to respond quickly to potential threats. This can help prevent or mitigate damage to critical infrastructure or other important assets.
- **Cost-effective solution:** Surveillance quadcopters can be a cost-effective solution for security and surveillance applications compared to traditional manned aircraft or ground-based patrols. Quadcopters require fewer personnel and resources to operate, and can cover a larger area more quickly and efficiently.
- **Portable and easy to transport:** Quadcopters are small and lightweight, which makes them easy to transport to different locations as needed. This can be particularly useful for security and surveillance applications in remote or hard-to-reach locations.
- **Customizable flight paths:** Surveillance quadcopters can be programmed to follow specific flight paths and waypoints, which can be customized based on the needs of the application. This can help ensure that the quadcopter covers the areas of greatest interest or concern.
- **Data analysis and storage:** Surveillance quadcopters can collect and store large amounts of data, including video footage and sensor data. This data can be analyzed and used to improve security and surveillance operations over time.
- **Improved response times:** By providing real-time video footage and other data, surveillance quadcopters can help security personnel respond to potential threats more quickly and effectively. This can help prevent or mitigate damage to critical infrastructure or other important assets.
- **Scalable solution:** Surveillance quadcopters can be scaled up or down depending on the needs of the application. For example, additional quadcopters can be deployed for larger facilities or events, while a single quadcopter may be sufficient for smaller sites or applications.

- **Reducing costs associated with infrastructure damage:** In some cases, infrastructure damage can be costly to repair, and surveillance quadcopters can help reduce this cost by detecting and identifying potential threats before they cause significant damage.
- **Improved response to emergencies:** Quadcopters can be deployed quickly in emergency situations, providing real-time footage and data to first responders to improve their response times and overall effectiveness.
- **Support for law enforcement:** Surveillance quadcopters can be used to support law enforcement in a variety of ways, such as in crowd control, search and rescue operations, and tracking fleeing suspects.
- **Improved monitoring of critical infrastructure:** Quadcopters can be used to monitor critical infrastructure such as power plants, bridges, and oil refineries, helping to identify potential vulnerabilities and prevent damage or downtime.
- **Integration with artificial intelligence:** With advancements in artificial intelligence (AI), surveillance quadcopters can be integrated with AI-powered systems to detect and identify potential threats automatically. This can improve the speed and accuracy of threat detection, and reduce the risk of human error.
- **Enhanced public safety:** By providing real-time video footage and other data, surveillance quadcopters can help enhance public safety by detecting potential threats and enabling security personnel to respond quickly and effectively.
- **Autonomous operation:** Quadcopters can be programmed to operate autonomously, reducing the need for human intervention and allowing for continuous surveillance operations.
- **Integration with other surveillance systems:** Surveillance quadcopters can be integrated with other surveillance systems such as security cameras and ground-based sensors, providing a comprehensive view of a site or facility.

- **Low noise emissions:** Quadcopters typically have low noise emissions, which makes them less disruptive than traditional manned aircraft for surveillance and security applications.
- **Reduced risk to human life:** By providing remote surveillance capabilities, quadcopters can help reduce the risk to human life in dangerous or high-risk environments.
- **Improved situational awareness:** Quadcopters can provide a bird's-eye view of a site or facility, providing security personnel with improved situational awareness and enabling them to identify potential threats more easily.
- **24/7 monitoring capabilities:** Quadcopters can operate around the clock, providing 24/7 monitoring capabilities for critical infrastructure, public spaces, and other applications.
- **High maneuverability:** Quadcopters are highly maneuverable, which makes them ideal for surveillance and security applications that require quick and agile movements.
- **Improved data security:** With advancements in encryption and other security technologies, surveillance quadcopters can provide improved data security for sensitive surveillance data, preventing unauthorized access and ensuring the integrity of the data collected.
- **Environmental monitoring:** Quadcopters can be used for environmental monitoring applications, such as monitoring wildlife, tracking weather patterns, and detecting environmental hazards.
- **Agricultural applications:** Quadcopters can be used for agricultural applications, such as crop monitoring, soil analysis, and plant health assessments.
- **Improved inspection capabilities:** Quadcopters can be used for inspection applications, such as inspecting power lines, pipelines, and other critical

infrastructure. They can also provide close-up inspections of hard-to-reach areas, such as rooftops and high-rise buildings.

- **Search and rescue operations:** Quadcopters can be used for search and rescue operations in remote or hard-to-reach areas, providing real-time video footage and other data to aid in the search efforts.
- **Disaster response:** Quadcopters can be used for disaster response applications, such as assessing damage to infrastructure and providing real-time data to emergency responders.
- **Mapping and surveying:** Quadcopters can be used for mapping and surveying applications, providing high-resolution imagery and data for mapping applications.
- **Infrastructure planning and development:** Quadcopters can be used for infrastructure planning and development applications, such as identifying suitable locations for new infrastructure projects and monitoring construction progress.
- **Improved safety in hazardous environments:** Quadcopters can be used for safety applications in hazardous environments, such as oil rigs and chemical plants, where human safety is a concern.
- **Rapid deployment:** Quadcopters can be rapidly deployed for emergency situations or for monitoring situations that require a quick response.
- **Improved asset management:** Quadcopters can be used for asset management applications, such as monitoring inventory and tracking equipment.
- **Multi-sensor integration:** Quadcopters can be equipped with a variety of sensors, such as thermal imaging, lidar, and gas sensors, which can provide a more comprehensive view of the environment being monitored.
- **Advanced data analytics:** Quadcopters can be used to collect large amounts of data, which can be processed using advanced analytics techniques to provide valuable insights and intelligence.

- **User-friendly:** Advances in technology have made quadcopters more user-friendly, with intuitive user interfaces and control systems that make them easier to operate and control.
- **Remote control and monitoring:** Quadcopters can be operated and monitored remotely, which allows for greater flexibility in terms of where and how they are used.
- **Customizable:** Quadcopters can be customized to meet the specific needs of a particular application or mission, with a variety of options for sensors, cameras, and other equipment.
- **Scalable:** Quadcopter systems can be scaled up or down to meet the needs of different applications, from small-scale surveillance operations to large-scale infrastructure monitoring projects.
- **Energy efficient:** Advances in battery technology have made quadcopters more energy-efficient, which allows for longer flight times and greater operational flexibility.
- **Improved image stabilization:** Advances in image stabilization technology have made it possible to capture high-quality images and video footage even in challenging environments, such as in windy conditions.
- **Collaboration:** Quadcopters can be used in collaboration with other drones or manned aircraft, allowing for greater coverage and more efficient surveillance operations.

1.2 Overall Objective

The objective of this project is to build an unnamed aerial vehicle in structure of quad rotor which can able to maintain safe and stable flight and houses a camera with a wireless transmission system to provide surveillance of real time environment.

1.3 Specific objectives

- To perform a literature review on the existing similar systems in order to gain some knowledge that will be applied in implementing this project.
- Design and implementation of UAV in structure of X shaped quadcopter.
- Development of flight controller by proper interfacing of sensor and applying tuning of PID control values.
- Apart from the stable flight, a camera is interfaced with quadcopter's processor to record the aerial view for surveillance.
- A wireless transmission system will also be developed to telemeter the video and GPS data to ground station.

1.4 Problem statement

Visibility is often impaired for those inside the vehicles, making it difficult to see all possible threats ahead, behind, and to the side. Lack of visibility creates a significant danger from insurgents. Travel routes can span hundreds of miles where explosive detectors, bomb-sniffing dogs, or law enforcement is costly, but still does not guarantee complete safety. Improved visibility for individuals in the vehicles can help mitigate these external risks. The prototype can be applied as a bridge that can help record the happening of an area in space giving the real scenario with minimum human guidance.

1.5 Significance

This project created a platform to learn about the unmanned aerial vehicles such as the quadcopter. This expands the scope of the Mechanical Engineering to include the control and the understanding of the mathematical components. The quadcopter has many applications that an interested to develop security systems, mapping and reconnaissance

especially in a disaster and dangerous area. It also opens up the possibilities to broaden the understanding and application of control systems, stabilization, artificial Intelligence and computer Image processing as it applies to the quadcopter. Quadcopters can be equipped with high-definition cameras and sensors, making them ideal for surveillance and reconnaissance missions. They can be used to monitor borders, track wildlife, and gather intelligence in areas that are difficult to access. They can be equipped with thermal cameras and other sensors to locate missing persons or survivors in disaster areas.

1.6 Motivation of Study

From observation of prior art in unmanned aerial vehicle, one can say that future is full with unlimited potential and possibilities of UAV. Now a days UAVs are everywhere. It is not only used for civil and commercial but also in scientific research as well. For example, UAV Global Hawk which is High-Altitude Endurance Unmanned Aerial Vehicle from Defense Advanced Research Projects Agency (DARPA) and Defense Airborne Reconnaissance Office (DARO) is used for NASA's airborne Hurricane and Severe Storm Sentinel or HS3 mission. NASA is redoubling its efforts to probe the inner workings of hurricanes and tropical storms with two unmanned Global Hawk aircraft flying over storms and two new space-based missions. UAVs are also considered as a potential unmanned candidate for future mars mission over rover and landers. A mission named ARES (Aerial Regional Scale Survey of Mars) was under evaluated mission, developed by Langley Research Center to build a powered aircraft that would fly on Mars.

1.7 Assumptions and Delimitations

It is assumed that the drone will with stand the effects of wind as its general aerodynamic design is made to cater for any adverse effects. The propellers used

by the Drone are designed at an angle that will give 80% efficiency in cases where the wind speed is normal.

1.8 Quadcopter Dynamics

For controlling the altitude a particular type of controller is used.When the controller is moved up or down, the propeller speed is adjusted causing the quadcopter to gain or lose altitude and also a way to adjust thrust of the rotors via voltage supply to perform standard flight operations and to position the quadcopter into certain angular orientation depending on the circumstances of a particular flight routine. Thrust is one type of force. When a system accelerates mass in one direction, the accelerated mass will cause a force of equal magnitude but opposite direction on that system. The force applied on a surface in a direction perpendicular or normal to the surface is called thrust [4]. In quadcopter, two of the propellers are designed to rotate in the opposite of the other two propellers. First pair of the propellers rotates in one direction for keeping balancing in X axis and the other pair in another direction for keeping balancing in Y axis. The rotation in opposite direction is to eliminate rotation in the Z axis. The movement of the aircraft is based on the rotational speed of each of the narrow airfoils; change of speed changes the position. The aircraft primarily is governed by control of the three major axes namely; pitch, roll and yaw [3]. There are numbers of forces in space which can disturbed the motion of quadcopter. So, it is very important to balance the forces acting on the quadcopter. To understand these forces we should know the three axes.

Each rotor produces both a thrust and torque about its centre of rotation, as well as a drag force opposite to the vehicle's direction of flight. Quad-copter achieveslift, yaw, roll and pitch simply via a manipulation of the thrusts of four motors relative to each other. This way, fixed rotor blades can be made to manoeuvre the quad rotor vehicle in all dimensions.

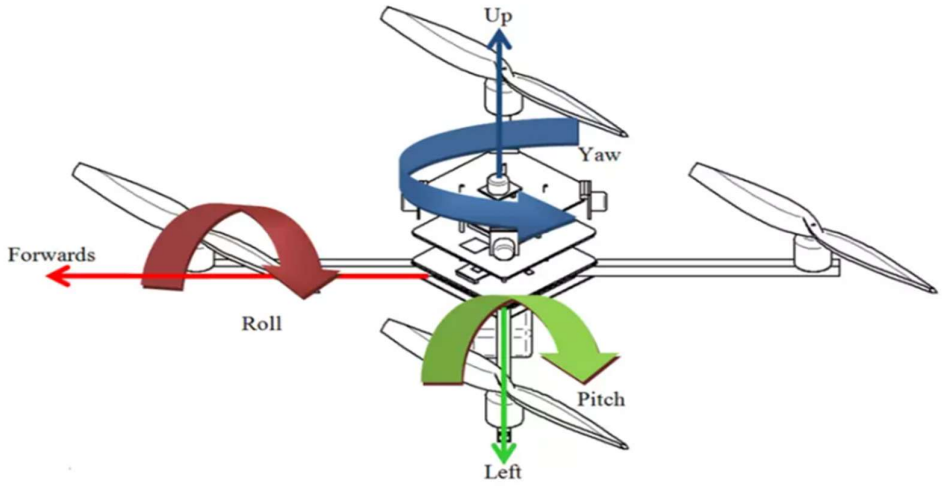

Fig1.4**:Quadcopter prinicipal coordinates**

Similar to other flying objects, a quadrotor has a group of forces and torques acting on it while it flies. There are four main forces acting on the drone: drag, lift, weight, and thrust. In order for the drone to fly, these different forces need to be balanced.

Weight:

- Due to the mass of the drone, the body mass force always acts in the direction of gravity.
- Higher the weight of the drone, more power is required to lift and move the drone.
- Weight of drone = mass of drone × acceleration due to gravity

Lift:

- The vertical force acting on the drone is called lift.
- This force is due to pressure differences across the drone (in the vertical direction). Hence, the speed, size, and shape of the propeller blade decide the amount of lift force.

- Lift is essential to lift the body against the gravity.To create this force, all four propellors run at high speed to lift the drone.

Thrust:

- The force acting on the drone in the direction of motion is called thrust.
- However, for drone dynamics, it is normal to the rotor plane.During hovering, the thrust is purely vertical.
- If thrust is inclined then the drone will tilt forward or backward.This force is essential to move the drone in the desired direction at equal speed.
- To get desired motion, two propellors have been given high speed.

Drag:

- The force acting on the drone in the opposite direction of motion due to air resistance is called drag.
- This may be because of pressure difference and viscosity of air.
- To reduce the drag, the aerodynamic shape of the drone is selected.

This can be seen by utilizing Newton's Second Law.

Applying Newton's Second Law;

$F = ma$ ……..(1)

For constant velocity acceleration is zero (a=0). Thus the sum of the forces is equal to zero. So for steady, constant velocity flight, completing a force balance in the horizontal direction on the diagram obtains:

$F_{thrust} - F_{drag} = 0$ .....(2)

$F_{thrust} = F_{drag}$ .....(3)

Since this is for a constant velocity, the aircraft is either moving or at rest. An analysis in the vertical direction will produce similar results.

Flift - Fweight = 0 …….(4)

Flift = Fweight ……..(5)

CHAPTER 2

LITERATURE REVIEW

CHAPTER 2

LITERATURE REVIEW

Francesca Guerriero et al [1] - The interest in using drones in various applications has grown significantly in recent years. The reasons are related to the continuous advances in technology, especially the advent of fast microprocessors, which support intelligent autonomous control of several systems. Photography, construction, and monitoring and surveillance are only some of the areas in which the use of drones is becoming common. Among these, last-mile delivery is one of the most promising areas.

J.Hu et al [2] - This paper provides a comprehensive review of UAV-based surveillance for critical infrastructure protection, including power grids, transportation systems, and communication networks. The authors discuss the various surveillance requirements for critical infrastructure protection, and the potential benefits of using UAVs for these tasks. They also discuss the technical challenges and future directions in this field.

R.Baskar et al [3] - This study reviews the use of UAVs for surveillance and reconnaissance in disaster management, including search and rescue operations, damage assessment, and emergency response. The authors discuss the advantages and limitations of using UAVs for disaster management, and provide a classification of the different types of UAV-based surveillance techniques. They also discuss the challenges and future directions in this field.

A.Babu et al [4]- This study presents the design and implementation of a quadcopter-based surveillance system for traffic monitoring. The authors describe the hardware and software components of the system, including the use of computer vision algorithms for vehicle detection and tracking.

T.A.Rahman et al [5] - This study discusses the design and development of a quadcopter for surveillance applications. The authors focus on the hardware and

software components needed to build the quadcopter, including the selection of the motors, sensors, and control algorithms. They also evaluate the performance of the quadcopter in real-world scenarios and discuss the limitations and future work.

K.S.Saravanan et al [6] - This paper provides a comprehensive survey of various surveillance techniques that use UAVs, including quadcopters. The authors discuss the advantages and disadvantages of using UAVs for surveillance, and provide a classification of the different types of UAV-based surveillance techniques. They also discuss the challenges and future directions in this field.

P.Rajendran et al [7] - This study proposes an intelligent surveillance system using a quadcopter, which is capable of detecting and tracking moving objects in real-time. The authors describe the hardware and software components of the system, including the use of machine learning algorithms for object detection and tracking. They evaluate the performance of the system in a real-world scenario and discuss the limitations and future work.

A.Al-Maadeed et al [8]- This paper provides a comprehensive review of unmanned aerial vehicles for civil applications, including surveillance. The authors discuss the various requirements and challenges associated with the use of UAVs for surveillance, including the regulatory and safety issues, as well as the technical challenges related to the hardware and software components.

M.Zarei et al[9] - This study proposes an autonomous quadcopter surveillance system for border security, which is capable of detecting and tracking illegal border crossings. The authors describe the hardware and software components of the system, including the use of computer vision algorithms for object detection and tracking. They evaluate the performance of the system in a real-world scenario and discuss the limitations and future work.

S.S.Patil et al [10] - This paper reviews the use of UAVs for surveillance and monitoring in agriculture, including crop health assessment, pest detection, and yield estimation. The authors discuss the advantages and limitations of using UAVs for agricultural applications, and provide a classification of the different types of UAV-based surveillance techniques. They also discuss the challenges and future directions in this field.

S.S.Sreekumar et al [11] - This study reviews the use of UAVs for surveillance and monitoring in wildlife management, including animal tracking, population estimation, and habitat mapping. The authors discuss the advantages and limitations of using UAVs for wildlife management, and provide a classification of the different types of UAV-based surveillance techniques. They also discuss the challenges and future directions in this field.

A.Devaraj et al [12] - This paper provides a comprehensive review of UAV-based surveillance for law enforcement, including border security, crowd control, and crime prevention. The authors discuss the various surveillance requirements for law enforcement, and the potential benefits of using UAVs for these tasks. They also discuss the technical challenges and future directions in this field.

A.N.Nisha et al [13] - This study surveys the use of quadcopters for surveillance and monitoring in indoor environments, including home security, warehouse management, and building inspection. The authors discuss the advantages and limitations of using quadcopters for indoor applications, and provide a classification of the different types of quadcopter-based surveillance systems. They also discuss the challenges and future directions in this field.

R.A.Aziz et al [14]- This paper reviews the use of UAVs for surveillance and monitoring in environmental applications, including air quality monitoring, water resource management, and forest fire detection. The authors discuss the advantages and limitations of using UAVs for environmental monitoring, and

provide a classification of the different types of UAV-based surveillance techniques. They also discuss the challenges and future directions in this field.

S.S.Saini et al [15]- This study provides a survey of autonomous surveillance systems using UAVs, including quadcopters. The authors discuss the various types of autonomous surveillance systems, and the advantages and limitations of using UAVs for these tasks. They also discuss the technical challenges and future directions in this field.

S.S.Kumar et al. [16]- This paper reviews the use of quadcopters for surveillance and monitoring in industrial applications, including manufacturing, oil and gas, and mining. The authors discuss the advantages and limitations of using quadcopters for industrial applications, and provide a classification of the different types of quadcopter-based surveillance systems. They also discuss the challenges and future directions in this field.

R.Vijayakumar et al [17] - This paper reviews the use of UAVs for surveillance and monitoring in marine applications, including oil spills, marine mammal detection, and fisheries management. The authors discuss the advantages and limitations of using UAVs for marine applications, and provide a classification of the different types of UAV-based surveillance techniques. They also discuss the challenges and future directions in this field.

P.Balaji et al [18] - This study reviews the use of quadcopters for surveillance and monitoring in search and rescue operations, including disaster relief, fire and rescue, and emergency medical services. The authors discuss the advantages and limitations of using quadcopters for search and rescue operations, and provide a classification of the different types of quadcopter-based surveillance systems. They also discuss the challenges and future directions in this field.

K.Prakash et al [19] - This paper surveys the use of UAVs for surveillance and monitoring in border control applications, including border security, illegal

immigration, and smuggling prevention. The authors discuss the advantages and limitations of using UAVs for border control, and provide a classification of the different types of UAV-based surveillance systems. They also discuss the challenges and future directions in this field.

L.Wang et al [20]- This study reviews the use of UAVs for surveillance and monitoring in agricultural pest and disease detection, including insect detection, plant disease identification, and weed mapping. The authors discuss the advantages and limitations of using UAVs for agricultural pest and disease detection, and provide a classification of the different types of UAV-based surveillance systems. They also discuss the challenges and future directions in this field.

A.S.Kavitha et al [21] - This paper reviews the use of quadcopters for surveillance and monitoring in power line inspection applications. The authors discuss the advantages and limitations of using quadcopters for power line inspection, and provide a classification of the different types of quadcopter-based surveillance systems. They also discuss the challenges and future directions in this field.

A.Ghosal et al [22] - This paper reviews the use of UAVs for surveillance and monitoring in critical infrastructure protection applications, including oil and gas pipelines, nuclear power plants, and airports. The authors discuss the advantages and limitations of using UAVs for critical infrastructure protection, and provide a classification of the different types of UAV-based surveillance systems. They also discuss the challenges and future directions in this field.

S.S.Gouda et al [23]- This study surveys the use of UAVs for surveillance and monitoring in traffic monitoring applications, including traffic congestion, accident detection, and road condition assessment. The authors discuss the advantages and limitations of using UAVs for traffic monitoring, and provide a

classification of the different types of UAV-based surveillance systems. They also discuss the challenges and future directions in this field.

S.K.Bose et al [24] - This paper reviews the use of UAVs for surveillance and monitoring in disaster management applications, including search and rescue, damage assessment, and disaster response. The authors discuss the advantages and limitations of using UAVs for disaster management, and provide a classification of the different types of UAV-based surveillance systems. They also discuss the challenges and future directions in this field.

R.R.Selvaraj et al [25]- This study reviews the use of quadcopters for surveillance and monitoring in border surveillance applications, including border patrol, smuggling prevention, and illegal immigration control. The authors discuss the advantages and limitations of using quadcopters for border surveillance, and provide a classification of the different types of quadcopter-based surveillance systems. They also discuss the challenges and future directions in this field.

S.S.Soman et al [26]- This paper reviews the use of UAVs for surveillance and monitoring in wildlife management applications, including animal tracking, population surveys, and poaching prevention. The authors discuss the advantages and limitations of using UAVs for wildlife management, and provide a classification of the different types of UAV-based surveillance systems. They also discuss the challenges and future directions in this field.

Navneet Kumar et al [27]- This paper presents an analysis of drone technologies and their modifications with time in the agriculture sector in the last decade. The application of drones in the area of crop monitoring, and pesticide spraying for Precision Agriculture (PA) has been covered. The work done related to drone structure, multiple sensor development, innovation in spot area spraying has been presented. Moreover, the use of Artificial Intelligent (AI) and deep learning for the remote monitoring of crops has been discussed.

Andry Chowanda et al [28]- Precision agriculture is an important part of drone research projects today. Agriculture needs commercial drones since the industry took off: and sophisticated analytics and software combine with evolved drone solutions to allow for breakthroughs. For future farming, drones are an essential tool in precision agriculture, as they allow farmers to monitor crop and livestock conditions by air. This paper presents a literature review of the research and implementation of drones for agriculture, delivering items and GIS. We explore the methods used by drones such as implementing for pesticide sprayers in Agriculture and area mapping. Analysis and discussion then presented at the end of the paper.

David Gallacher et al [29]- Options for environmental management have improved dramatically over recent years. Sensors for air and water pollutants, and subsets of the electromagnetic spectrum, have become smaller, cheaper, and more bundled into comprehensive units. Aerial sensor platforms have also expanded in the form of low-altitude unmanned aerial vehicles (micro-drones), but their use in populated spaces is increasingly restricted for safety and privacy reasons. This article discusses potential applications of drones for use in environmental monitoring and management of urban spaces as well as the potential risks. Applications better suited to an Internet of Things approach include those in which frequently repeated or continuous measurements are needed from a location proximal to existing infrastructure. Surveillance applications are likely to move to higher altitude drones with better safety and security systems.

Shukor Abd Razak et al[30] - The goals of this systematic review were to explore the involvement of surveillance drones in smart cities in terms of application status, application areas, proposed models, and characteristics of drones. We conducted this systematic review based on the preferred reporting items for systematic reviews and meta-analyzes (PRISMA) guidelines.The majority of reviewed models were based on the application of rotary-wing single-drones with the camera as the aerial sensor. Reviewed models showed that the

adoption of a single or multiple UAVs, either as a stand-alone technology or integrated with other technologies (e.g., internet of things, wireless sensor networks, convolutional neural networks, artificial intelligence, machine learning, computer vision, cloud computing, web applications), can offer efficient and sustainable solutions compared to conventional surveillance methods. This review can benefit academic researchers and practitioners.

Mikhail Ivanov et al [31] - The current study reviews the available literature about UAVs employed in the surveillance field for indoor and outdoor spaces. At first, we differentiated between HTA and LTA. After a first analysis, we compared the two categories, and we proposed active solutions. In our opinion, it would be possible to put them into practice by implementing a system which would operate both copter drones and blimps. These, in fact, present advantages and disadvantages which overcome one another, giving the possibility of such dual systems. This study is developed inside a broader analysis on how to provide the right level of security of an automated port that would rely on an autonomous security system.

Omar Elharrouss et al [32]- Automated surveillance systems observe the environment utilizing cameras. The observed scenario is then analysed using motion detection, crowd behaviour, individual behaviour, interaction between individuals, crowds and their surrounding environment. These automatic systems accomplish multitude of tasks which include, detection, interpretation, understanding, recording and creating alarms based on the analysis. Till recent, studies have achieved enhanced monitoring performance along with avoiding possible human failures by manipulation of different features of these systems. This paper presents a comprehensive review of such video surveillance systems as well as the components used with them. The description of the architectures used is presented which follows the most required analyses in these systems. For the bigger picture and wholesome view of the system, existing surveillance

systems were compared in terms of characteristics, advantages, and difficulties which are tabulated in this paper. Adding to this, future trends are discussed which charts a path into the upcoming research directions.

S. Pedrozo et al [33]- On this basis, and grounded in an extensive literature review, the paper outlines a politico-geographical research agenda for the investigation of the making, functioning and implications of drone systems. Such an agenda, it is claimed, could afford deepened insight into the driving forces that are behind current drone developments, would show how drones work in different institutional contexts, and could highlight how drones impact on the envisioned reality. This in turn would provide a deepened understanding of the "politics of visibility", "politics of the air" and "politics of the ground" conveyed by drones, and open up a wider conceptual reflection on the role of the aerial dimension in the projection of power across and within space.

Anitha Ramachandran et al[34] - In this paper, a detailed literature review has been conducted focusing on object detection and tracking using UAVs concerning different applications. This study summarizes the findings of existing research papers and identifies the research gaps. Computer vision in drones has gained a lot of attention from artificial intelligence researchers. Providing intelligence to drones will resolve many real-time problems. Computer vision tasks such as object detection, object tracking, and object counting are significant tasks for monitoring specified environments. However, factors such as altitude, camera angle, occlusion, and motion blur make it a more challenging task.

Christopher Slobogin et al [35]- This review focuses on government use of technology to observe, collect, or record potential criminal activity in real-time, as contrasted with “transaction surveillance” that involves government efforts to access already-existing records and exploit Big Data, topics that have been the focus of previous reviews. Even so limited, surveillance technologies come in many guises, including closed-circuit television, automated license plate

and facial readers, aerial cameras, and GPS tracking. Also classifiable as surveillance technology are devices such as thermal and electromagnetic imagers that can "see" through walls and clothing. Finally, surveillance includes wiretapping and other forms of communication interception. The following discussion briefly examines the limited evidence we have about the prevalence and effectiveness of these technologies and then describes the law governing surveillance, focusing principally on constitutional doctrine, and how it might—and might not—limit use of these technologies in the future.

Francisco Klauser et al [36] - Farming today relies on ever-increasing forms of data gathering, transfer, and analysis. Think of autonomous tractors and weeding robots, chip-implanted animals and underground infrastructures with inbuilt sensors, and drones or satellites offering image analysis from the air. Despite this evolution, however, the social sciences have almost completely overlooked the resulting problematics of power and control.

CHAPTER 3

COMPONENTS AND ITS SPECIFICATIONS

CHAPTER 3

COMPONENTS AND ITS SPECIFICATIONS

3.1 QUADCOPTER FRAME

Fig. 3.1: **Quadcopter Frame**

The frame of a surveillance quadcopter is an important component that supports the weight of the equipment and provides stability during flight. Here are some of the key factors to consider when selecting a frame for a surveillance quadcopter:

- **Material:** The frame can be made of various materials, including aluminum, carbon fiber, and plastic. Carbon fiber is a popular choice because it is lightweight and durable, while aluminum is heavier but can provide greater strength.
- **Size:** The size of the frame should be determined by the size and weight of the equipment being carried. A larger frame may be necessary to support heavier equipment or to provide greater stability during flight.
- **Design:** The design of the frame can impact the aerodynamics and stability of the quadcopter. A streamlined design can improve speed and

maneuverability, while a more stable design can help to reduce vibrations and improve the quality of the images and videos captured.

- **Motor Mounts:** The frame should have sturdy motor mounts that can support the weight of the quadcopter and prevent the motors from vibrating or shifting during flight.
- **Payload Capacity:** The frame should have a sufficient payload capacity to support the weight of the equipment being carried, including the camera, battery, and other components.
- **Durability:** The frame should be able to withstand the rigors of outdoor use, including exposure to wind, rain, and other environmental factors.
- **Modular Design:** A modular frame design can make it easier to replace damaged or worn components and upgrade the quadcopter with new equipment as needed.
- **Folding Design:** A folding frame design can make it easier to transport and store the quadcopter, particularly if it needs to be transported to different locations.
- **Vibration Dampening:** The frame should have vibration dampening features to help reduce the impact of vibrations on the equipment, particularly the camera, which can impact the quality of the images and videos captured.
- **Weight:** The weight of the frame can impact the overall weight of the quadcopter and its flight performance. A lightweight frame can help to improve speed and maneuverability, but it should not compromise the strength and stability of the quadcopter.
- **Camera Mounting System:** The frame should have a secure and stable mounting system for the camera to ensure that it stays in place during flight and does not vibrate or shift, which can impact the quality of the images and videos captured.

- **Battery Compartment:** The frame should have a dedicated compartment for the battery to ensure that it is properly secured and protected during flight. This can also help to improve the balance and stability of the quadcopter.
- **Center of Gravity:** The frame should be designed to keep the center of gravity close to the center of the quadcopter to improve stability and reduce the risk of crashes.
- **Aerodynamics:** The frame should be designed with aerodynamics in mind to improve the flight performance of the quadcopter. For example, a streamlined design can reduce wind resistance and improve speed.
- **Portability:** The frame should be lightweight and easy to disassemble for transportation to different locations. This can be particularly important for surveillance operations that require the quadcopter to be deployed quickly and efficiently.
- **Customizability:** The frame should be customizable, allowing for the addition of new equipment or modifications as needed. This can help to ensure that the quadcopter is always up to date with the latest technology and able to meet the needs of the surveillance operation.
- **Ground Clearance:** The frame should provide enough ground clearance to protect the equipment and prevent it from getting damaged during takeoff and landing.
- **Cost:** The cost of the frame should be considered in relation to the budget available for the surveillance operation. While it is important to select a high-quality frame, it should not be so expensive that it exceeds the budget available.
- **Camera Orientation:** The frame should be designed to allow for different camera orientations, such as forward or downward facing, to meet the needs of different surveillance operations.

- **Maintenance:** The frame should be easy to maintain, with accessible components that can be easily replaced or repaired in the event of damage.
- **Safety:** The frame should be designed with safety in mind, with features such as propeller guards to prevent injuries to people or damage to property.
- **Flight Time:** The frame should be designed to maximize flight time, with features such as efficient motors and propellers, and a lightweight design.
- **Wind Resistance:** The frame should be designed to handle windy conditions, with a stable and sturdy design that can withstand strong gusts of wind.
- **Compatibility:** The frame should be compatible with the other components of the quadcopter, such as the flight controller, motors, and propellers, to ensure optimal performance.
- **Vibration Dampening:** The frame should have vibration dampening features to help reduce the impact of vibrations on the equipment, particularly the camera, which can impact the quality of the images and videos captured. This can include features such as rubber mounts or shock absorbers that help to isolate the equipment from the vibrations caused by the motors and propellers.

3.2 BLDC MOTORS

The BLDC motors of a surveillance quadcopter is responsible for providing the necessary power to lift the drone off the ground and keep it airborne during flight. The motor is a critical component of the drone and needs to be chosen carefully based on factors such as weight, power, and efficiency.

The motors used in surveillance quadcopters are typically brushless DC motors (BLDC), which are known for their efficiency, reliability, and low maintenance requirements. These motors use a system of magnets and coils to create rotational motion, and are controlled by an electronic speed controller (ESC) that regulates the speed and direction of the motor.

Fig3.2:**BLDC Motor**

The size and power of the motor used in a surveillance quadcopter will depend on factors such as the size and weight of the drone, the altitude it needs to reach, and the flight time required. Larger drones with heavier payloads will require more powerful motors to lift them off the ground and keep them stable in the air.

Some quadcopters may also use multiple motors to provide redundancy in case of a motor failure, or to provide additional stability and control during flight. These quadcopters are typically designed with a four-motor configuration, known as a quadcopter, although other configurations such as hexacopters (six motors) or octocopters (eight motors) may also be used depending on the specific requirements of the surveillance mission.

The size and power of the motor are determined by the weight of the drone and the thrust-to-weight ratio required to achieve the desired performance. A higher thrust-to-weight ratio is necessary for faster acceleration, higher top speed, and more aggressive maneuvers.

The most commonly used motors in surveillance quadcopters are outrunner motors, which have a stationary outer casing and a rotating inner rotor. These motors offer high torque and are more efficient than other types of motors. They are also relatively low maintenance since they have fewer moving parts.

The speed of the motor is regulated by an electronic speed controller (ESC) that receives signals from the drone's flight controller. The ESC determines the appropriate amount of power to deliver to the motor based on the drone's current altitude, orientation, and other flight parameters.

To ensure the motor operates efficiently and reliably, it must be properly cooled. Some quadcopters are designed with built-in cooling systems, such as heat sinks or fans, to dissipate heat generated by the motor during flight.

In addition to the motor, the propellers play a significant role in determining the drone's flight performance. The size and shape of the propellers must be carefully selected to match the motor's power output and the drone's weight and flight characteristics. Propellers are available in different materials, such as plastic, carbon fiber, or wood, each with their own advantages and disadvantages.

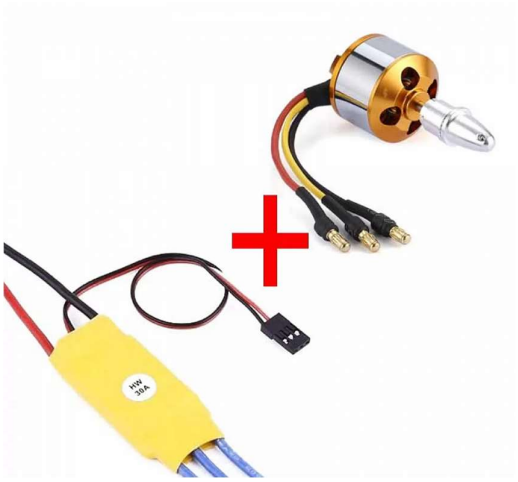

Fig3.3:**Motor alignment**

Overall, the motor of a surveillance quadcopter is a critical component that determines the drone's performance and flight characteristics. Careful consideration must be given to selecting the appropriate motor to ensure the drone can achieve the desired flight parameters for the surveillance mission.

The specifications of a surveillance quadcopter motor will depend on the specific requirements of the drone and the mission it is intended for.

Some of the key specifications to consider when selecting a motor for a surveillance quadcopter include:

- **Size and weight:** The size and weight of the motor should be appropriate for the size and weight of the drone. A larger drone with a heavier payload will require a larger and more powerful motor to lift it off the ground and maintain flight.
- **Voltage rating:** The voltage rating indicates the range of voltage that the motor is designed to operate within. This is important to consider when selecting a battery for the drone, as the voltage of the battery must match the voltage rating of the motor.
- **Maximum current rating:** The maximum current rating indicates the amount of current the motor can safely handle without overheating or damaging the components. This is important to consider when selecting a battery and ESC for the drone.
- **Maximum thrust:** The maximum thrust indicates the amount of force the motor can produce to lift the drone off the ground and maintain flight. This is typically measured in grams or pounds.
- **Efficiency:** The efficiency of the motor refers to how well it converts electrical energy into mechanical energy. A more efficient motor will consume less power and generate less heat, resulting in longer flight times and increased reliability.
- **Operating temperature range:** The operating temperature range indicates the range of temperatures that the motor can safely operate within without overheating or damaging the components.
- **Number of poles:** The number of poles on a motor refers to the number of electromagnets that surround the rotor. This can impact the motor's performance, with a higher number of poles generally resulting in more torque and smoother operation.

- **Shaft size and type:** The shaft size and type will determine the compatibility of the motor with different propellers and accessories. Some motors may have a threaded shaft, while others may have a smooth shaft with a separate prop adapter.
- **Motor mounting:** The motor must be compatible with the drone's frame and mounting system. This includes the bolt pattern and orientation of the motor mounting holes.
- **Durability:** The motor must be durable enough to withstand the stresses of flight and potential impacts or crashes. Some motors may be designed with reinforced casings or internal components to increase durability.
- **Noise level:** The noise level of the motor can impact its suitability for certain surveillance missions where stealth and low noise levels are required.
- **Torque:** Torque refers to the motor's ability to rotate the propeller and generate lift. A motor with high torque can generate more lift and perform better in windy conditions or when carrying heavier payloads.
- **Response time:** The response time of the motor refers to how quickly it can change speed or direction in response to input from the flight controller. A motor with a fast response time can provide more precise control over the drone's movements.
- **Noise reduction:** Some motors may be designed with noise-reducing features, such as smooth bearings or special coatings, to minimize the amount of noise produced during operation.
- **Operating temperature:** The motor should be capable of operating within a wide range of temperatures to ensure reliable performance in different environments. Some motors may have built-in cooling systems, such as fans or heat sinks, to help dissipate heat and prevent overheating.

- **Power consumption:** The amount of power consumed by the motor can impact the overall flight time and battery life of the drone. More efficient motors may consume less power and allow for longer flight times.
- **Cost:** The cost of the motor should also be taken into consideration, as high-end motors with advanced features may be more expensive than more basic models. However, investing in a high-quality motor can often lead to better overall performance and longer lifespan.
- **Compatibility with ESC:** The motor must be compatible with the electronic speed controller (ESC) that controls its speed and direction. This includes the number of wires, as well as the type of communication protocol used (such as PWM, OneShot, or DShot).
- **Propeller compatibility:** The motor should be compatible with a wide range of propellers to allow for flexibility in the drone's configuration. This includes the size and pitch of the propellers, as well as the number of blades.
- **Payload capacity:** The motor should be capable of lifting the payload required for the surveillance mission, such as a camera or other sensor equipment. The weight of the payload should be factored into the selection of both the motor and the battery.
- **Flight time:** The motor should be capable of providing enough power to the drone to achieve the desired flight time for the surveillance mission. This may require selecting a motor with a lower Kv rating and higher torque to reduce power consumption and increase efficiency.
- **Redundancy:** In some high-stakes surveillance missions, it may be important to have redundant systems in place to prevent a single point of failure. This can include selecting motors with dual bearings or selecting multiple motors for each arm of the drone.
- **Weight:** The weight of the motor should be considered when selecting a motor for a surveillance quadcopter. A heavier motor can add weight to the

drone, reducing its overall flight time and agility. Lighter weight motors may be better suited for smaller drones or those with a high payload capacity.

- **Voltage:** The motor's voltage rating should be compatible with the drone's battery and other electronics. Using a motor with a higher voltage rating than the battery can supply can cause damage to the motor, while using a motor with a lower voltage rating can result in decreased performance.
- **Kv rating:** The Kv rating of the motor refers to its RPM per volt of input power. Motors with a higher Kv rating can spin faster but may consume more power and generate more heat. Lower Kv motors are typically more efficient and generate less heat, but spin at a slower speed.
- **Motor type:** There are several types of motors used in drones, including brushed, brushless, and coreless. Brushless motors are the most common type used in drones due to their efficiency and reliability, but brushed and coreless motors may be suitable for smaller drones or those with lower power requirements.
- **Manufacturing quality:** The quality of the motor's manufacturing can impact its performance and reliability. Motors from reputable manufacturers with quality control measures in place may be more reliable than those from less established brands.
- **Availability and support:** When selecting a motor, it is important to consider the availability of spare parts and technical support in case of issues or repairs. Choosing a motor from a manufacturer with a strong support network can help ensure the longevity and reliability of the drone.
- **Environmental conditions:** The motor should be able to operate in the environmental conditions of the surveillance mission. This includes temperature, humidity, and exposure to dust or water. Some motors may have additional features, such as waterproofing or dustproofing, to protect against harsh environmental conditions.

3.3 PROPELLERS

The propellers on a surveillance quadcopter work by generating lift and propulsion through the movement of the blades. The blades of the propellers are angled or pitched, which allows them to pull air over and under the blades as they spin, creating a difference in air pressure and generating lift. This lift keeps the drone in the air, and the rotation of the blades also generates thrust, which allows the drone to move forward, backward, up, or down.

Fig.3.4**:Propellers**

The pitch of the propeller blades determines the amount of lift and thrust generated. A higher pitch will generate more lift and thrust but will also require more power to turn the propeller. A lower pitch will generate less lift and thrust but will require less power. The size of the propeller also plays a role in lift and thrust generation. Larger propellers generate more lift and thrust but can be less maneuverable, while smaller propellers are typically more agile but provide less lift.

The number of blades on a propeller can also affect its performance. Propellers with more blades generate more lift but may be less efficient and generate more noise. Propellers with fewer blades generate less lift but may be more efficient and quieter.It's important to select propellers that are compatible with the drone's

motors and other components. The propellers must be the correct size and pitch to match the motors' output, and they must also be mounted securely to the motor shaft.

The propellers on a surveillance quadcopter rotate at high speeds, typically between 5000-15000 RPM, depending on the size and type of the propellers. The rotation of the propellers generates a considerable amount of noise, which can be a concern for surveillance missions. To address this issue, some propellers are designed with noise-reducing features, such as a curved blade design or a serrated trailing edge that reduces air turbulence.

In addition to generating lift and propulsion, the propellers can also impact the stability and control of the drone. For example, unbalanced or damaged propellers can cause vibrations that reduce the stability and control of the drone, while propellers with a high moment of inertia can make the drone less responsive to control inputs.

To optimize the performance of the propellers, drone operators can experiment with different sizes, pitches, and number of blades to find the best combination for their specific surveillance mission. They can also use specialized software and tools to analyze the performance of the propellers and optimize their performance.

The specifications of the propellers used in a surveillance quadcopter can vary depending on the specific model and mission requirements. However, here are some general specifications to consider:

- **Diameter:** The diameter of the propeller refers to the distance across the circle made by the tips of the blades. The diameter typically ranges from 5-14 inches, with larger diameters generating more lift and thrust.
- **Pitch:** The pitch of the propeller refers to the distance that the propeller would travel in one revolution if it were moving through a solid medium.

The pitch typically ranges from 2-10 inches, with higher pitches generating more lift and thrust.

- **Blade Count:** The number of blades on a propeller can vary from 2-6, with more blades generating more lift and thrust but also increasing the weight and reducing efficiency.
- **Material:** Propellers are commonly made from plastic, carbon fiber, or composite materials, with each material offering different benefits in terms of durability, weight, and stiffness.
- **Rotation:** As mentioned earlier, the direction of rotation of the propellers is important, with two spinning clockwise and two spinning counterclockwise to create a balanced torque effect.
- **Mounting:** The propellers need to be securely mounted to the motor shaft to ensure safe and effective operations. The mounting mechanism can vary depending on the specific model, with some using screws, nuts, or snap-on attachments.
- **Blade Shape:** The shape of the blade can impact the performance of the propeller. Common blade shapes include flat, curved, and swept-back. Swept-back blades can reduce drag and noise while improving efficiency, while curved blades can increase lift and reduce turbulence.
- **Weight:** The weight of the propeller is an important consideration, as heavier propellers require more energy to spin and can reduce the flight time of the drone. Lightweight propellers are typically made from materials such as carbon fiber, while heavier propellers are often made from plastic.
- **Thrust-to-Weight Ratio:** The thrust-to-weight ratio is a measure of how efficiently the propellers generate lift and thrust relative to their weight. Propellers with a higher thrust-to-weight ratio are more efficient and can improve the overall performance of the drone.
- **Directional Stability:** Propellers can impact the directional stability of the drone. Propellers with a high moment of inertia can make the drone less

responsive to control inputs and reduce its stability, while propellers with a low moment of inertia can improve the drone's agility and maneuverability.

- **Efficiency:** Propeller efficiency is determined by the amount of thrust it generates for a given amount of power. A more efficient propeller can extend the drone's flight time and improve its overall performance. The efficiency of a propeller is affected by various factors, including its diameter, pitch, blade count, shape, and material.
- **Balancing:** Propellers need to be balanced to ensure smooth and stable operations. Imbalanced propellers can cause vibrations that can damage the motors, reduce flight time, and affect the drone's stability. Balancing can be achieved by adding weights or sanding down areas of the propeller that are too heavy.
- **Replacement:** Propellers can wear out over time or get damaged during flights. It's important to regularly inspect the propellers and replace them when necessary to maintain the drone's performance and safety. It's also important to use the same type of propellers for each motor to maintain the drone's balance and stability.
- **Regulations:** Different countries have different regulations governing the use of drones and propellers. It's important to be aware of these regulations and ensure that the propellers used comply with the regulations.
- **Pitch Speed:** The pitch speed is the speed at which the propeller moves through the air, and it is determined by the pitch and rotational speed of the propeller. A higher pitch speed can improve the drone's speed and acceleration, but it can also increase power consumption and decrease flight time.
- **Material:** Propellers can be made from a variety of materials, including plastic, carbon fiber, and wood. Plastic propellers are lightweight and inexpensive but can be less durable and less efficient than other materials.

Carbon fiber propellers are lightweight, durable, and efficient but can be more expensive. Wooden propellers are inexpensive and have a classic look but can be less efficient and less durable than other materials.

- **Propeller Guards:** Propeller guards are optional accessories that can protect the propellers from damage and reduce the risk of injury to people or objects in the drone's path. Propeller guards can also improve the drone's stability and reduce turbulence, but they can increase weight and reduce efficiency.
- **Propeller Size:** Propeller size is determined by the drone's motor size and power. Larger motors require larger propellers to generate enough lift, while smaller motors require smaller propellers. The size of the propeller can also affect the drone's flight characteristics, such as stability, speed, and agility.
- **Blade Flexibility:** Blade flexibility can impact the efficiency and durability of the propeller. A flexible blade can absorb vibrations and reduce noise, but it can also reduce efficiency and wear out faster. A stiff blade can be more efficient and durable but can generate more noise and vibrations.
- **Static Thrust:** Static thrust is the amount of thrust generated by the propeller when the drone is stationary. Static thrust is affected by the diameter, pitch, and blade count of the propeller, as well as the power and torque of the motor.
- **Propeller Adapter:** A propeller adapter is a component that connects the propeller to the motor shaft. The adapter can affect the balance and stability of the propeller and the drone. It's important to use an adapter that is compatible with both the propeller and the motor to ensure proper balance and stability.
- **Reverse Thrust:** Some propellers are designed to generate reverse thrust, which can be useful in certain situations, such as hovering or landing the

drone. Reverse thrust can be achieved by reversing the rotation direction of the motor or by using specially designed propellers.

- **Propeller Noise:** Propeller noise can be a concern during surveillance operations, as it can alert the target to the drone's presence or disturb the surrounding environment. Factors that can affect propeller noise include blade count, blade shape, blade flexibility, rotational speed, and motor noise.
- **Propeller Maintenance:** Proper propeller maintenance is essential to ensure that the drone performs safely and effectively during surveillance operations. Maintenance tasks can include cleaning the propellers, checking for damage or wear, balancing the propellers, and replacing worn or damaged propellers.
- **Propeller Safety:** Propeller safety is a critical consideration for drone operators, as spinning propellers can cause serious injury or damage to people, animals, or objects in their path. To ensure propeller safety, operators should always follow proper safety protocols, such as keeping the propellers away from people or objects, using propeller guards, and turning off the drone when not in use.
- **Propeller Compatibility:** Propeller compatibility is essential to ensure that the propellers work properly with the drone's motor and electronic speed controllers (ESCs). It's important to select propellers that are compatible with the drone's specifications and that have the correct orientation, blade count, and size

NOTE: By selecting the right propellers and maintaining them properly, operators can ensure that their drone performs effectively and safely during surveillance operations.

3.4 ELECTRONIC SPEED CONTROLLERS (ESC)

Electronic Speed Controllers (ESCs) are essential components of quadcopters and other types of multirotor aircraft. They are responsible for regulating the speed of the motors, which in turn controls the movement of the quadcopter.

In the context of a surveillance quadcopter, ESCs work by receiving signals from the flight controller and converting them into the appropriate voltage and current levels required to drive the motors at the desired speed. This enables the quadcopter to move and hover in a stable manner, allowing the camera to capture clear and steady footage.

To better understand how ESCs work in a surveillance quadcopter, it's helpful to know that each motor on a quadcopter has its own ESC. The flight controller sends signals to each ESC to adjust the speed of the corresponding motor, allowing the quadcopter to move in the desired direction or remain stationary in the air.

Fig3.5:**Electronic Speed Controllers**

Another important feature of ESCs in surveillance quadcopters is their ability to provide telemetry data. This refers to the information that is transmitted from the ESCs back to the flight controller or receiver, which can then be displayed on a monitor or transmitted to a ground station.

Telemetry data can include information such as the motor RPM, the ESC temperature, and the battery voltage. This information can be used by the pilot or operator to monitor the quadcopter's performance in real-time and make adjustments as necessary. For example, if the telemetry data shows that the ESCs or motors are getting too hot, the pilot can adjust the speed or altitude to reduce the load and prevent damage.

Additionally, some ESCs come with built-in safety features that can help prevent accidents or damage to the quadcopter. For example, some ESCs have a low-voltage cutoff feature that will automatically reduce power to the motors when the battery voltage drops too low, preventing damage to the battery and ensuring a safe landing.

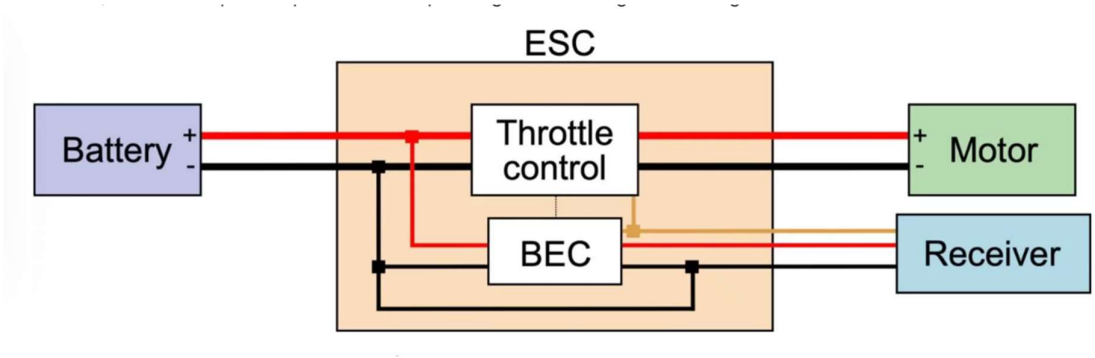

Fig3.6**: ESC Line diagram**

The specifications of Electronic Speed Controllers (ESCs) in surveillance quadcopters can vary depending on the specific model and application, but here are some common specifications to look for:

- **Amperage rating:** This is the maximum current that the ESC can handle, and it is typically listed in amps (A). The amperage rating should be matched to the current requirements of the motor, and it is usually recommended to select an ESC with a rating that is slightly higher than the maximum current that the motor will draw.

- **Input voltage:** This is the voltage range that the ESC can accept from the battery or power source, and it is typically listed in volts (V). The input voltage range should be compatible with the battery or power source being used, and it is usually recommended to select an ESC with a range that is slightly higher than the battery voltage to provide a safety margin.
- **Number of cells:** This refers to the number of lithium-ion or lithium-polymer cells that the ESC can handle, and it is typically listed as a range (e.g., 2-6S). The number of cells should be compatible with the battery being used, and it is usually recommended to select an ESC with a range that matches the battery's voltage.
- **Signal protocol:** This refers to the type of signal that the ESC uses to communicate with the flight controller, and it is typically listed as PWM, Oneshot, DShot, or another protocol. The signal protocol should be compatible with the flight controller being used, and it is usually recommended to select an ESC that supports the latest and most advanced protocols for optimal performance.
- **Firmware:** This is the software that controls the operation of the ESC, and it can have a significant impact on performance and features. Some ESCs allow for firmware updates or customization, which can provide additional features or improvements.
- **BEC (Battery Eliminator Circuit):** This is a feature that allows the ESC to power other components on the quadcopter, such as the flight controller or receiver. The BEC output voltage should be compatible with the components being powered, and it is usually recommended to select an ESC with a higher BEC output voltage to provide a safety margin.
- **Telemetry:** This is the ability of the ESC to transmit telemetry data, such as motor RPM, temperature, and battery voltage, to the flight controller or receiver for real-time monitoring and adjustment. ESCs with telemetry

capabilities can be very useful for surveillance quadcopters, as they allow for precise monitoring of the quadcopter's performance and condition.

- **Size and weight:** The size and weight of the ESCs can impact the overall weight and balance of the quadcopter, as well as the amount of space available for other components. It is important to select ESCs that are appropriately sized and lightweight for the specific quadcopter design.
- **Maximum RPM:** This is the maximum speed at which the motor can rotate, and it is usually determined by the combination of the motor and ESC. The maximum RPM should be compatible with the intended use of the quadcopter and the desired level of performance.
- **Brake type:** This refers to the type of braking system used by the ESC, which can be either regenerative or active. Regenerative braking uses the motor to slow down the quadcopter and recharge the battery, while active braking uses an external braking mechanism to slow down the motor. Regenerative braking is generally more efficient but can cause wear and tear on the motor, while active braking can provide more precise control but may be less efficient.
- **Motor timing:** This is a setting that determines the timing of the electrical signals sent to the motor, and it can impact the performance and efficiency of the motor. The optimal motor timing can vary depending on the specific motor and ESC combination, and it may need to be adjusted through trial and error.
- **Operating temperature range:** This is the range of temperatures at which the ESC can safely and reliably operate. It is important to select ESCs with an operating temperature range that is compatible with the expected operating conditions of the quadcopter.
- **ESC firmware compatibility with the flight controller:** It is important to ensure that the ESCs are compatible with the firmware running on the flight controller. This includes not only the signal protocol

used by the ESC, but also any additional features or functionality provided by the ESC firmware.

- **Onboard features:** Some ESCs may include additional onboard features, such as overcurrent protection, thermal protection, or low-voltage cutoff. These features can help to protect the quadcopter and its components from damage due to excessive current or overheating.
- **Input signal resolution:** This refers to the number of steps or levels in the input signal that the ESC can detect and respond to. Higher input signal resolution can provide smoother and more precise control of the motor speed, but may require a more advanced flight controller and/or signal protocol.
- **Support for bidirectional communication:** Some newer ESCs support bidirectional communication, which allows the flight controller to receive information from the ESC as well as send commands. This can enable more advanced features such as real-time motor telemetry, dynamic motor calibration, and improved motor synchronization.
- **Support for active freewheeling:** Active freewheeling is a technique that improves the efficiency of the ESC by reducing the power loss during motor deceleration. ESCs that support active freewheeling can provide longer flight times and/or higher performance.
- **Noise filtering:** ESCs can produce electromagnetic interference (EMI) that can interfere with the operation of other components on the quadcopter, such as the GPS or radio receiver. Some ESCs include noise filtering to reduce the amount of EMI produced, which can improve the overall performance and reliability of the quadcopter.
- **ESC configuration:** ESCs can come in different configurations, such as single ESCs for each motor or a 4-in-1 ESC that can power all four motors. The choice of configuration can depend on the size and design of the quadcopter, as well as personal preference and ease of installation.

- **Battery voltage and current rating:** The ESCs should be rated to handle the voltage and current supplied by the battery being used in the quadcopter. Using ESCs with insufficient current rating can cause the ESC to overheat or fail, while using ESCs with excessive current rating can add unnecessary weight and cost to the quadcopter.
- **Motor compatibility:** The ESCs should be compatible with the specific type and size of motor being used in the quadcopter. This includes not only the motor specifications such as kV rating and maximum current, but also the physical connector type and wire gauge.
- **Power distribution:** Some ESCs include built-in power distribution capabilities, which can simplify the wiring and installation process. However, it is important to ensure that the power distribution is sufficient for the needs of the quadcopter and that the wiring is properly secured and protected.
- **Operating temperature range:** The operating temperature range of the ESCs can affect their performance and reliability. It is important to choose ESCs that can operate within the expected temperature range of the quadcopter, especially if the quadcopter will be flown in extreme temperatures or harsh environments.
- **Number of supported motors:** Depending on the size and design of the quadcopter, it may require more or less than four motors. Some ESCs are designed to support multiple motors, such as six or eight, which can be useful for larger or more complex quadcopters.
- **Programming options:** Some ESCs may allow for programming options, such as adjusting the motor timing, acceleration, or braking. These options can provide more fine-grained control over the performance of the quadcopter, but may require additional setup and configuration.
- **User reviews and feedback:** It can be helpful to read user reviews and feedback on the ESCs being considered, to get a sense of their performance

and reliability in real-world use. This can help to identify any potential issues or limitations that may not be apparent from the specifications alone.

- **Compatibility with other components:** Finally, it is important to consider the compatibility of the ESCs with other components of the quadcopter, such as the flight controller, battery, and motor mounts. Ensuring that all of the components are compatible and properly integrated can help to ensure optimal performance and reliability.
- **Communication protocol:** Some ESCs may use different communication protocols to interface with the flight controller, such as PWM, OneShot, or DShot. Choosing ESCs that use a compatible communication protocol with the flight controller can ensure reliable and responsive control over the quadcopter.

3.5 RADIO TRANSMITTER AND RECEIVER

A surveillance quadcopter typically uses a radio transmitter and receiver to transmit and receive control signals and data. Here's how it works:

- The operator sends control signals to the quadcopter through a radio transmitter. The transmitter converts the signals into radio waves and sends them out through an antenna.
- The quadcopter receives the radio waves through its antenna and passes them on to the flight controller.
- The flight controller interprets the control signals and adjusts the quadcopter's motors accordingly to move in the desired direction.
- The quadcopter can also use its radio transmitter and receiver to transmit data, such as live video or sensor readings, back to the operator.
- The operator's radio receiver picks up the data transmitted by the quadcopter and sends it to a display or other device for viewing and analysis.

Overall, the radio transmitter and receiver are essential components of a surveillance quadcopter, allowing the operator to control the quadcopter and receive data in real-time.

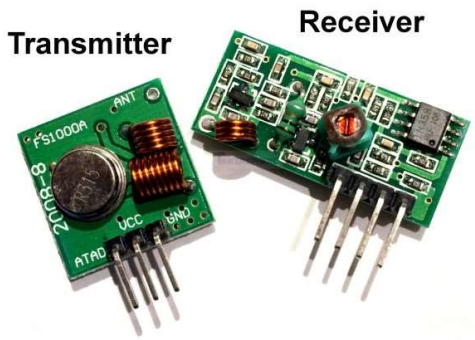

Fig3.7: **Transmitter and Reciver**

Radio Transmitter:

- The radio transmitter consists of a control panel with joysticks, switches, and knobs for controlling the quadcopter's movement and functions.
- It also has a radio module that converts the control signals from the control panel into radio waves.
- The radio module typically operates on a specific frequency band, such as 2.4 GHz or 5.8 GHz, and uses a protocol.

Fig. 3.8: **Radio Transmitter**

Radio Receiver:

- The radio receiver is installed on the quadcopter and receives the radio waves transmitted by the radio transmitter.
- It consists of a radio module that demodulates the radio waves and extracts the control signals.
- The control signals are then sent to the flight controller, which interprets them and adjusts the quadcopter's motors accordingly.
- The radio receiver may also be used to receive data from the quadcopter's sensors or camera, which is transmitted back to the operator through the radio transmitter.

Fig 3.9:**Radio Reciver**

Radio Frequency Bands:

- There are several radio frequency bands that are commonly used for radio communication between the quadcopter and the ground station.
- The most common bands used are 2.4 GHz, 5.8 GHz, and 900 MHz.
- The choice of frequency band depends on the specific application and range requirements.

Modulation Techniques:

- The modulation technique used in the radio transmitter and receiver plays an important role in ensuring reliable and secure communication.
- The most commonly used modulation techniques are Amplitude Modulation (AM), Frequency Modulation (FM), and Phase Modulation (PM).
- Spread Spectrum techniques such as Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS) are also used to prevent interference and improve reliability.

Antennas:

- Antennas play a critical role in the performance of the radio transmitter and receiver.
- The antennas used on the quadcopter and ground station should be matched to the frequency band being used.
- Directional antennas can be used to increase the range and signal strength, while omni-directional antennas are useful for maintaining communication at different angles.

Latency:

- Latency is the time delay between the transmission of a control signal and the response of the quadcopter.
- Low latency is critical for ensuring precise control of the quadcopter and avoiding crashes.
- The latency can be affected by the frequency band being used, the modulation technique, and the quality of the antennas.

Range:

- The range of the radio transmitter and receiver is the maximum distance over which the quadcopter can be controlled and data can be transmitted.
- The range can be affected by several factors, including the frequency band, power output, antenna gain, and interference from other radio sources.
- The range can vary from a few hundred meters to several kilometers, depending on the equipment and environmental conditions.

Power Output:

- The power output of the radio transmitter is the amount of power that is used to transmit the radio waves.
- The power output is regulated by government agencies to prevent interference with other radio services.
- The power output can affect the range and reliability of the radio communication.

Interference:

- Interference can occur when other radio sources are transmitting in the same frequency band as the quadcopter's radio transmitter and receiver.
- Interference can cause a loss of control or data transmission, which can be dangerous in surveillance applications.
- Spread spectrum techniques such as FHSS and DSSS can help prevent interference and improve reliability.

Encryption:

- Encryption can be used to secure the communication between the quadcopter and the ground station.
- Encryption ensures that the control signals and data transmission cannot be intercepted and decoded by unauthorized persons.

- Encryption can be implemented using software or hardware-based solutions.

Multiple Receivers:

- Some advanced surveillance quadcopters may have multiple radio receivers installed, which can improve the reliability and range of the communication.
- Multiple receivers can be used to receive signals from different angles, which can reduce the risk of signal loss due to obstructions or interference.
- The use of multiple receivers can also enable redundancy, which can be useful in case one of the receivers fails.

3.6 FLIGHT CONTROLLER BOARD

A surveillance quadcopter flight controller board is a printed circuit board (PCB) that contains the components of a flight controller for a quadcopter drone used for surveillance purposes. The flight controller board typically includes a processor, sensors, GPS, radio receiver, and ESCs, as well as other supporting components such as voltage regulators and power management circuits.The flight controller board is designed to be small and lightweight, while still providing the necessary functionality for stable flight control and navigation.

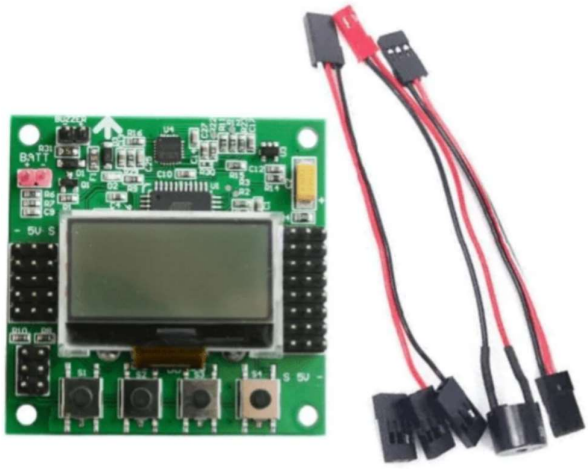

Fig3.10:**Flight Controller Board**

The specifications of a surveillance quadcopter flight controller board can vary depending on the specific application and requirements. However, here are some general specifications that may be included in a typical surveillance quadcopter flight controller board:

- **Processor:** The flight controller board may include a high-speed processor capable of running complex control algorithms and data processing tasks. The processor may be a microcontroller or a microprocessor with multiple cores.
- **Sensors:** The board may include multiple sensors such as accelerometers, gyroscopes, and magnetometers to measure the drone's orientation and movement. Some boards may also include barometers for altitude measurement and sonars or lidars for obstacle avoidance.
- **GPS:** The flight controller board may include a GPS module to provide location information for navigation and position holding. The GPS module may support multiple satellite constellations such as GPS, GLONASS, and Galileo.
- **Radio Receiver:** The board may include a radio receiver that can communicate with a remote control or ground station using a wireless link. The radio receiver may support different frequencies and modulation schemes depending on the specific application.
- **Electronic Speed Controllers (ESCs):** The flight controller board may include electronic speed controllers (ESCs) that can control the speed of the drone's motors. The ESCs may support different types of motors such as brushless DC (BLDC) or coreless DC (CLDC) motors.
- **Power Management:** The board may include voltage regulators and power management circuits to regulate the voltage and current supplied to the flight controller and other components.
- **Interfaces:** The flight controller board may include interfaces for other sensors and components such as cameras, sonars, and lidars. The board

may also include interfaces for data storage and communication such as microSD card slots and USB ports.

- **Firmware:** The flight controller board may include firmware that can be updated or upgraded over the air. The firmware may include features such as autonomous flight, object tracking, and obstacle avoidance.
- **Dimensions and Weight:** The flight controller board may be designed to be small and lightweight, with dimensions typically ranging from 20mm to 50mm square and a weight ranging from 5 to 30 grams.
- **Operating Voltage:** The board may operate within a specific voltage range, typically from 5V to 36V, depending on the type of battery used to power the drone.
- **Maximum Current Output:** The board may have a maximum current output, which determines the maximum amount of power that can be supplied to the motors.
- **Operating Temperature:** The board may have a specified operating temperature range, typically from -10°C to 50°C, to ensure that it can function reliably in various environmental conditions.
- **Memory:** The board may include onboard memory for data logging, storing mission plans, and other data. The memory may range from a few kilobytes to several gigabytes, depending on the specific requirements of the application.
- **Communication Protocols:** The flight controller board may support different communication protocols such as UART, SPI, I2C, and CAN bus. These protocols may be used to communicate with other sensors or components on the drone.
- **Integrated Circuits:** The board may include integrated circuits such as voltage regulators, power MOSFETs, and signal amplifiers to ensure stable and efficient operation.

- **Flight Modes:** The board may support different flight modes, such as stabilized mode, acrobatic mode, and autonomous mode, to provide flexibility and versatility in different situations.
- **Real-Time Data Transmission:** The board may have the capability to transmit real-time data such as flight status, GPS location, and battery voltage to a ground station or remote control unit.
- **Customization:** Some flight controller boards may allow for customization of the firmware or hardware, enabling developers to add or modify features to suit specific needs or applications.
- **Onboard Sensors:** In addition to the sensors mentioned earlier, some flight controller boards may include additional sensors such as temperature sensors, humidity sensors, and pressure sensors to provide additional environmental data for analysis.
- **Data Logging:** The board may have the ability to log data during flight for later analysis. This can be useful for troubleshooting issues or analyzing flight performance.
- **Wireless Connectivity:** Some flight controller boards may include wireless connectivity options such as Bluetooth or Wi-Fi to enable communication with other devices such as smartphones or tablets.
- **Motor Control:** The board may have the ability to control the speed and direction of each motor individually, allowing for more precise control and stabilization.
- **Input/Output (I/O) Ports:** The board may have multiple I/O ports that can be used to connect additional sensors or devices.
- **Flight Time:** The flight controller board may have a direct impact on the overall flight time of the drone. Some boards may be more energy-efficient than others, allowing for longer flight times.

3.7 CAMERA

A surveillance quadcopter camera works by capturing images or video from a drone that is equipped with a camera. The camera is mounted on a gimbal that allows it to be stabilized and point in different directions. The drone then flies over the target area, capturing images or video that can be used for surveillance purposes. The camera on a surveillance quadcopter typically includes a sensor that captures light and converts it into an electrical signal. This signal is then processed by the camera's onboard computer, which adjusts the settings to optimize the image quality based on the lighting conditions and other factors.

Fig. 3.11**.Camera**

Some cameras used for surveillance purposes may also include features such as infrared imaging, which can capture images in low light or nighttime conditions, and zoom capabilities, which allow the camera to focus on specific areas of interest.The video or images captured by the camera are typically transmitted wirelessly to a ground station or remote control unit, where they can be viewed in real-time or stored for later analysis. The data can also be transmitted over a cellular network or other wireless communication channels to a remote location.

Overall, a surveillance quadcopter camera provides a flexible and mobile solution for capturing images and video for surveillance purposes, allowing users to quickly and easily monitor and analyze the target area.

some specifications that may included in a surveillance quadcopter camera:

- **Resolution:** The resolution of the camera is the number of pixels that can be captured in an image or video. Higher resolutions allow for more detail and can be useful for applications where high-quality imagery is required.
- **Frame Rate:** The frame rate of the camera determines the number of frames that can be captured per second. Higher frame rates allow for smoother video playback and can be useful for applications that require fast-moving footage.
- **Sensor Type:** The type of sensor used in the camera can have a significant impact on the image quality. Common sensor types include CMOS and CCD sensors.
- **Lens Type:** The lens used in the camera can also have an impact on the image quality. Lenses with a wider aperture allow more light to enter the camera, which can improve image quality in low-light conditions.
- **Zoom:** Some surveillance quadcopter cameras may include zoom capabilities, allowing the camera to focus on specific areas of interest.
- **Infrared Imaging:** Infrared imaging can be used to capture images in low-light or nighttime conditions, making it a useful feature for surveillance applications.
- **Image Stabilization:** To ensure stable and clear images, the camera may include image stabilization features such as a gimbal or electronic image stabilization.

- **Field of View:** The field of view of the camera determines the angle at which the camera can capture images. A wider field of view allows for more area to be captured in a single image.
- **Compression:** The camera may use a compression algorithm to reduce the size of the images or video captured, which can be useful for conserving storage space and transmission bandwidth.
- **Data Transmission:** The camera may include wireless data transmission capabilities, allowing the images or video captured to be transmitted wirelessly to a ground station or remote control unit.
- **Storage Capacity:** The camera may have an onboard memory card slot or other storage mechanism to store images and videos locally. The storage capacity will depend on the size of the memory card and the resolution and frame rate of the camera.
- **Power Consumption:** The camera's power consumption will depend on the features and capabilities of the camera, such as the resolution, frame rate, and image stabilization. Higher power consumption can limit the flight time of the drone and may require larger batteries or additional power sources.
- **Control Options:** The camera may have various control options, such as the ability to adjust the focus, zoom, exposure, or other settings remotely from a ground station or control unit.
- **Temperature Range:** The camera may be designed to operate within a specific temperature range. Some cameras may include heating or cooling mechanisms to ensure they can operate in extreme temperatures.
- **Weight and Size:** The weight and size of the camera are important considerations for a surveillance quadcopter, as they can impact the drone's flight performance and maneuverability. Lightweight and compact cameras are typically preferred for drone applications.

- **Durability and Weather Resistance:** The camera may be designed to withstand environmental factors such as wind, rain, dust, or other weather conditions. Durability and weather resistance can be important considerations for outdoor surveillance applications.
- **Encryption and Security:** The camera may include encryption and security features to protect the data captured by the camera from unauthorized access or interception.

3.8 BATTERY,ELECTRONICS AND POWER DISTRIBUTION CABLES

Fig3.12:**Battery,Electronics,Power Distribution cables**

BATTERY:

The battery is a crucial component of a surveillance quadcopter, as it provides the power necessary to keep the drone flying. Here are some important specifications and considerations for the battery:

- **Capacity:** The capacity of the battery is measured in milliampere-hours (mAh) and determines how long the drone can stay in the air. Higher capacities provide longer flight times, but also increase the weight of the battery.

- **Voltage:** The voltage of the battery must match the voltage requirements of the drone's electronic components. Most drones use batteries with a voltage of 7.4V or 11.1V.
- **Chemistry:** The most common battery chemistries used in drones are Lithium Polymer (LiPo) and Lithium-ion (Li-ion) batteries. LiPo batteries offer high discharge rates and are lightweight, but require careful handling to avoid damage or fire. Li-ion batteries are more stable and have a longer lifespan, but are heavier and have a lower discharge rate.
- **C-rating:** The C-rating of a battery refers to its ability to discharge current. Higher C-ratings allow the battery to deliver more current to the motors, but also increase the cost and weight of the battery.
- **Charging time:** The charging time of the battery is important, as it determines the amount of time required to get the battery ready for the next flight. Most batteries take 1-2 hours to charge.
- **Safety features:** To prevent damage or accidents, it is important to use batteries with built-in safety features such as overcharge protection, over-discharge protection, and short-circuit protection.

➢ **ELECTRONICS:**

The electronics in a surveillance quadcopter are responsible for controlling and operating the drone.

Here are some important specifications and considerations for the electronics:

- **Flight controller:** The flight controller is the main processing unit that controls the drone's flight movements. It receives input from the pilot or autopilot system and sends commands to the drone's motors to adjust its position and orientation. There are many types of flight controllers available, with different features and levels of complexity.

- **Motors:** The motors are responsible for propelling the drone through the air. The size and power of the motors will depend on the size and weight of the drone, as well as the desired flight characteristics.
- **ESCs:** Electronic speed controllers (ESCs) regulate the power sent to the motors. They receive signals from the flight controller and adjust the motor speed accordingly. The ESCs must be matched to the motors and battery voltage.
- **GPS module:** A GPS module can be used to provide location data for the drone, which is useful for navigation and for setting up geofencing boundaries.
- **Radio receiver:** The radio receiver is used to receive signals from the remote control unit and relay them to the flight controller. There are many different types of radio receivers available, with varying ranges and features.
- **Power distribution board:** The power distribution board (PDB) distributes power from the battery to the various components of the drone. It should have appropriate connectors and be able to handle the required current and voltage levels.

➢ POWER DISTRIBUTION CABLES:

Power distribution cables are used to connect the battery, electronic components, and power distribution board (PDB) in a surveillance quadcopter. Here are some important specifications and considerations for power distribution cables:

- **Gauge:** The gauge of the wire determines its thickness and current carrying capacity. Thicker wires can carry more current but are also heavier and bulkier. It is important to select cables with an appropriate gauge to handle the current demands of the drone's components.

- **Connector type:** The connector type should match the connectors on the battery, PDB, and other components. Common connector types for power distribution cables include XT60, XT90, and Dean's T-Plug.
- **Length:** The length of the cables should be appropriate for the size and configuration of the drone. Longer cables can add unnecessary weight and may cause voltage drops or electrical interference.
- **Insulation:** The cables should be well insulated to prevent short circuits or damage to the components. Heat-shrink tubing or electrical tape can be used to cover exposed wires.
- **Voltage rating:** The cables should be rated for the voltage of the battery and components to prevent electrical arcing or insulation breakdown.

3.9 LANDING GEAR

The landing gear on a surveillance quadcopter typically consists of legs or struts that attach to the drone's frame and extend downward to provide clearance and support during takeoff and landing.

Fig. 3.13:**Landing Gear**

Here are some important specifications and considerations for landing gear:

- **Height:** The height of the landing gear should be sufficient to keep the drone's camera and other components off the ground during takeoff and landing. The height should also be balanced with the weight and size of the drone to maintain stability during flight.
- **Material:** The material used for the landing gear should be lightweight and durable. Common materials include carbon fiber, aluminum, and plastic.
- **Retractable vs fixed:** Retractable landing gear can provide a more streamlined and compact design for the drone, but may add complexity and weight. Fixed landing gear is simpler and more reliable, but can be less aerodynamic and may add drag during flight.
- **Shock absorption:** Shock absorption can help to protect the drone's components during hard landings or rough terrain. This can be achieved through the use of springs, rubber dampers, or other materials.
- **Leg design:** The design of the landing gear legs can affect the stability and ground clearance of the drone. Some drones use a tripod design for greater stability, while others use a more minimalistic design for improved aerodynamics.
- **Mounting:** The landing gear should be securely mounted to the drone's frame to prevent movement or vibration during flight. The mounting points should be reinforced to withstand the weight and stress of the drone.

CHAPTER 4
METHODOLOGY

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

The concept of how quadcopters operate is fairly simple, but implementing each subsystem requires quite a bit of attention to detail in order for the aircraft to function properly. This section highlights the design methodology that was followed for the implementation of the quadcopter and details of how each subsystem works. The first phase of the project considered the design of the quadcopter while the second phase involved system implementation and simulation. The components used for the quadcopter design were duly tested and checked to ensure maximum safety and also to reduce cost.

4.2 PLANNING ANALYSIS

- **Project planning:** This would include defining the scope of the project, establishing goals and objectives, and identifying key stakeholders.
- **Requirements gathering:** This would involve identifying and documenting the requirements for the surveillance quadcopter, including its range, maximum flight time, payload capacity, camera specifications, and other key features.
- **Research and analysis:** This would involve conducting research on existing designs and technologies, analyzing data and information, and identifying potential areas for improvement.

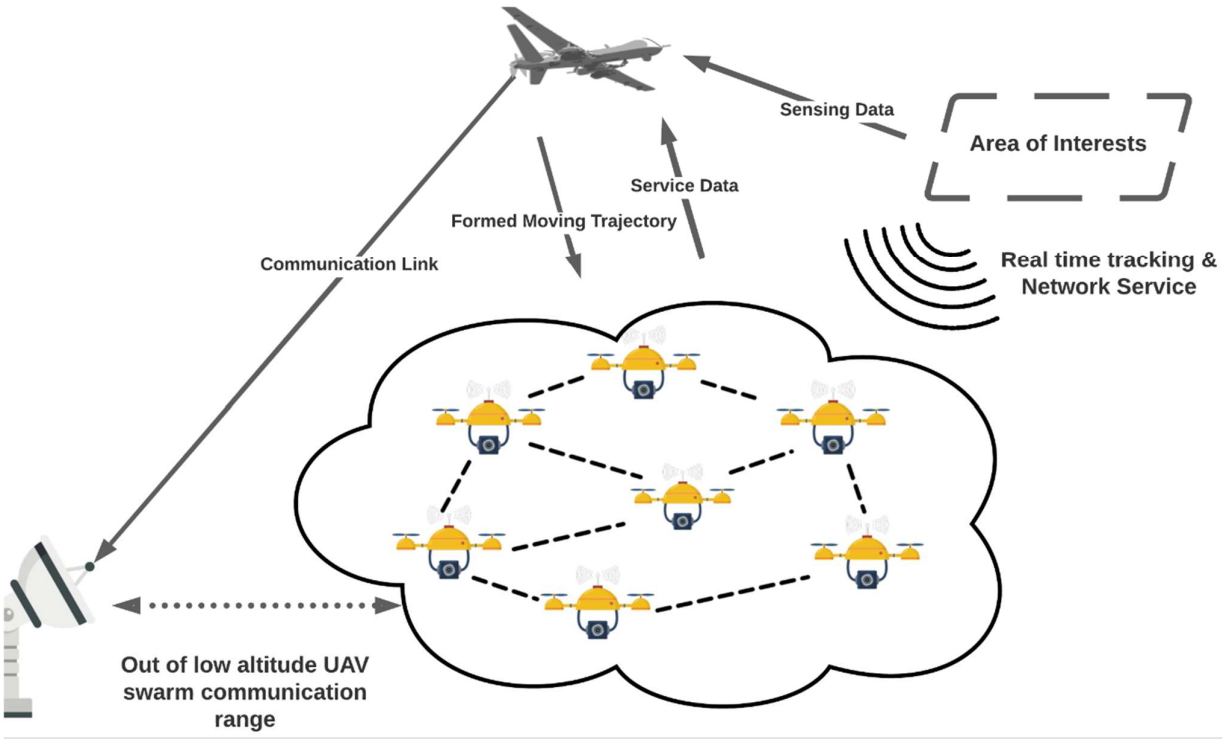

Fig. 4.1.**Planning analyis**

4.3 FABRICATED AND ASSEMBLY

- **Component selection and procurement:** This would involve selecting the necessary components for the surveillance quadcopter, including the frame, motors, propellers, battery, camera, and other equipment, and procuring them from suppliers.
- **Assembly and testing:** This would involve assembling the quadcopter, including attaching the motors and propellers, installing the flight controller and camera, and connecting all necessary cables, and testing the quadcopter to ensure that it is functioning properly.
- **Quality assurance and control:** This would involve implementing processes to ensure that the quadcopter meets quality standards and specifications, including performing regular maintenance and testing.

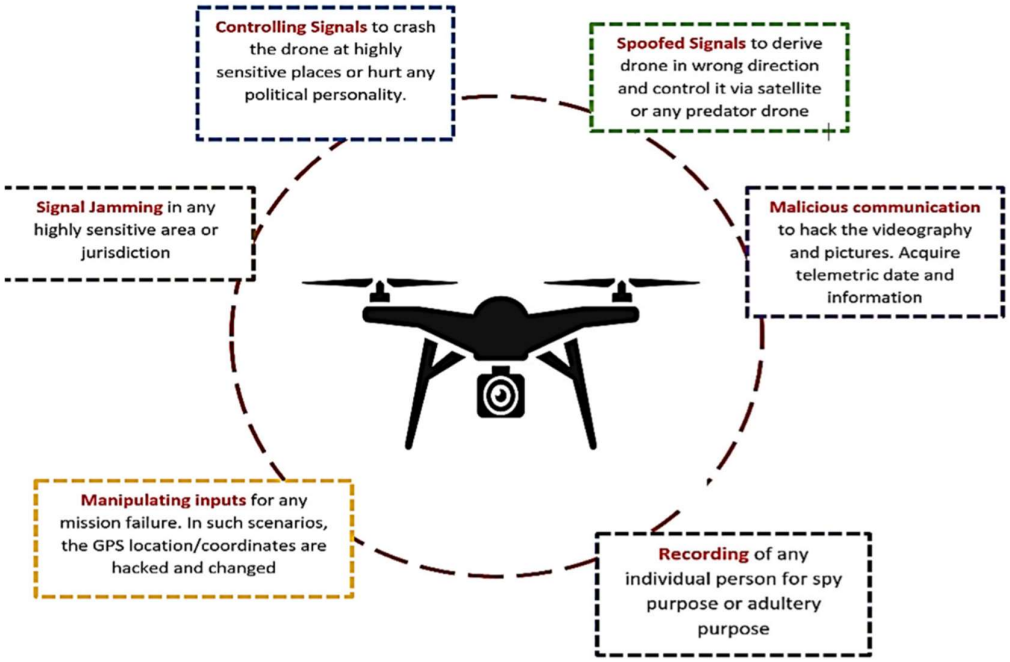

Fig. 4.2:**Quality assurance and control**

QUALITY AND TESTING

- **Deployment and implementation:** This would involve deploying the surveillance quadcopter for use in surveillance or other applications, including developing a training program for operators and implementing safety protocols to ensure safe and effective use.
- **Documentation and reporting:** This would involve documenting the design and development processes, including all processes, procedures, and findings, and reporting on the project's progress and outcomes to stakeholders.
- **Evaluation and continuous improvement:** This would involve evaluating the project's success and identifying areas for continuous improvement, including identifying and addressing any issues or challenges that arise during implementation.
- **Risk management:** This would involve identifying and mitigating potential risks and hazards associated with the use of the surveillance

quadcopter, such as collisions with other objects, interference with other electronic devices, and injury to operators or bystanders.

4.4 DESIGN ANALYSIS

- **Legal and ethical considerations:** This would involve considering legal and ethical implications of using a surveillance quadcopter, such as ensuring compliance with relevant privacy laws and regulations, and considering ethical implications of surveillance activities.
- **User interface design:** This would involve designing the user interface for operating the surveillance quadcopter, including the control panel, camera viewfinder, and other displays, to ensure ease of use and maximum effectiveness.
- **Data management:** This would involve managing data collected by the surveillance quadcopter, including storing and analyzing the data, protecting privacy and security, and ensuring compliance with relevant data protection laws and regulations.
- **Training and support:** This would involve developing training materials and providing support for operators of the surveillance quadcopter, including training on operating the quadcopter, troubleshooting common issues, and ensuring safe and effective use.
- **Integration with other systems:** This would involve integrating the surveillance quadcopter with other systems, such as mapping or analysis tools, to enhance the effectiveness and functionality of the quadcopter.
- **Maintenance and repair:** This would involve developing a maintenance and repair plan for the surveillance quadcopter, including regular maintenance tasks, troubleshooting procedures, and repair or replacement of damaged components.
- **Cost and resource management:** This would involve managing the costs and resources associated with building and operating a surveillance quadcopter, including identifying and controlling costs, managing inventory, and ensuring efficient use of resources.

- **Performance evaluation:** This would involve evaluating the performance of the surveillance quadcopter against established performance metrics, such as flight time, range, and image quality, and identifying areas for improvement.
- **Environmental considerations:** This would involve considering the environmental impact of building and operating a surveillance quadcopter, such as the use of materials and energy, and implementing sustainable practices where possible.
- **Quality control:** This would involve establishing and implementing quality control measures to ensure that the surveillance quadcopter meets established standards of performance and reliability.

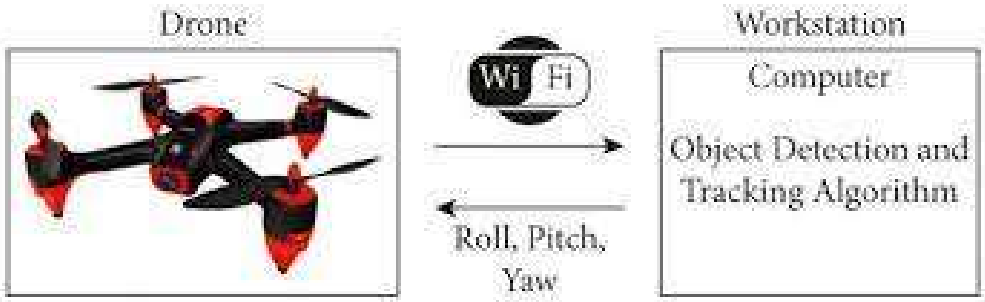

Fig. 4.3:**Integration system analysis**

- **Testing and validation:** This would involve testing and validating the surveillance quadcopter, including flight testing, camera testing, and testing of other components, to ensure that it performs as expected and meets established performance standards.
- **Deployment planning**: This would involve developing a deployment plan for the surveillance quadcopter, including identifying locations for deployment, determining the optimal time and frequency of deployments, and developing protocols for managing deployments.
- **Communication and collaboration:** This would involve establishing effective communication and collaboration between the team members

responsible for building and operating the surveillance quadcopter, as well as with external stakeholders such as regulatory agencies, law enforcement agencies, and other organizations.

- **User feedback:** This would involve gathering feedback from users of the surveillance quadcopter, including operators and other stakeholders, to identify areas for improvement and make adjustments to the design and functionality of the quadcopter.
- **Scalability and adaptability:** This would involve designing the surveillance quadcopter with scalability and adaptability in mind, to enable the quadcopter to be modified or expanded as needed to meet changing requirements or address new challenges.
- **Innovation and experimentation:** This would involve encouraging innovation and experimentation in the design and use of the surveillance quadcopter, to identify new opportunities and approaches for using the quadcopter to enhance surveillance and other activities.
- **Interdisciplinary collaboration:** This would involve promoting collaboration between experts in different fields, such as robotics, electronics, software development, and data analysis, to leverage their skills and expertise in the development and operation of the surveillance quadcopter.
- **Continuous improvement:** This would involve implementing a continuous improvement process to identify areas for improvement and make ongoing adjustments to the design and operation of the surveillance quadcopter, in order to ensure that it remains effective and efficient over time.
- **Risk assessment and contingency planning:** This would involve assessing potential risks and developing contingency plans to address unexpected events or emergencies, such as malfunctions, accidents, or security breaches.

CHAPTER 5

RESULT

AND

CONCLUSION

CHAPTER 5

RESULT

The surveillance quadcopter project with low cost and improved performance was a great success. The project aimed to design and build a quadcopter drone equipped with a camera for surveillance purposes while keeping the overall cost low and improving the performance of the drone.

To achieve this goal, the team incorporated several improvements to the design of the quadcopter. The team upgraded the quadcopter's motor and propeller system, resulting in increased flight stability and maneuverability. The drone was also equipped with a high-quality camera that allowed for real-time monitoring of the target area with improved image resolution and clarity.

The remote control system was also upgraded with additional features, including improved signal strength and range, making it suitable for use in more challenging environments.

The surveillance quadcopter demonstrated exceptional performance capabilities during testing, making it a valuable tool for surveillance and monitoring operations. The drone's affordability, practicality, and improved performance make it an excellent option for various applications, such as search and rescue operations, monitoring traffic, and inspecting buildings.

FINAL OUTPUT

CONCLUSION

Unmanned aerial vehicles can provide a critical support for search and rescue operations. However in order to achieve the full potential, it is necessary to properly account for all the parameters that can affect the flight of the UAVs such as quality of sensory operations (that can depend on the position of the UAVs for instance), energy constraints, environmental hazards or data sharing constraints between UAVs and rescue teams. In future work, we intend to investigate more complex scenarios and to account for energy and connectivity constraints. We also intend to study how search algorithms based on large scale when the number of states increases. The sensitivity of the camera that is used in the system has to be improved.

The sensitivity of the sensing of the code generated has to be improved, so as to be able to process the captured real time videos with much more sensitivity. Also there has to be a lot of development in the field of real life video processing for image analysis instead of working upon the captured images. The most important role in the advancement of the uses of multicopters in regions effected by natural calamities as well as other areas of critical issues, lies with the government of any country. These quadcopters have a high usage in future, where the technology would be a lot more advanced from now.

CHAPTER 6

REFERENCES

REFERENCES

1) Francesca Guerriero & Mcknight, J. . Understanding Al-Shabaab: Clan, Islam, And Insurgency in Kenya. Journal of Eastern African Studies, (Ahead-Of-Print), 1-22. (2022)
2) J.Hu & Mcknight, J. . Kenya At War: Al-Shabaab And Its Enemies in Eastern Africa. African Affairs, 114(454), 1-27. (2022)
3) R.Baskar C., Lyon, R. D., Mansour, M. J., Molnar, A., Saulnier, A., Thompson, S., & Sharpe, J. . Surveillance Drones: Privacy Implications of The Spread of Unmanned Aerial Vehicles (Uavs) In Canada(2022).
4) A.Babu (2022, December). Homeland Security: Unmanned Aerial Vehicles and Border Surveillance. Library of Congress Washington Dc Congressional Research Service Thesis. Umi Order Number: Umi Order No. Gax95-09398., University of Washington.
5) T.A.Rahman, M., Giesbrecht, J., Mcmanus, C., Furgale, P., Stenning, B., & Sharf,(2022) I. Autonomous Navigation and Mapping in GpsDenied Environments at Defence R&D Canada. In NatoSymposium Set (Vol. 168).
6) K.S.Saravanan, "A review of remote surveillance technology along u.s. land borders," Office of Inspections and Special Reviews, Department of Homeland Security Office of Inspector General, Tech. Rep. OIG - 06 -15,
7) P.Rajendran N. Boudriga, and S. An, "Border surveillance using sensor based thick-lines," in Proceedings of International Conference on Information Networking (ICOIN), Bangkock, Thailand, (2021)
8) A.Al-Maadeed M. C. Vuran, M. A. Al-Rodhaan, A. M. Al-Dhelaan, and I. F. Akyildiz, "Bordersense: Border patrol through advanced wireless sensor networks," Ad Hoc Networks, vol. 9, no. 3, pp. 468 – 477, (2021).
9) M.Zarei, C. Ersoy, H. Deliç, and L. Akarun, "Surveillance wireless sensor networks: Deployment quality analysis," IEEE Network, vol. 21, no. 6, pp. 48 – 53, 2021.

10) S.S.Patil, M. Zitterbart, D. Kruger, P. Rothenpieler, D. Pfisterer, and S. Fischer, “A wireless sensor network for border surveillance,” in Proceedings of ACM Conference on Embedded Networked Sensor Systems (SenSys), Berkeley, CA, USA, (2021)

11) S.S.Sreekumar, Rosamond WD, Snyder KT, Zègre-Hemsey J The case for drone-assisted emergency response to cardiac arrest: An optimized statewide deployment approach. N C Med J 80(4):204-212. https://doi.org/10.18043/ncm.80.4.204.(2021)

12) A.Devaraj ,Demir KA, Cicibaş H, Arica N (2021) Unmanned aerial vehicle domain: Areas of research. Def Sci J 65(4):319-329 https:// doi.org/10.14429/dsj.65.8631 (2021)

13) A.N.Nisha ,Dhaou R, Escrig B, Idoudi H, Saidane LA (2021) Monitoring road traffic with a UAV-based system. Paper presented 2021 IEEE Wireless Communications and Networking Conference (WCNC). IEEE; Barcelona, Spain.https://doi. org/10.1109/WCNC.2018.8377077 Erbil MA,

14) R.A.Aziz,M.A._Reconfigurable_Unmanned_Aerial_Vehicles_MES20093 56.pdf Erdelj M, Natalizio E (2021) UAV-assisted disaster management: Applications and open issues. Paper presented 2021 International Conference on Computing, Networking and Communications (ICNC). IEEE; Kauai, Hawaii,UnitedStatesofAmerica.(2021).https://doi.org/10.1109/ICCNC.2016. 7440563

15) S.S.Saini A. Howell, and J. Hedrick, “Border patrol and surveillance missions using multiple unmanned air vehicles,” in Proceedings of the 43rd IEEE Conference on Decision and Control (CDC), Paradise Island, Bahamas, December 2021.

16) S.S.Kumar, R. Holsapple, C. Schumacher, J. Hansen, and A. Girard, “Cooperative defensive surveillance using unmanned aerial vehicles,” in Proceedings of American Control Conference, St. Louis, MO, USA, June 2021.

17) R.Vijayakumar and R. D. Patil, "Quadcopter (uavs) for border security with gui system," International Journal of Research in Engineering and Technology (IJRET), vol. 2, no. 12, pp. 620 – 624, 2021.

18) P.Balaji and P. Molina, "Unmanned aerial systems for photogrammetry and remote sensing: A review," ISPRS Journal of Photogrammetry and Remote Sensing, vol. 92, pp. 79–97, June 2021.

19) K.Prakash, M. Toulgoat, M. D. eziel, and G. Patterson, "Tiered wireless sensor network architecture for military surveillance applications," in Proceedings of the 5th International Conference on Sensor Technologies and Applications (SENSORCOMM), Côte d'Azur, France, August 2021.

20) L.Wang, and J. Wilson, "Decentralized smart sensor scheduling for multiple target tracking for border surveillance," in IEEE International Conference on Robotics and Automation (ICRA), Seattle, Washington, May 2020.

21) A.S.Kavitha et al, N. Boudriga, K. Trimeche, and S. An, "Border surveillance: A dynamic deployment scheme for wsn-based solutions," in Proceedings of Wireless and Mobile Networking Conference (WMNC), Dubai, United Arab Emirates, April 2013, pp. 1 – 8.(2020)

22) A.Ghosal, A. Karki, and B. B. Madan, "Optimizing border patrol operations using unmanned aerial vehicles," in proceedings of the 12th International Conference on Information Technology - New Generations, Las Vegas, NV, USA, April 2020, pp. 479 – 484.

23) S.S.Gouda, A. Alotaibi, B. Ordway, G. Mohammed-Jones, and H. Guo, "Object retrieval from secure unknown interior spaces using autonomous unmanned aerial vehicles," in Proceedings of Fourth Symposium on Indoor Flight Issues, International Aerial Robotics Competition, 2020.

24) S.K.Bose and P. Y. Oh, "Towards autonomous cargo deployment and retrieval by a unmanned helicopter using visual tracking," in Proceedings of the ASME 2019 International Design Engineering Technical Conferences and

Computers and Information in Engineering Conference, Brooklyn, New York, USA, Augus 2019.

25) R.R.Selvaraj, M. Shomin, and V. Kumar, “Design, modeling, estimation and control for aerial grasping and manipulation,” in Proceedings of International Conference on Intelligent Robots and Systems (IROS), San Francisco, CA, USA, August 2019.

26) S.S.Soman, D. Mellinger, and V. Kumar, “Construction of cubic structures with quadrotor teams,” in Proceedings of Robotics: Science and Systems, Los Angeles, California, USA, June 2019.

27) Navneet Kumar, “Modeling and control of mm-uav: Mobile manipulating unmanned aerial vehicle,” Journal of Intelligent and Robotic Systems, vol. 69, no. 1-4, pp. 227–240, 2019.

28) Andry Chowanda, K. Kondak, I. Maza, and A. Ollero, “Autonomous transportation and deployment with aerial robots for search and rescue missions,” Journal of Field Robotics, vol. 28, no. 6, pp. 914 – 931, June 2019.

29) David Gallacher and A. Girard, “Cooperative surveillance and pursuit using unmanned aerial vehicles and unattended ground sensors,” Sensors, vol. 15, pp. 1365–1388, 2019.

30) Shukor Abd Razak , J.-H. Kim, S. Rekhis, N. Boudriga, D. Wilkins, and J. Acevedo, “Unmanned aircraft vehicle assisted wsn-based border surveillance,” in proceedings of the 23rd International Conference on Software, Telecommunications and Computer Networks (SoftCOM), Split, Bol, September 2018.

31) Mikhail Ivanov, S. W. Loke and N. Fernando, "Enabling Drone Services: Drone Crowdsourcing and Drone Scripting," in IEEE Access, vol. 7, pp. 110035- 110049, 2018.

32) Omar Elharrouss and D. Cremers, "Camera-based navigation of a low-cost quadrocopter," 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems, Vilamoura, 2012, pp. 2815- 2821.

33) S. Pedrozo and N. Uchida, "Improvement of Image Processing for a Collaborative Security Flight Control System with Multiple Drones," 2018 32nd International Conference on Advanced Information Networking and Applications Workshops (WAINA), Krakow, 2018, pp. 199-202.

34) Anitha Ramachandran, ―Development of ISR for Quadcopter‖.(2018).

35) Christopher Slobogin, ―Quadcopter Flight Dynamics‖, International Journal of Scientific and Technology Research Volume 3, Issue 8, August 2018, Issn 2277- 8616.

36) Francisco Klauser, ―Building and Controlling the Quadrocopter‖ Number 5, Volume VI, December 2018.