A Seminar Report

on

Advancements in Unmanned Aerial Vehicles

For the partial fullfilment of

requirement of degree

in

Bachelor of Technology

in

Electronics and Telecommunication

Submitted By

Hitesh Roy

(ID-14004015)

Under the Guidance of

Mrs. R. R. Harne

Assistant Professor

Department of Electronics Engineering

Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)

2018-2019

Government College of Engineering, Amravati
Department of Electronics Engineering
CERTIFICATE

This is to certify that the seminar(ETU 709) entitled, **Advancements in Unmanned Aerial Vehicles**, is being submitted here by **Hitesh Roy** (ID:14004015) in B.Tech. VII^{th} semester. The seminar has been carried out with full efforts under my guidance and supervision satisfactorily.

Mrs. R. R. Harne	**Dr. D.V. Rojatkar**
Project Guide	Head of Department
Department of Electronics Engineering	Department of Electronics Engineering

DECLARATION

I hereby declare that this report titled **"Advancements in Unmanned Aerial Vehicles"** has been exclusively prepared by me for the course seminar (ETU 709) as per the requirements of VII^{th} semester of degree of B.Tech. in Electronics and Telecommuniation Engineering, under the guidance of Mrs. R. R. Harne, Assistant Professor, Department of Electronics Engineering, Government College of Engineering, Amravati.

Place: Amravati **Hitesh Roy**

Date: **ID:** 14004015

Contents

List of Figures

List Of Abbreviations

Abbreviation	**Illustration**
UAV	Unmanned Aerial Vehicles
UAS	Unmanned Aircraft System
IoT	Intenet of Things
ML	Machine Learning
AI	Artificial Intelligence
API	Application Programming Interface
WiFi	Wireless Fidelity
LTE	Long Term Evolution
RTH	Return to Home
CCTV	Closed-Circuit Television

Abstract

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot aboard. UAVs are a component of an unmanned aircraft system (UAS); which include a UAV, a ground-based controller, and a system of communications between the two. The flight of UAVs may operate with various degrees of autonomy: either under remote control by a human operator or autonomously by onboard computers. Compared to manned aircraft, UAVs were originally used for missions too "dull, dirty or dangerous" for humans. While they originated mostly in military applications, their use is rapidly expanding to commercial, scientific, recreational, agricultural, and other applications, such as policing, peacekeeping, and surveillance, product deliveries, aerial photography, agriculture, and drone racing. UAVs are becoming more and more intelligent and their structure is becoming more robust and fault proof. In this report, we shall explore the recent advances in Unmanned Aerial Vehicles for their use in Internet of Things, Security and Survelliance, 3D Mapping and Agriculture purposes.

Chapter 1

INTRODUCTION

1.1 Background

An unmanned aerial vehicle (UAV) is defined as a "powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload". Hence, missiles are not considered UAVs because the vehicle itself is a weapon that is not reused, though it is also unmanned and in some cases remotely guided.

In its earliest use, UAV or drone type aircraft were used in Australian battlefields in 1849. Drones continued to develop throughout World War I and early versions of pilot-less aircraft controlled by radio were tried and tested on the battlefields. Where UAVs were conventionally bulky and basic forms, and were only available to government organisations, today they have developed to become complex examples of robotics that are easily affordable, accessible and used by trained professionals.

In today's world UAVs are a very viable technological tool for a number of industries. Now, advances in technological developments have made it possible for a huge variety of drones to be produced in different sizes, weights and capable of holding different payloads and sensors, making them useful for various applications. Police forces, farmers, engineers and filmmakers all make use of this incredible technology, and the great advantages they can bring to many tasks.

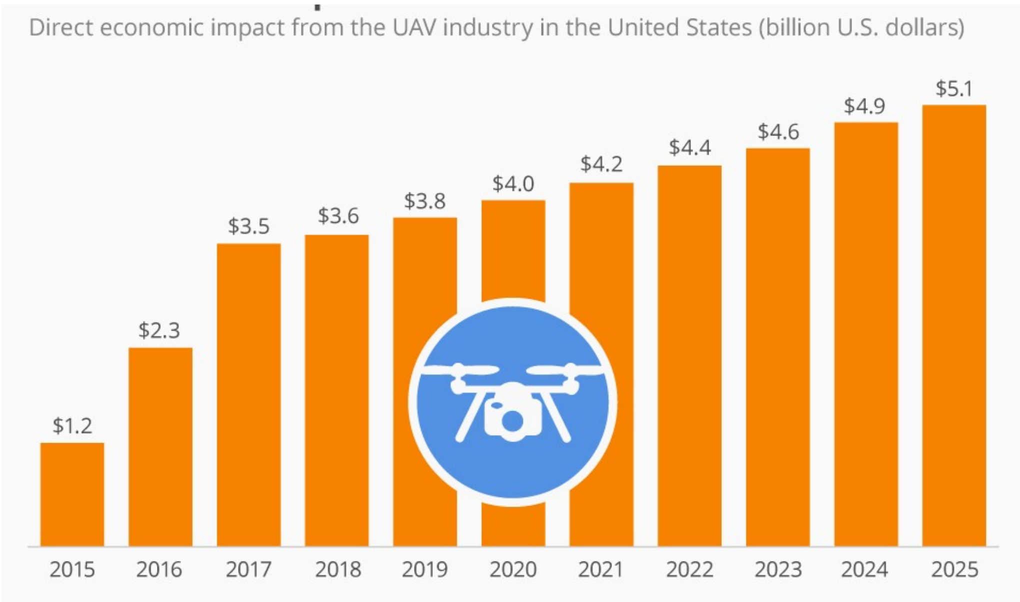

Figure 1.1: Economic Impact of the Commercial Drone Sector

1.2 Need

UAS are already being used in a variety of applications, and many more areas will benefit by their use, such as:

1. Wildfire mapping
2. Agricultural monitoring
3. Disaster management
4. Thermal infrared power line surveys
5. Law enforcement
6. Telecommunication
7. Weather monitoring
8. Aerial imaging/mapping

UAS have a durable life span of approximately 11 years and are relatively easy to maintain. The manufacture of these products requires technical skills equivalent to a college degree so there will always be a plentiful market of job applicants willing to enter this market. The average price of the UAS is a fraction of the cost of a manned aircraft, such as a helicopter or crop duster, without any of the safety hazards. For public safety, the price of the product is approximately the price of a police squad car equipped with standard gear. It is also operated at a fraction of the cost of a manned aircraft, such as a helicopter, reducing the strain

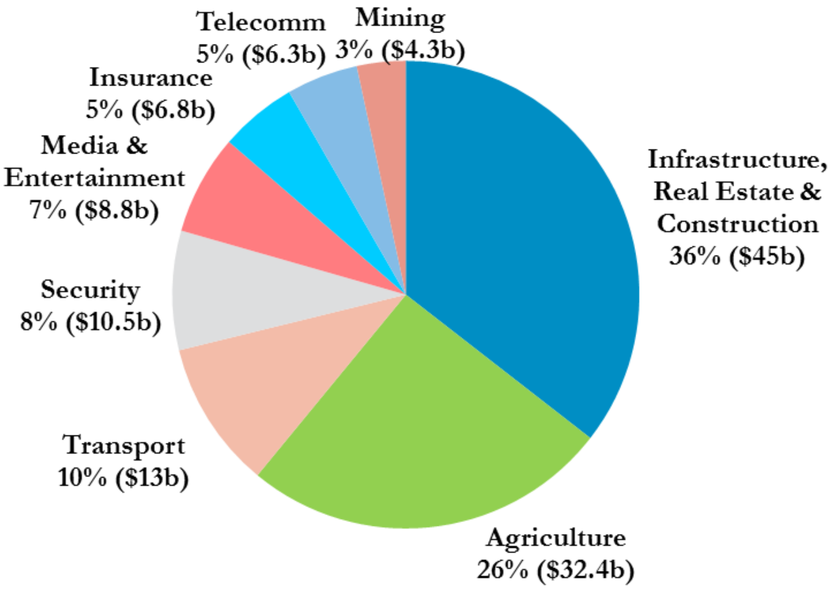

Figure 1.2: Top Industries using Drones

on agency budgets as well as the risk of bodily harm to the users in many difficult and dangerous situations. Therefore, the cost-benefit ratios of using UAS can be easily understood.

Chapter 2

PROBLEM STATEMENT

Farms and fields require hundreds of hours of human effort for their maintenance and while farmers are known for their field scouting abilities, very few actually have time to do that on foot. They need data on type of soil, crop health and insect attacks.

Human patrols, vehicles, fixed CCTV, IP cameras and ground sensors have been around at a large scale for the past decade, but they have their demerits, such systems are vulnerable to attacks and failures. Their security can be easily compromised.

When a disaster or incident threatens lives and livelihoods, emergency responders need information and real-time imagery in order to make better decisions and save time. Firefighters or volunteer rescue teams need to searching over vast areas for missing persons and victims in need of rescue and in any environment.

In all such situations UAS comprising of UAVs can be used.

Chapter 3

LITERATURE SURVEY

The earliest efforts to create an unmanned, remotely-guided weapon fitted with explosive warheads was initiated by Captain Archibald M. Low of the Royal Flying Corps in 1916. The following year, the Aerial Target was launched, and it did respond to radio control demonstrated by Nikola Teslas teleautomaton. In the US, the radio-controlled Hewitt-Sperry Automatic Airplane, or the flying bomb, successfully carried a 300-pound bomb while flying 50 miles after being launched by a catapult in 1917.

During the World War II, drones were primarily used to deliver ordinance and detonate bombs across more types of remote controlled vehicles emerged used both to train anti-aircraft gunners and to launch attack missions. The US military and the Germans accelerated the development of unmanned aircrafts as they were making more sophisticated missiles.

In the late 1946, the US Air Force established a special pilotless aircraft branch to develop three types of drones for training targets. The most important among the three was the Firebees, which was built by Ryan Aeronautical Company, and was tested in 1951 at the Holloman Air Force Base. The Firebird evolved slowly until it began to be used solely for reconnaissance and intelligence gathering purposes. However, these drones were little more than remote-controlled airplanes until the Vietnam War.

A drone revolution started in the 1970s after a symposium sponsored by the US Air Force and the Rand Corporation, giving birth to remotely piloted vehicles (RPVs). The range and the electronic surveillance capabilities of RPVs were improved. Drones were getting bigger and bigger, and some earlier surveillance drones were upgraded and weaponized.

An IAI engineer Abraham Karem emigrated from Israel to Los Angeles and started to build an aircraft in his garage. Karem developed the Albatross, which gained funding from the Defense Advanced Research Projects Agency. Using the grant money, he developed the drone called Amber under his previous company, Leading Systems Inc. Eventually, Amber was improved by being equipped with GPS navigation, infrared and low-light cameras the updated version rolled out in 1989 as the GNAT-750.

When the Leading Systems became bankrupt, it was bought by the US defense contractor General Atomics, which continued the development of the GNAT-750. Because of this, the CIA asked General Atomics to redesign the GNAT-750. They created the Predator, a larger UAV that incorporates satellite communications. They fled it in Afghanistan during 2000 to search for al-Qaeda leader Osama Bin Laden. On September 7, 2000, the Predator photographed what it appeared to be bin Laden.

In the 2010s, the drones for civilian applications started to become popular. The Parrot AR Drone, a smartphone-controlled quadcopter that was introduced to the public in 2010, was claimed to be the original commercial drone that captured the imagination of the US public.

Recently, Director General of Civil Aviation in India has announced its policy for drones. Set to come into effect from December 1, 2018, the new policy defines what will be classified as a drone, how they can be flown and the restrictions they will have to operate under.

Chapter 4

METHODOLOGY

4.1 Drone Components

4.1.1 Propellers

Drone has two different types of propellers and motors. One set is designed to spin clockwise, while the other is designed to spin counter clockwise. The purpose of drone propellers is to generate thrust and torque to keep the drone flying.
The upward thrust force generated by the propellers is usually measured in pounds or grams. To keep a drone flying at a hover, the upward thrust needs to equal the weight of a drone. The thrust to weight ratio TWR (thrust divided by weight), indicates how much thrust a drone generates relative to its weight.
Typically, drone propellers produce more thrust the faster they spin. They are also influenced by the flight dynamics of the drone. Some propellers produce much more thrust when the drone is stationary, as opposed to when it is flying. Other props perform much better at higher speeds.
Torque is generated when the propellers accelerate up or down. This force is responsible for the ability of the drone to rotate on the yaw axis. Torque is an effect of Newtons third law, where every action has an equal and opposite reaction. As the propeller rotates, and pushes through the air, the air pushes back and causes a counter rotation on the body of the drone. This is why all of the propellers on a multirotor drone do NOT rotate in the same direction. The counter rotation effect of all propellers cancels out, and we have no rotation.

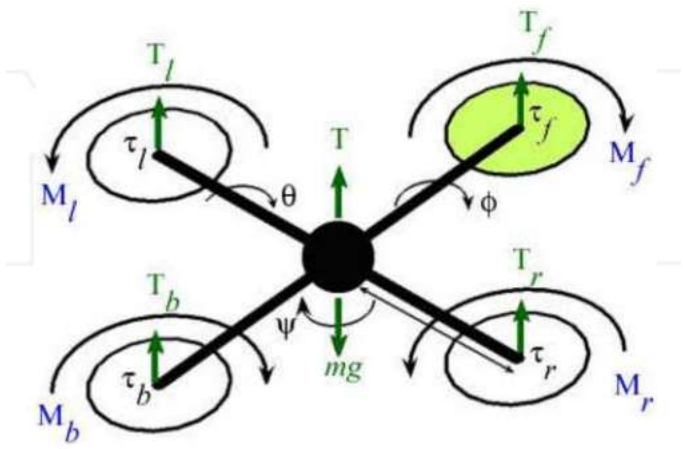

Figure 4.1: Forces on Drone

4.1.2 Brushless motors

The reason we make use of brushless motors over motors with brushes is efficiency. Brushless motors are more efficient. Brushless DC electric motor, or synchronous DC motors, are synchronous motors powered by DC electricity via an inverter switching power supply which produces an AC electric current to drive each phase of the motor via a closed loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor.

4.1.3 Electronic Speed Controllers

An electronic speed control or ESC is an electronic circuit with the purpose to vary an servo-motor speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on motors essentially providing an electronically-generated three-phase electric power low voltage source of energy for the motor. It also allows much smoother and more precise variation of motor speed in a far more efficient manner than the mechanical type with a resistive coil and moving arm once in common use. The DC power that comes from the battery is converted into AC by the ESC so that it can be received by the brushless AC motors.

4.1.4 Gimbals

A gimbal, in videography, is a tool that uses a set of motors and sensors to keep the camera steady, resulting in smooth footage but maintaining the ability to move around the scene. Unlike a tripod, gimbals are small and handheld. Gimbals are a modern, motorized version of Steadicams. While Steadicams use physics and moving parts to keep the camera level, gimbals instead uses digital sensors, motors and a small computer processor to handle all that data. When the sensors detect camera movement, the motors adjust so that the camera stays on the same level, eliminating shake in the footage. A gimbal uses sensors to measure the movement of the camera. A gimbal uses accelerometer and gyroscope sensors to determine how fast and in what direction the camera is moving. Then, the gimbals motors respond to that movement with an opposite motion, which keeps the camera in the same location and eliminates any distrotion.

4.1.5 RC Transmitter and Receiver

The transmitter is used to control a drone. In the case of a drone, user will move the joysticks on the transmitter, a signal will then be sent to the receiver, which will then instruct the servos to move the control surfaces to turn the drone, or instruct the motor to speed up or slow down. If an autopilot is used, we don't technically need a transmitter since the autopilot automatically sends instructions to the vehicle on what to do. The most common is 2.4Ghz, this gives a very reliable link that is robust to interference. Since most of today's radios operate on the 2.4Ghz frequency this is what should be uses. Other radios that operate on FM frequency are ideal if we want to use the 2.4Ghz band for video or telemetry, however they are more prone to interference if other pilots nearby are also on the same band.

4.1.6 Flight Controller (Autopilot)

The flight controller is the brains of a multi rotor UAV. Flight controllers are used to help stabilise multi rotor, and some more advanced flight controllers can also autonomouly fly the UAV to pre programmed waypoints including takeoff and

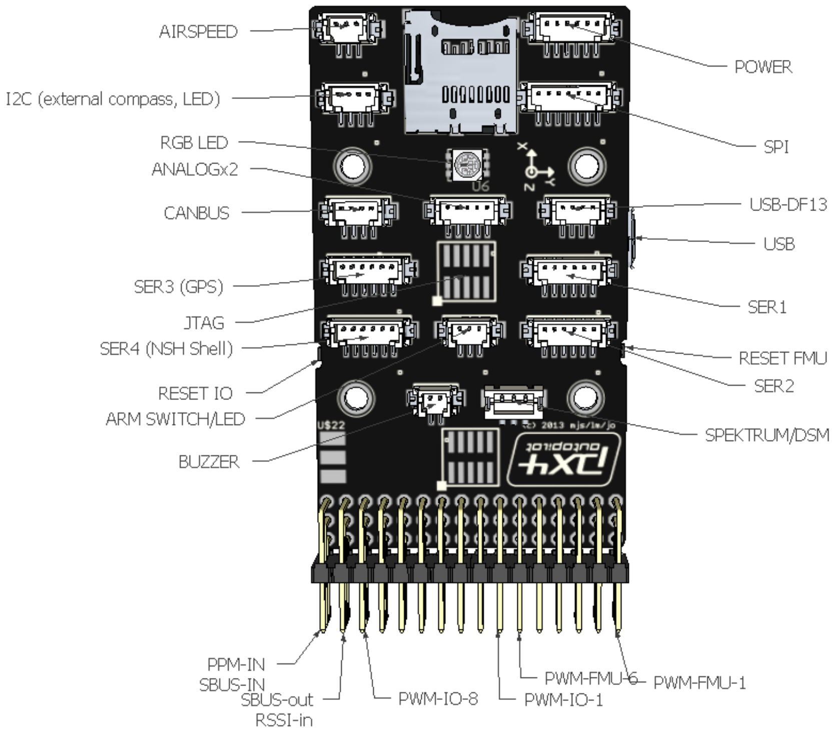

Figure 4.2: Internal Circuit Diagram of Pixhawk

landing. The PX4 Autopilot was developed to support Pixhawk flight controller, later they added support for few more hardware boards. The project PixHawk started in 2009 as a Hardware platform for Ardupilot and is being further developed and used at Computer Vision and Geometry Lab of ETH Zurich.

4.1.7 Battery

The battery provides power the UAV. The battery will control both the Flight Controller and Motors. Lithium Polymer batteries are almost always used for multi-copters as they have a high power to weight ratio and are readily available. When choosing a battery the two main factors are the capacity, and voltage. The voltage is dependant on the number of cells (3 or 4 cell are common). The capacity common ideal for multi-rotors are around 3000mah. The higher capacity generally enable longer flight times, but since they are heavier there is a limit depending on what other payload user want to carry such as cameras.

4.2 Drone Kinematics

To get the mathematical model, it is necessary to define two coordinate systems:

1. Earth fixed frame (E-frame, α^E)
2. Body fixed frame (B-frame, β^B)

Some quadcopter physical properties are measured in α^E (roll, pitch and yaw angles, angular velocities), while some properties are measured in β^B (linear accelerations). α^E is the inertial right-handed coordinate system where positive direction of E axis is in the direction from the earth. Quadcopter position E and attitude η are defined in α^E. β^B is fixed on quadcopter body. Positive direction of the B axis goes through the propulsor 1 which is located on the front side of quadcopter. Positive direction of the B axis goes through the propulsor 4 which is located on the left side of quadcopter. The B axis is perpendicular to B and B axes and its positive direction is in the direction of propulsors thrust forces. Assumption is that the origin of β^B coincides with the center of gravity of the quadcopter. Linear velocities B, angular velocities ω B , forces B and torques $r^B$are defined in β^B.

Quadcopter position is defined with vector η between origins of α^E and β^B and $\eta = [XYZ]^T$.

Quadcopter attitude n is defined with the orientation of β^B with the respect to the α^E. The orientation is defined with three consecutive rotations around the ^{E} coordinate axes. Roll-pitch-yaw order is applied $n = [\phi \quad \theta \quad \sigma]$. Motion equations are more suitable to formulate with the respect to the β^B.

4.2.1 Transforming Reference Frames

Translation and rotation matrices are used to transform one coordinate reference frame into another desired frame of reference

1. Transformation from F(i) to F(v) provides the displacement vector from the origin of the Inertial frame to the center of gravity (COG) of the quadrotor Vehicle
2. Transformation from F(v) to F(b) is rotational in nature the roll, pitch and

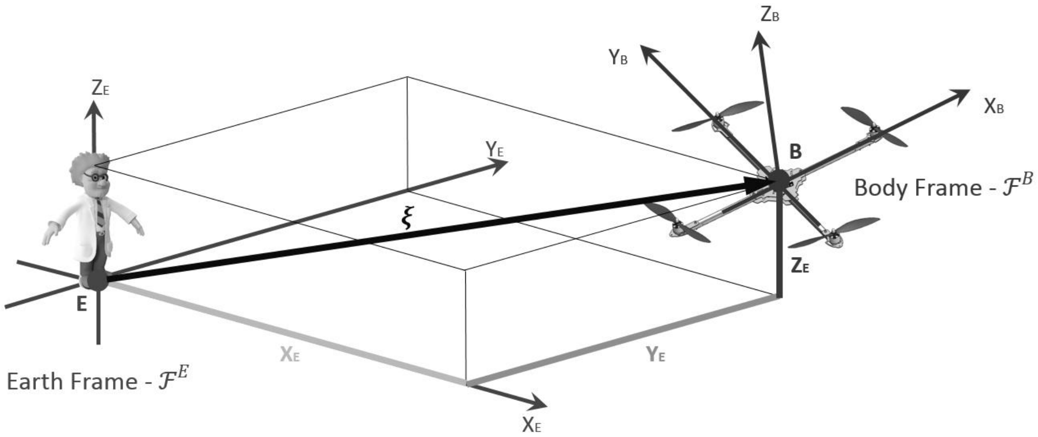

Figure 4.3: Earth and Body Frames

yaw angles.

4.2.2 Maneuvers of a Drone

There are basically four primary maneuvers of a Drone -

Roll

It is the rotation of the vehicle on the front to back axis (nose to tail) and is also called longitudinal axis. The vehicle when making a turn moves to one side or the other by banking left or right. A positive roll angle will lift the left side wing and lower the right one. For Roll, change in relative speed of the right and left rotors must be achieved.

Pitch

It is the rotation of the vehicle fixed between the side to side axis (on an airplane wingtip to wingtip) also called the lateral or transverse axis. This movement means the vehicles nose and tail will move up and down. If the pitch is positive then this would raise the front end and lower the tail end. This is used to help manage ascent and descent. To achieve pitch, change in relative speed of the front and back rotors must be achieved.

Yaw

Yaw is the rotation around the vertical axis and lies perpendicular to the wings of an aircraft and in the center line. The yaw motion is a side to side nose movement of the aircraft as shown below from its center of gravity. To change Yaw, Change in speed of clockwise rotating pair and counter-clockwise rotating pair of motors must be done.

Throttle

The throttle is part of the engine controls. It's role is to control and regulate the flow of air and fuel into an engine, thus changing the power and the speed of the engine. It does control altitude of the vehicle getting drone airborne and of course speed.

Thrust

Increasing or decreasing the speeds of all four rotors simultaneously controls the collective thrust. If the rotor area is A and the density of air is , then this would be an expression for the thrust force (magnitude) as a function of air speed.

4.3 Working Principle

As mentioned earlier there are 4 motions in quadcopter viz. throttle, elevator, aileron and rudder. These motions are controlled by the help on a radio control transmitter.
The transmitter transmits the data to the receiver which is placed over the quad.
The receiver then sends the data to the flight control board.
The flight controller is an inbuilt microprocessor that manipulates the signals received by it and commands the BLDC motors through the ESCs.
After the command is received the motors act according to the signal transmitted by the remote.
The throttle is created by rotating all 4 rotors at the same speed.
An elevator is created by rotating the 2 rear rotors at greater speed compared to the front rotors whereas for backward motion the front rotors have higher speed

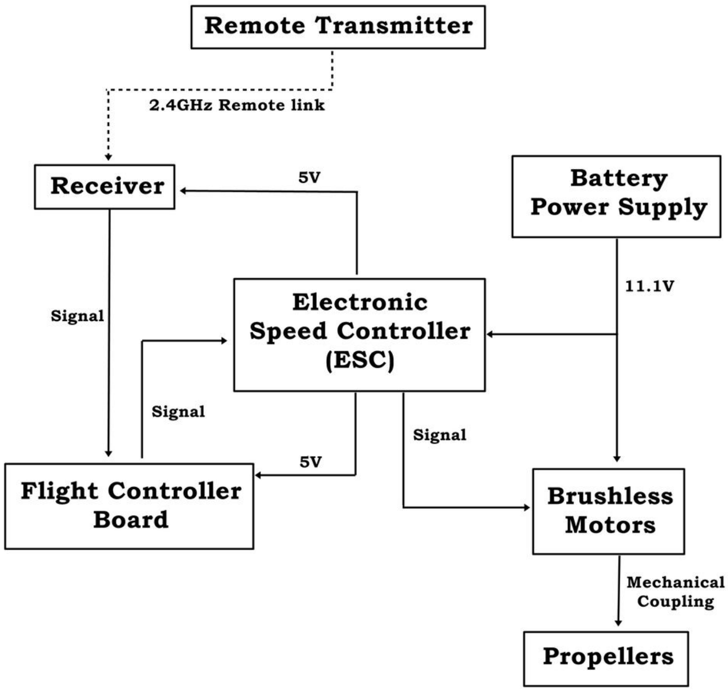

Figure 4.4: Block Diagram of a Simple Drone

than rear rotors.
Aileron is created by rotating the left 2 rotors to rotate at a higher speed than the right rotors for the right turn and vice versa for the left turn.
Rudder action is created by rotating the diagonally situated rotors moving with the same spin to rotate at a greater speed than the other two.

4.4 Types of Drones

4.4.1 Existing Drone Types

The main drone types are fixed-wing systems and multirotor systems. The majority of existing drones can be defined within these two types. Other systems like hybrid systems and ornithopters are also briefly discussed.

Fixed-Wing Systems

Fixed-wing is a term mainly used in the aviation industry to define aircraft that use fixed, static wings in combination with forward airspeed to generate lift. Examples of this type of aircraft are traditional airplanes, kites that are attached to the surface and different sorts of gliders like hang gliders or paragliders. Even a simple paper airplane can be defined as a fixed-wing system. An example of a fixed-wing drone is the widely used Raven.

Multirotor Systems

Multirotor systems are a subset of rotorcraft. The term rotorcraft is used in aviation to define aircraft that use rotary wings to generate lift. A popular example of a rotorcraft is the traditional helicopter. Rotorcraft can have one or multiple rotors. Drones using rotary systems are almost always equipped with multiple small rotors, which are necessary for their stability, hence the name multirotor systems. Commonly,these drones use at least four rotors to keep them flying. A popular example of these multirotor drones is the widely used Phantom drone made by the Chinese company DJI.

Other Systems

Some types of drones cannot be labeled as a fixed-wing or a multirotor drone. Sometimes because the drone simply is neither fixed-wing nor multirotor, sometimes because the drone has characteristics of both types. Hybrid systems are systems that have characteristics of both multirotor and fixed-wing systems. The hybrid quadcopter is an example of such a drone.1 This drone uses multiple rotors to take-off and land vertically but also has wings so it can fly longer distances.

4.4.2 Level of Autonomy

Because of the absence of a pilot, drones always have a certain level of autonomy. An important distinction within the concept of autonomy is the difference between automatic and autonomous systems. An automatic system is a fully preprogrammed system that can perform a preprogrammed assignment on its own. Automation also includes aspects like automatic flight stabilization. Autonomous systems, on the other hand, can deal with unexpected situations by using a preprogrammed ruleset to help them make choices. Automatic systems cannot exercise this freedom of choice.

The United States Department of Defense distinguishes four levels of autonomy in their roadmap for unmanned systems.7 The most basic level of autonomy is a human operated system in which a human operator makes all the decisions regarding drone operation. This system does not have any autonomous control over its environment. A higher level of autonomy is a human delegated system. This system can perform many functions independent of human control. It can perform tasks when delegated to do so, without further human input.

The third level of autonomy is a human supervised system. This system can perform various tasks when it is given certain permissions and directions by a human. Both the system itself and the supervisor can initiate actions based on sensed data. However, the system can only initiate these actions within the scope of the current task. The final level of autonomy is a fully autonomous system. This system receives commands input by a human and translates these commands in specific tasks without further human interaction.

4.4.3 Differences in Energy Source

There are four main energy sources: traditional airplane fuel, battery cells, fuel cells, and solar cells. Airplane fuel (kerosene) is mainly used in large fixed-wing drones. An example of such a drone is the military Predator drone. This drone is used a lot by the US army and can be equipped with a number of different sensors, but also with rockets and other types of ammunition. Battery cells are mainly used in smaller multirotor drones. These drones are short range and require less operating time than drones using kerosene. These drones are often for recreational use, making it more practical for the drone to run on a rechargeable battery cell. A fuel cell is an electrochemical device that converts chemical energy from fuel directly into electrical energy. Because of the lack of conversions in thermic and mechanical energy, this conversion is efficient and environment friendly. Fuel cells are currently rarely used in drones. Only fixed-wing drones can be equipped with such a cell because of the cells relatively high weight. A major advantage of using a fuel cell is the fact that drones can fly longer distances without recharging. For example, the Stalker drone which uses a fuel cell has a flight time of 8 h instead of 2 h. Drones using solar cells are rare in the current drone industry. Drones using solar cells are mainly fixed-wing drones. Because of the low efficiency of current solar cells, these cells are usually suitable for many multirotor drones.

4.4.4 Widely Used Drone Models

Currently, drone models are developing fast and numerous drone models already exist. Due to the increasing popularity of drone technology, new models are developed at a fast pace. Therefore, it is impossible to describe here every drone model currently existing. Hence, only some models which have been in the media to some degree and models which are widely available for governments, industry, and citizens are described here. These are the widely used, well-known, and available drone models.

Hubsan x4 Drone

The Hubsan x4 is a small multirotor drone developed by the Chinese company Hubsan. This mini drone is fairly simple in design and operation. It has four rotors and can be operated with a controller. Some models of the x4 drone come with a built-in camera for making pictures and recording video. The drone is currently a popular and relatively cheap alternative for the more advanced drones. The drone has a weight of 30 g, a radius of around 100 m and can operate for 7 min with a fully charged battery.

DJI Phantom

The Phantom drone is a multirotor drone with four rotors and is mainly built for recreational purposes. The drone comes with a camera and can be controlled using a smartphone or a WiFi controller. The smartphone can also control the camera to move and make pictures or record video. The Phantom can fly at around 54 km/h and it can operate for about 25 min. Just by programming the flight altitude and certain waypoints the drone can take-off, land, make recordings, and return automatically.

Raven

The Raven is a fixed-wing drone developed in 2002. The drone was originally developed for the US Army but is frequently used by many other countries as well, making it one of the most widely used drones in the world at this moment. The main purpose of the Raven is surveillance and it can be controlled remotely or preprogrammed for autonomous operation. The Raven has a width of 1.4 m, weighs about 2 kg, and can stay operational for 6090 min within a range of 10 km. It is equipped with an optic and an infrared camera. Like regular model airplanes, the Raven can be launched by throwing it in the air.

4.4.5 Types of Payloads

Various types of payloads can be attached to drones. Virtually all kinds of payloads can be attached to drones, the only restrictions are usually the weight and size of payloads. Most drones are equipped with cameras by its manufacturer. Other payloads can be ordered at drone manufacturers, but drone users also can attach payloads to their drone themselves. Sensors and other types of payloads are discussed below.

Sensors

The weight, model, and energy source of a drone are major factors influencing its maximum altitude, flight duration, flight range, and maximum payload. An important category of payloads are sensors. Most drones are nowadays equipped with cameras. Cameras and microphones are the most often used payloads for drones and often come standard when buying a drone. Cameras may enable night vision and heat sensing. Other sensors include biological sensors that can trace microorganisms, chemical sensors (sniffers) that can measure chemical compositions and traces of particular chemical substances including radioactive particles and meteorological sensors that can measure wind, temperature, humidity, etc. Cameras can be useful payloads for the prevention, criminal investigation, criminal prosecution, and sentencing of criminal behavior. Most applications assume drones to be flying camera surveillance. The preventive function of camera surveillance shows mixed results. Other sensors may also provide be added. For instance, heat sensors are very useful for detecting hemp that people are growing in their attics. Chemical sensors may be useful for detecting traces of illegal drugs. Drones equipped with WiFi hotspots may provide clues about someones position and can be used for tapping phone and Internet use.

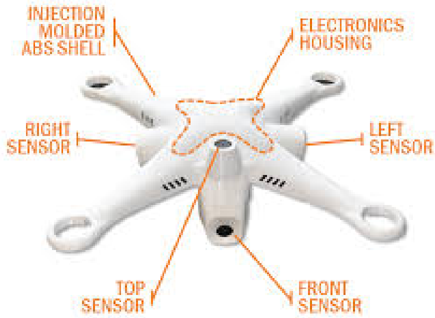

Figure 4.5: Sensors on DJI Phantom

Other Payloads

All kinds of other payloads can be attached to drones. Most payloads that are not sensors involves cargo that needs to be delivered, i.e., mail like letters and parcels, medicines, meals, supplies, and fire extinguishers. Cargo can also be illegal, such as narcotics and firearms. In some cases, the cargo is not intended for delivery; examples of such payloads are ads and WiFi hotspots. From a commercial perspective, drones are considered interesting for delivering mail, parcels, and other cargo. A typical example would be supplying oil drilling platforms or remote islands. In the US there are speculations about delivering pizzas using drones and in Russia pizzas are already delivered using drones.

4.5 Concerns with use of Drones

Drones use frequencies that may cause harmful interference for a number of reasons. These can be

1. Drones bought outside the European Union and used in Europe might well use frequencies intended for other use in Europe and interfere with that other usage.
2. The use of a particular frequency requires a license because other users also make use of those frequencies. If no license is issued no planning has taken place and interference can occur.
3. The combination of emitting equipment might cause interference.
4. Radio equipment in a drone may malfunction.
5. The use of high transmission power may not be in accordance with regulations.

Chapter 5

CONCLUSION

5.1 Conclusion

The paper discussed recent progress in the technology for unmanned aerial vehicles from the modeling, control and guidance perspectives. Dynamics of rotorcraft-based un-manned aerial vehicle is presented to describe the underlying principle of modeling for the control synthesis. The parts of drones and modern drones models are also discussed.

5.2 Advantages

Advantages of UAVs are different in various applications listed below:
1. Effective for Surveillance and Security:
a) Drones ability to give an aerial view of the surroundings is one great advantage for survival. User can easily identify whats going on in the area or if there are any disturbances nearby.
b)It can warn of the presence of intruders or roving bands of armed goons and help prepare if there should be a conflict, thus giving user the upper hand in protecting.
2. Remote-Controlled:
a) The ability to control the drone from a distance allows user to detect trouble before it gets to the user without having to expose themselves to any potential threats.
b) There are even models where user can monitor flight paths and adjust settings

through smartphones and tablet apps.

3. Stealth Capabilities:

a) Usually, drones can be pretty quiet and capable of long-range views, which is good for scouting perimeter.

b) Also, avoiding and tampering with drones is difficult compared to mounted cameras.

5.3 Disadvantage

- Short Battery Life :

a) Although drones are convenient to use, they have a short battery life.

b) The average lifespan of its battery is ten to fifteen minutes. Larger drones can fly up to twenty-five minutes and take around three hours to completely charge the batteries.

- Can be Shot Down :

a) One of the drawbacks of drones is that they can be shot down, captured, and disabled by an intruder.

b) When that happens, we lose the information or supplies they are carrying.

- Hackable:

a) Hackers can take over the drones network and main control system without the knowledge of the operator.

b) If the users connect their social media profile to the drones system, then their confidential information is at risk.

5.4 Application

A few applications of Drones are listed below:

- Agriculture :

Drones can support farmers in the efficient use of plant protection products, providing important data on the type of soil, helping them increase yield and reduce crop damage.

- Disaster Management :

UAVs can provide real-time visual information and data in the aftermath of an earthquake or hurricane. UAVs can provide situational awareness over a large area quickly, reducing the time and the number of searchers required to locate and rescue an injured or lost person, greatly reducing the cost and risks of search and rescue missions.

- 3D Mapping and surveying :

The great advantage of UAV systems is the ability to quickly deliver high temporal and spatial resolution information and to allow a rapid response in a number of critical situations where immediate access to 3D geo-information is crucial. They feature real-time capability for fast data acquisition, transmission and, processing. UAVs can be used in high risk situations and inaccessible areas. UAVs can be a replacement of terrestrial acquisition (images or range data). The derived high-resolution images can be used, for texture mapping purposes on existing 3D data, for orthophoto production, map and drawing generation or 3D building modelling.

5.5 Future Scope

There are three major developments in drone technology:
Miniaturization, Autonomy and Swarms.

1). The first development, miniaturization, is the most incremental development. As in most areas of robotics, each new generation of drones is a bit smaller, lighter, and cheaper than the previous generation. For instance, new materials and lighter and more efficient batteries create better trade-offs between the drone and its flight range, maximum altitude, and maximum payload. Cheaper and smaller drones are also likely to result in the ubiquity of drones. Whereas drones may now still be a rare sight in the sky, it is expected that within a few years, there will be plenty of drones available among the general public. This expectation is based on the rate at which drones are manufactured and sold.

Drones are popular among photographers and sportsmen and there is an increase in small companies that offer drones services.

2). A second major development is the further increasing autonomy of drones. Drones are often seen as remote control aircraft, but there are technologies that enable autonomous operations, in which the remote control by a human operator is partially of completely excluded. Most drones that are commercially available are remotely controlled, but at the same time they already contain elements of autonomy, mostly software for flight stabilization. More professional drones offer the possibility to pre-program flights. In the near future, more autonomy is expected with regard to determining flight routes, sense and avoid systems.

3). A third major development is the use of drones in swarms. The increasing autonomy of drones enables the cooperation between drones in so-called swarms. The use of swarms may widen the range, flight duration, and maximum payload for particular applications.

References

[1] Bas Vergouw, Huub Nagel, Geert Bondt and Bart Custers, *"Drone Technology: Types, Payloads, Applications, Frequency Spectrum Issues and Future Developments"*, 2016 18th International conference, IEEE

[2] Konstantin Kakaes,Faine Greenwood,Mathew Lippincott and Shannon Dosemagen, *"Drones and Aerial Observation: New Technology For Property Rights, Human Rights, and global Development"*, International conference 2015, IEEE

[3] Zoran Beni1, Petar Piljek and Denis Kotarski, *"Mathematical Modelling Of Unmanned Aerial Vehicles With Four Rotors"*, International conference 2016, IEEE

[4] Sevkuthan KURAK1, Migdat HODZIC, *"Control and Estimation of a Quadcopter Dynamical Model"*, International conference 2016, IEEE

[5] Agus Budiyono, *"Advances in Unmanned Aerial Vehicles Technologies "*, International conference 2016, Springer

[6] Shahid Mahmood, *"Unmanned Aerial Vehicle (UAV) Communications"*, International conference 2016, Springer

[7] A. Elsayed Ahmed, A. Hafez, A. N. Ouda, H. Eldin Hussein Ahmed, H. Mohamed Abd-Elkader, *"Modeling of a Small Unmanned Aerial Vehicle"*, International conference 2015, Springer

[8] B. Cheng, A. Papageorgiou, F. Cirillo and E. Kovacs, *"Geelytics: Geo-distributed edge analytics for large scale iot systems based on dynamic topology,"*, International conference 2015, IEEE

[9] Shlok Agarwal, Apoorva Mohan, Kamlesh Kumar, *"Mathematical Modeling and Control System Design of Tiltrotor UAV"*, International conference 2013, IJSER

[10] Christopher Hackney and Alexander Clayton, *"Unmanned Aerial Vehicles (UAVs) and their application in geomorphic mapping"*, Vol. 5, Springer 2015

Acknowledgement

It gives me immense pleasure on bringing out the seminar entitled **Advancements in Unmanned Aerial Vehicles**. I express my sincere gratitude to my guide, Asistant Professor, Mrs. R.R. Harne and Head of Department, Dr. D.V. Rozatkar. I thank them for extending the necessary help, providing facilities and time to time guidance and motivation. I would like to express my sincere gratitute towards Dr. R.S. Dalu, Principal, Government College of Engineering, Amravati. Last but not the least; I would like to thank all the staff members of Electronics Engineering Department and the people who directly or indirectly helped me in completing this task successfully.

Hitesh Roy
(14004015)