UNMANNED FLYING VEHICLES FOR VARIOUS APPLICATIONS AND THEIR FUTURE SCOPE IN INDIA

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Abstract

Now a day’s people are becoming very smarter and trying to do any task in a simple way. To make the life simple and convenient many devices are available at present in the market. For example, in earlier days people can work hard for the things like getting water from a well but now whenever we switch ON the motor the water comes out of the well and we can store it where ever we want. Likewise there exist many technologies like vehicles, computers, smart phones etc… Among recent improved technologies, Unmanned Aerial Vehicle (UAV) also known as drones in some applications has becoming very popular because of its use in aerial photography, surveillance purposes etc… Its features like easy accessibility and simple construction made them more popular. This paper discusses about the complete idea behind UFV (Unmanned Flying Vehicles) and its origin; construction, different parts, their selection and it’s working. It also discuss about various applications of UFV and their future scope in INDIA.

Key words: Unmanned Aerial Vehicle (UAV), Unmanned Flying Vehicles (UFV), DRONES

I. Introduction

In 1849 Austria sent unmanned, bomb-filled balloons to attack Venice [IV]. But due to wind, they flow in another direction and drop the explosives, which caused loss of property, human lives. With these types of UAV’s there is chance of unpredictable incidents. UAV has been in the arena of air combat as early as 1915 when the concept was first introduced by Nicola Tesla [X]. In 1959, the U.S Air Force, concerned about losing pilots over hostile territory, began planning for the use of unmanned aircraft. These aircraft can also termed as UAV stands for Unmanned Aerial Vehicle, which means the aircraft without a human in its cockpit. UAV development continued during World War I [IV]. More emerged in the technology rush during World War II used both to train antiaircraft gunners and to fly attack
missions. Israel developed the first UAV with real-time surveillance during the 1973 Yom Kippur War. The images and radar decoying provided by these UAVs helped Israel to neutralize Syria’s air defenses at the start of the 1982 Lebanon War. Israel was developed proof-of-concept capabilities in tailless, stealth-based, three-dimensional thrust vectoring flight control, jet steering UAVs by the end of the 1980’s [VII]. In the 1980s, new attention was focused on aircraft propelled by solar power. Solar photovoltaic (PV) cells are not very efficient, and the amount of power provided by the Sun over a unit area is relatively modest[V]. A solar-powered aircraft must be lightly built to allow low-powered electric motors to get it off the ground. Such aircraft had been developed in the competition for the Kremer Prize for human-powered flight. The U.S commander Delmer Fahmey adopted the name DRONE for UAV’s on the basis of its buzzing sound and unable to make their own decision. Because “drone” means a stingless male bee in a colony of social bees (especially honey bees) whose sole function is to mate with the queen and it also means the sustained buzzing sound. Later on with the increased technology drones become smaller and smarter and some are undetectable like micro UAV’s also called mini drones, which are in the form of insects. Some drones are used for navigation purposes to locate the places for delivering. These drones are abbreviated as Dynamic Remotely Operated Navigation Equipment. Almost all drones works on battery and hence its flight time depends on its battery. Initially they are used for military purpose to hit the target on ground. Later they are also used for surveillance purposes used in borders to monitor the entry of new people into the country. They are very expensive, heavy and very difficult to construct. These are used in military till the mid 20th century. Now a small camera with less weight is fixed to the bottom of the drone or in front of drone in such a way that they are used to take footage during disasters to know the conditions of the affected area; footage during special occasions. With the use of GPS (Global Positioning System) they can able to deliver the goods to particular address. Australian drone start-up Flirtey has become the first company to receive approval from the FAA to deliver packages by unmanned aerial vehicle (UAV). In this case, medical supplies will be delivered via drone to a rural coal mining region in Wise County, Southwest Virginia, which is one of the most isolated places in the world [VI]. They are used in agriculture purposes to cut weeds and used to spray pesticides. This technology was first used in Japan. In India, Mumbai was the first city to use the drones to deliver the pizza order by a little known pizza chain in Mumbai. Recently drones enter the Hyderabad officially[XII]. They are used to identify the missing persons in densely forested areas; in pilgrims based on facial recognition, color, and height. They are used to attack and also used to give information about terrorists who are hiding in mountain and densely forested areas. The helicopter camera can determine how big the spill is and how it is moving before personnel are sent in [III]. UAV’s, drones and all aerial vehicles flies in air for various applications. So they are commonly termed as unmanned flying vehicles (UFV).
II. Construction of a UFV

In order to construct a drone first choose an application and then select parts. The process of construction is shown in Figure-1.

- **Step-1**: Choose an application
- **Step-2**: Choose number of arms
- **Step-3**: Choose number of equipments based on arms
- **Step-4**: Design remote control
- **Step-5**: Design flight control board based on application
- **Step-6**: Assemble the equipment on a frame

Figure-1 Flow of construction

Let us consider an application for what the drone is used. Then choose the no. of arms it required. There exist many configuration based on number of arms and based on that the drone is termed as follows:

II.i. Different configurations of a UFV

Due to advanced technology the UFVs are first reduced to the UAVs with 2 propellers also known as Diy drones from the fixed wing UFVs. Out of two propellers of Diy drone one is rotated in clockwise direction and other is rotated in anticlockwise direction. Later the drones replace these Diy drones with three propellers and then 4, 6, 8 in order to reduce the load on motors. The configuration of the drones with 3,4,6,8 propellers is shown in Figure 2.
These drones are firstly made of 2 propellers later the no. of propellers increased to reduce the load on the motors. Later the 2 propeller drone is replaced by 3 propeller drone and later 4, 6, 8. For DIY drones one propeller is clockwise rotated and another one is counter clockwise rotated.[VIII]. Next for tri copter two propellers are rotated in clockwise and other is rotated in counterclockwise. For quad, hexa, octo drones the diagonally connected propellers are connected in same direction and adjacent diagonal propellers are oppositely connected.

In the above configurations, for every design there exists two configurations namely ‘X’ and ‘+’ configurations except for tri copter. Both ‘X’ and ‘+’ configuration are preferable based on our application if the payload is more then...
choose X configuration. It provides easy lift because in any direction the weight is shared by two motors where as in ‘+’ configuration weight is carried by single motor only. If payload is less then any of the two configurations is preferred. In ‘+’ configuration all arms of the drone are appeared completely or partially where as in X configuration all the arms are not visible. In ‘+’ configuration, for forward and backward movements there exist one motor to change the speed so it has to overcome speeds of other three motors where as for ‘X’ configuration there exist two motors to share the load.

II.i Selection of parts

As explained in figure-1 the first two steps are completed. The third step is to select the number of motors, ESC’s (Electronic Speed Controller) and propellers. They are selected based on number of arms i.e., number of arms = number of motors = number of ESC’s = number of propellers. These three equipments can be selected according to the payload. Payload means the weight that is carried by the drone. If payload is more then consider the motors having more rating.

II.i.a. Motors

For the drones BLDC motors are used because of its features like compact size, reliable and no brushes means no sparking. The BLDC motors are rated in Kv means velocity constant, which means the RPM per Volt. Depending on payload and altitude (the maximum height of the drone that it lifted in vertical direction from ground) rpm of the motor is selected as follows.

\[
\text{Rpm of motor} = \text{Kv rating} \times \text{Maximum voltage of motor}
\]

Where, Kv is velocity rating of motor means rpm per volt and Maximum voltage is on motor itself.

Required thrust by each motor = (total weight*2)/4

Here multiply the total weight with 2 to avoid turbulence or vibrations caused by air during flying.

II.i.b. Propellers

Choose a propeller made of plastic mixed with fiber to reduce brittleness and to withstand air blows while flying. Propellers number can be dependent on type of drone. For example quad copter require 4 propeller, hexa copter requires 6 propellers likewise we choose them depending on application and payload. Propellers are measured in inches for diameter and width, for example the propeller of 10” X 4.7” means the propeller with 10 inch diameter and 4.7 inch width. Width
should be less than the half of the diameter.

Figure-4 Propeller of 2 blades

II.iic Electronic Speed Controller (ESC)

ESC, whose rating is dependent on motor current rating. ESC rating must be 1.5 times greater than the maximum current rating of the motor or its rating is 5 amps more than the motor rating if not it could overheat and may die. These ESC’s are included with battery eliminating circuit (BEC). So connect these ESC’s to motors and other equipment[IX,XIII]. This is one of the parts of the drone that connected directly to battery. The maximum current drawn by the drone should be less than maximum current of the ESC, if not ESC will be damaged. All other equipments are powered through this ESC’s. ESC pins are connected to the equipments as specified below and it looks as shown in Figure 5.

Figure-5 Electronic Speed Control

II.iid. Battery

Lithium polymer batteries are used instead of lithium ion batteries because the lithium ion batteries require external protection circuit to maintain voltage and currents within safety limits but the lithium polymer batteries doesn’t require any external circuits as lithium ion batteries. So in UFVs lithium polymer batteries are used because of its features like less weight, high capability and reliability[II]. Choose the batteries, in such a way that its maximum current should be greater than the maximum current drawn by the UFV. The required maximum current of the battery is calculated as follows

Maximum current of battery = number of propellers* maximum current of motor.

Figure-6 Lipo Battery
Depending on the required maximum current of the battery choose the battery rating. But the battery can be rated in milli amp hours (mAH) and C rating. So from the values on the battery we calculate maximum current of the battery as follows

Maximum battery current = C rating * rating of battery (mAH)

Rating of battery gives the current it can produce.

In C rating of a battery C indicates capacity of battery, which gives the continuous current drawn by the battery.

For example if we consider a battery of 5000mah and 100C means its max current is 5000mamp means 5amp.

Total capacity = 100* 5amp = 500amps.

After choosing above equipment calculate the flight time (the amount of time it flies in air) based on motor and battery rating as follows

\[ \text{Flight time (minutes)} = \left( \frac{\text{battery rating (mah)}}{1000} \right) \times \frac{1}{\text{max. constant current drawn by motor}} \times 60. \]

II.iii. Flight control board

The brain of quad copter is the **flight control board**, which controls the whole drone. It can include microcontrollers to control the motors the 4 outputs of microcontroller is connected to 4 motors and it also consists of sensors like gyroscopes to tell the rotational acceleration and accelerometer tells the acceleration other than rotational. The combination of gyroscopes and accelerometer are called Micro Electro Mechanical System (MEMS). GPS is also used to navigate the UFV from the controller. The receiver of the transmitter is connected to the microcontroller as inputs. A barometer is connected to the board to give the pressure of air at the altitude where the UFV flies. LED’s also connected to it based on application. These are connected on a board with suitable wires. Depending on our application, the microcontroller can be programmed in C+, C++, Java and CAD and in MATLAB. The power for this board is given from ESC’s because the sensors and controllers all require less voltage where as battery rating is more. The ESC’s takes the battery power and reduce it to certain values based on equipments and then serve the equipment.

II.iii. Controlling the UFV

There are two ways to control the UFVs based on the application and the distance that it travel. They are as follows:

1. Using a remote control.
2. Using the computers by a single or multiple persons.

II.iii.a. Using Remote Control

This type of control is used where the distance travel by the UFV is within the sight of the controller. Also used by the individuals for their own purposes like aerial photography etc… The main part of the remote control is crystal oscillator it
has 4 leads among them 2 leads are connected to battery and another lead is connected to joystick. The crystal oscillator is as shown below

![Crystal Oscillator](image)

Figure-7a Crystal Oscillator

When power is ON, the voltage varies in between minimum to maximum voltage of oscillator many times depending on frequency of oscillator i.e., if oscillator has 1 megahertz frequency then in one second one million times the voltage vary between minimum to maximum voltage. Depending on joystick movement the voltage is selected given to the microcontroller and it transfers 4 bit data to output port. This 4-bit output is connected to encoder, which encode the signal and send it to transmitter. The receiver receives the signal and decode it and given to flight control board. If not these transmitters along with receiver are readily available in market. The readily available remote control is as shown in Fig-8.

![Remote and Receiver](image)

Figure-8 Remote and Receiver

### ii.iii.b. Using computers

This type of control is used where the distance travelled by the UFV is long that it cannot visible to the controller. For this type we use the predefined path to the drone and gives instructions to reach a defined address using GPS. This type is used to deliver the goods like food orders, medicines etc... to the particular address using the code which is already written in LINUX software in PC. The commands from PC are coded to PPM (Pulse Position Modulation) signals and these signals are converted to PWM (Pulse Width Modulation) signals by PPM to PWM encoder and then transmit through PWM transmitter[XI]. The receiver receives the PWM signal and decode them into PPM using PWM to PPM decoder and then given to flight control board. The advantage of using this type of control is to avoid bothering about the
flying path since it is already defined in the program itself. The program of the UFV is done in Java or C++. When the drone delivers the goods then it return to its origin.

II.iv. Assembling of a UFV

After choosing the parts, choose frame to fix the parts and then start constructing. First fix the propellers to motors in such a way that the diagonally connected motors are clockwise and next diagonally connected are anticlockwise to make the resultant torque to zero when starting. Because in starting all motors get equal voltage and all are rotated with same speed if all are rotated in same direction then torque is increased and the drone lift into air by moving forward or backward. So to avoid this forward or backward movement we connect two are in anticlockwise and two are in clockwise direction.

Secondly, connect the ESC’s to motors and battery. Next construct the flight control board using sensors, microcontrollers and LED’s, which indicates power on and off and depending on application connect, as many LED’s as required. Finally construct the transmitter and receiver (or) takes readily available remote and receiver then connectsthe receiver to the input pins of microcontroller on the flight control board. The schematic diagram of the drone which shows how to connect all equipments together is as shown

![Figure- 9 Schematic diagram of a drone](image)

II.v. Control flow of a Drone:

The control flow of drone can start from remote control by moving the joysticks. The movement of joystick can give electric signals to transmitter from crystal oscillator and convert it to waves of high frequency depending on its frequency and sent to receiver. Now it receives the signal through its antenna and it converts to electrical signals and sent to flight control board. In flight control board it tells the ESC’s how much voltage does each motor gets then ESC’s give that much
voltage to the corresponding motor from the battery there by the drone flies depending on programming we wrote.

III. Different types of UFV based on applications

Based on application, UFVs are classified into three types namely
1. Military purpose UFV.
2. Civilian purpose UFV.
3. Commercial purpose UFV.

III.i. Military purpose UFV:
The name implies that these UFV are used only for military purpose like hitting targets, surveillance purposes. For this application there exist some types of UFV as follows

III.i.a. Blimps:
These are not considered as UFVs but these are the reasons for the origin of drones in early 19th century. They are used to carry the explosives and used to drop them where we required. Some of these are failed in hitting the targets. At present they are used for surveillance purposes in such a way that they are supposed to sit up in the sky at one particular place for monitoring. They don’t require any remote
control and battery like equipment because they are just balloons of large size and a camera is fixed to this for surveillance. U.S to monitor the eastern Afghanistan for surveillance invents these. Later, they are tested in U.S – Mexico borders.

Figure-11 Blimps.

**III.i.b. Fixed wing type UFV for target hitting**

These are another form of drones used for military purposes to release missiles on targets which are on ground. They can run on fuels and their flight time is about several days. They are operated using computers which are several miles away from the drone by more than one person. They are heavy and look like a manned aircraft in size. They can fly about 25,000 feet height and stay in air about 40 hours. They can able to hold huge payloads like missiles. Ex. The Predator or The Global Hawk.

Figure-12 Global Hawk

**III.i.c. Fixed wing type UFV for surveillance**

These are also an early form of drone used only for surveillance purpose. They can stay in air for more than 24 hours and can fly at very high altitudes. They are domestically used in U.S. Ex. Boeing Scan Eagle.

Figure-13 Boeing scan eagle

**III.ii. Civilian purpose UFVs**

These are the drones used by the government for many civilian applications like inspection, environment tracking and search and rescue etc.

**III.ii.a. Surveillance purpose UFVs**

These are all fitted with video recorder and camera depending on application for this purpose. These are the drones used for safety, security and inspection
purposes in the places where the human access is difficult and risky, like gathering information about illegal activities like smuggling; used to monitor government construction site for work update. These are also used to inspect pipelines, power lines etc. about its conditions.

IIII.b Environment Tracking UFVs
These are all fitted with special sensors to track the environment for any chance of occurring disasters like storms, hurricanes etc. With this type of drone one can prevent the loss of lives and property.

IIII.c Search and Rescue purpose UFVs
These are fitted with special technologies like facial recognition and Radar technologies to identify the missing persons in the densely forested areas, in pilgrims etc. They are also used for identifying vehicles.

IIII.d Disaster Relief UFVs
These are used to give the information about the places where the disaster occurs and the condition of the affected area. They are also used to deliver the relief services like providing medicines, food etc.

IIIII. Commercial purpose UFVs
These are drones used by non government companies for various applications like delivering the goods, monitoring pipelines in oil and gas industries, photography, for news collection, wildlife research and in agriculture etc.

IIIII.a UFVs for delivering purpose
These are designed to carry the payload of 2 kilos excluding its own weight. These are used to delivery food orders like pizza etc… and used to deliver medicines to the remote locations.

IIIII.b UFVs for Photography
These are fitted with high quality cameras. These are used to take footage of occasions like disasters, marriages etc. These are fitted with special equipment like high power zoom lenses etc. to get the clear footage.

IIIII.c Agricultural UFVs
These are used to monitor the crop growth, spraying pesticides etc., there by increasing the yield.

IIIV. UFVs for Wildlife Research
These are used to observe the behavior of the wild animals from a distance, which reduce the risk of human life. They are also used to track the animals from far away.

IV. Limitations of UFV
Though they are used for various applications it also has some disadvantages as stated below.
1. When it go beyond the range of the controller it may lost its incoming signals that may lead to crash the UFV.
2. In the countries where the power transfer is through overhead lines, if the UFV touch to the power lines then it may burn and fall down which may cause damage to human and also property.

3. If the number of UFVs are more in a place then the signals may interrupted by some other signals then UFV may malfunction.

4. The UFVs are like flying computers so there may be a chance of hacking the UFVs. So security is must to prevent hacking.

5. Many of them are fitted with cameras, so misuse of it leads to privacy issues.

V. UFVs in INDIA

At first in India drones are used for military purpose in Kargil war in 1999 with Pakistan. Until then India have that drone only; after India lost it in Pakistani infrared homing missile Israel supplies an IAI Heron drone along with some searcher drones used to acquire target information along the line of control. Later India’s ministry of defense rejected the offer by Israel Aerospace Industries and India’s Defense Research and Development Organization (DRDO) develop the new version of Heron drones and they are only used for surveillance purpose. The UFVs are used over Maoist activities. This can be limited to Andhra- Odisha and Andhra-Chhattisgarh areas since they are densely forested areas. Now India seriously worked to develop a missile carrying drones.

Under current regulation use of drones for commercial purposes is still illegal. Now India banned the use of drones by private organization and individuals. India joined in a club of 5 countries worldwide with DGCA (Directorate General of Civil Aviation) which works to set the rules and regulations to commercial use of drones.

India now plans to buy the drones from Israel that are fitted with weapons to hit the target on ground. India is still trying to develop its own drone to combat and the researchers are struggled to integrate the missile on Rustom series of UAV’s.

As soon as possible the Indian government announces the rules and regulation for commercial use of drones. After that its use becomes even more popular in all sectors. During disasters they are very useful like giving the conditions of the effected place and may use to deliver the relief services like providing food, medicine etc… and they are used to deliver the goods, which may buy through online.

In future there may be a chance of having wars using drone. Also it may hack because they are like flying computers.

VI. Conclusion

Lot of scope for UFV’s in various applications all over the world especially developing countries like INDIA. If the air traffic control sets the control rules and maintains the traffic properly, UFV’s will create miracles. UFV’s are designing now a days such that, they can travel both in water as well as in the air. If this technology works, then UFV’s can widely used during floods and disasters for medicinal purpose, delivery purpose to remote areas to save many lives.
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