**CHAPTER 1**

**INTRODUCTION TO DRONE TECHNOLOGY**

**1.1 INTRODUCTION**

A drone, in technological terms, is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAVs) or unmanned aircraft systems (UASs). Essentially, a drone is a flying [robot](https://searchenterpriseai.techtarget.com/definition/robot) that can be remotely controlled or fly autonomously through software-controlled flight plans in their [embedded systems](https://internetofthingsagenda.techtarget.com/definition/embedded-system), working in conjunction with onboard [sensors](https://whatis.techtarget.com/definition/sensor) and [GPS](https://searchmobilecomputing.techtarget.com/definition/Global-Positioning-System).

In the recent past, UAVs were most often associated with the military, where they were used initially for anti-aircraft target practice, intelligence gathering and then, more controversially, as weapons platforms. Drones are now also used in a wide range of civilian roles ranging from search and rescue, surveillance, traffic monitoring, weather monitoring and firefighting, to personal drones and business drone-based photography, as well as videography, agriculture and even delivery services.

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**1.2 THE HISTORY OF DRONES**

Many traces the history of drones to 1849 Italy, when Venice was fighting for its independence from Austria. Austrian soldiers attacked Venice with hot-air, hydrogen- or helium-filled balloons equipped with bombs.

The first pilotless radio-controlled aircraft were used in World War I. In 1918, the U.S. Army developed the experimental Kettering Bug, an unmanned "flying bomb" aircraft, which was never used in combat.

The first generally used drone appeared in 1935 as a full-size retooling of the de Havilland DH82B "Queen Bee" biplane, which was fitted with a radio and servo-operated controls in the back seat. The plane could be conventionally piloted from the front seat, but generally it flew unmanned and was shot at by artillery gunners in training. The term drone dates to this initial use, a play on the "Queen Bee" nomenclature. UAV technology continued to be of interest to the military, but it was often too unreliable and costly to put into use. After concerns about the shooting down of spy planes arose, the military revisited the topic of unmanned aerial vehicles. Military use of drones soon expanded to play roles in dropping leaflets and acting as spying decoys.

Military drone use solidified in 1982 when the Israeli Air Force used UAVs to wipe out the Syrian fleet with minimal loss of Israeli forces. The Israeli UAVs acted as decoys, jammed communication and offered real-time video reconnaissance.

Drones have continued to be a mainstay in the military, playing critical roles in intelligence, surveillance and force protection, artillery spotting, target following and acquisition, battle damage assessment and reconnaissance, as well as for weaponry.

**1.3 MODERN DRONE HISTORY**

A Wall Street Journal report claims widespread drone use began in 2006 when the U.S. Customs and Border Protection Agency introduced UAVs to monitor the U.S. and Mexico border.

In late 2012, Chris Anderson, editor in chief of Wired magazine, retired to dedicate himself to his drones’ company, 3D Robotics, Inc. (3DR). The company, which started off specializing in hobbyist personal drones, now markets its UAVs to aerial photography and film companies, construction, utilities and telecom businesses, and public safety companies, among others.

In late 2013, Amazon CEO Jeff Bezos announced a plan to use commercial drones for delivery activities. However, in July 2016, Reno-based start-up Flirtey beat Amazon to the punch, successfully delivering a package to a resident in Nevada via a commercial drone. Other companies have since followed suit. For example, in September 2016, Virginia Polytechnic Institute and State University began a test with Project Wing, a unit of Google owner Alphabet, Inc., to make deliveries, starting with burritos produced at a local Chipotle restaurant. Then in December 2016, Amazon delivered its first Prime

Air package in Cambridge, England. In March of 2017, it demonstrated a Prime Air drone delivery in California.

Drone education is also expanding; Embry-Riddle Aeronautical University, long a training ground for the aviation industry, now offers a Bachelor of Science in unmanned systems applications, a Master of Science in unmanned systems and an undergraduate minor in unmanned aerial systems.

**1.4 TYPES OF DRONES**

A “Drone” is basically an Unmanned Aerial Vehicle (UAV) – an aircraft without a human pilot aboard. In this article, we explore the different types of drones out there in the market – some of which are just concepts, while most others are already in action.

“Drones” can be classified on a different basis – say based on ‘usage ‘like Drones for Photography, Drones for aerial Mapping, Drones for Surveillance etc. However, the best classification of ‘Drones’ can be made on the basis of aerial platforms. Based on the type of aerial platform used, there are 4 major types of drones.

* Multi Rotor Drones
* Fixed Wing Drones
* Single Rotor Helicopter
* Fixed Wing Hybrid VTOL and E

**1.4.1 Multi Rotors Drones**

Multi Rotor drones are the most common types of drones which are used by professionals and hobbyists alike. They are used for most common applications like aerial photography, aerial video surveillance etc. Different types of products are available in this segment in the market – say multi-rotor drones for professional uses like aerial photography (whose price may range from 500USD to 3K USD) and there are lots of variants for hobby purposes like amateur drone racing, or leisure flying (price range from 50USD to 400USD). Out of all the 4 drone types (based on aerial platform), multi-rotor drones are the easiest to manufacture and they are the cheapest option available as well.

Multi-rotor drones can be further classified based on the number of rotors on the platform. They are **Tricopter** (3rotors), **Quadcopter** (4rotors), **Hexacopter** (6rotors) and **Octocopter** (8 rotors). Out of these, Quadcopters are the most popular and widely used variant.

Although easy to manufacture and relatively cheap, multi-rotor drones have many downsides. The prominent ones being it’s limited flying time, limited endurance and speed. They are not suitable for large-scale projects like long distance aerial mapping or surveillance. The fundamental problem with the multicopters is they have to spend a huge portion of their energy (possibly from a battery source) just to fight gravity and stabilize themselves in the air. At present, most of the multi-rotor drones out there are capable of only a 20 to 30 minutes flying time (often with a minimal payload like a camera).

**1.4.2 Fixed Wing Drones**

Fixed Wing drones are entirely different in design and build to multi-rotor type drones. They use a ‘wing’ like the normal airplanes out there. Unlike multi-rotor drones, fixed wing type models never utilize energy to stay afloat on air (fixed wing types can’t stand still on the air) fighting gravity. Instead, they move forward on their set course or as set by the guide control (possibly a remote unit operated by a human) as long as their energy source permits.

Most fixed wing drones have an average flying time of a couple of hours. Gas engine powered drones can fly up to 16 hours or higher. Owing to their higher-flying time and fuel efficiency, fixed wing drones are ideal for long distance operations (be it mapping or surveillance). But they cannot be used for aerial photography where the drone needs to be kept still on the air for a period of time.

The other downsides of fixed-wing drones are higher costs & skill training required in flying. It’s not easy to put a fixed wing drone in the air. You either need a ‘runway’ or a catapult launcher to set a fixed wing drone on its course in the air. A runway or a parachute or a net is again necessary to land them back in ground safely. On the other side, multi-rotor drones are cheap – anyone with a few hundred dollars to spare can buy a decent quadcopter. Flying a quadcopter doesn’t require special training. You just take them to an open area and fly it. Guiding and controlling a quadcopter can be learned on the go.

**1.4.3 Single Rotor Drones**

Single rotor drones look very similar in design & structure to actual helicopters. Unlike a multi rotor drone, a single rotor model has just one big sized rotor plus a small sized one on the tail of the drone to control its heading. Single rotor drones are much efficient than multi rotor versions. They have higher flying times and can even be powered by gas engines. In aerodynamics, the lower the count of rotors the lesser will be the spin of the object. And that’s the big reason why quadcopters are more stable than octocopters. In that sense, single rotor drones are much efficient than multi-rotor drones.

However, these machines come with much higher complexity and operational risks. Their costs are also on the higher side. The large sized rotor blades often pose a risk (fatal injuries have been recorded from rc copter accidents) if the drone is mishandled or involves in an accident. Multi-rotor drones, often owing to their small rotor blades have never been involved in fatal accidents (though a scar on human body is likely). They also demand special training to fly them on air properly (though they may not need a runway or a catapult launcher to put them on air).

**1.4.4 HybridVTOL**

These are hybrid versions combining the benefits of Fixed wing models (higher flying time) with that of rotor-based models (hover). This concept has been tested from around 1960’s without much success. However, with the advent of new generation sensors (gyros and accelerometers) this concept has got some new life and direction.

Hybrid VTOLs are a play of automation and manual gliding. A vertical lift is used to lift the drone up into the air from the ground. Gyros and accelerometers work in automated mode (autopilot concept) to keep the drone stabilized in the air. Remote based (or even programmed) manual control is used to guide the drone on the desired course.

There are some versions of this hybrid fixed wing models available in the market. However, the most popular one is drone used in Amazon commercials (for its Prime delivery service).

**1.5 APPLICATIONS OF DRONE TECHNOLOGY**

**AERIAL PHOTOGRAPHY**

Drones are now being used to capture footage that would otherwise require expensive helicopters and cranes. Fast paced action and sci-fi scenes are filmed by aerial drones, thus making cinematography easier. These autonomous flying devices are also used in real estate and sports photography. Furthermore, journalists are considering the use of drones for collecting footage and information in live broadcasts.

**SHIPPING AND DELIVERY**

Major companies like Amazon, UPS, and DHL are in favour of drone delivery. Drones could save a lot of manpower and shift unnecessary road traffic to the sky. Besides, they can be used over smaller distances to deliver small packages, food, letters, medicines, beverages and the like.

**GEOGRAPHIC MAPPING**

Available to amateurs and professionals, drones can acquire very high-resolution data and download imagery in difficult to reach locations like coastlines, mountaintops, and islands. They are also used to create 3D maps and contribute to crowd sourced mapping applications.

**DISASTER MANAGEMENT**

Drones provide quick means, after a natural or man-made disaster, to gather information and navigate debris and rubble to look for injured victims. Its high- definition cameras, sensors, and radars give rescue teams access to a higher field of view, saving the need to spend resources on manned helicopters. Where larger aerial vehicles would prove perilous or inefficient, drones, thanks to their small size, are able to provide a close-up view of areas.

**PRECISION AGRICULTURE**

Farmers and agriculturists are always looking for cheap and effective methods to regularly monitor their crops. The infrared sensors in drones can be tuned to detect crop health, enabling farmers to react and improve crop conditions locally, with inputs of fertilizer or insecticides. It also improves management and effectuates better yield of the crops. In the next few years, [nearly 80% of the agricultural market will comprise of](http://www.newsweek.com/32-billion-market-agricultural-drones-527741) [drones.](http://www.newsweek.com/32-billion-market-agricultural-drones-527741)

**SEARCH AND RESCUE**

Presence of thermal sensors gives drones night vision and makes them a powerful tool for surveillance. Drones are able to discover the location of lost persons and unfortunate victims, especially in harsh conditions or challenging terrains. Besides locating victims, a drone can drop supplies to unreachable locations in war torn or disaster-stricken countries. For example, a drone can be utilized to lower a walkie-talkie, GPS locator, medicines, food supplies, clothes, and water to stranded victims before rescue crews can move them too someplace else.

**WEATHER FORECAST**

Drones are being developed to monitor dangerous and unpredictable weather. Since they are cheap and unmanned, [drones can be sent into hurricanes and tornadoes](http://www.popsci.com/how-drone-swarms-could-make-tornado-predictions-better), so that scientists and weather forecasters acquire new insights into their behavior and trajectory. Its specialized sensors can be used to detail weather parameters, collect data, and prevent mishaps.

**WILDLIFE MONITORING**

Drones have served as a deterrent to poachers. They provide unprecedented protection to animals, like elephants, rhinos, and big cats, a favorite target for poachers. With its thermal cameras and sensors, drones have the ability to operate during the night. This enables them to monitor and research on wildlife without causing any disturbance and provides insight on their patterns, behavior, and habitat.

**LAW ENFORCEMENT**

Drones are also used for maintaining the law. They help with the surveillance of large crowds and ensure public safety. They assist in monitoring criminal and illegal activities. In fact, fire investigations, smugglers of migrants, and illegal transportation of drugs via coastlines, are monitored by the border patrol with the help of drones.

**ENTERTAINMENT**

Drones are being developed to provide entertainment for players so that they can be used in fight clubs. Known as a cage match, two contenders and their drones are put up against each other. The destruction of any of the player’s drones results in the other’s win. Moreover, artificial drone intelligence is used in several ways to capture videos and photographs, for example, [the Dronie, which is used to take selfies.](https://techcrunch.com/2014/06/16/twitter-embraces-the-sky-selfie-with-its-new-dronie-account-featuring-patrick-stewart/)

As technology advances, drones will become more robust and advanced, accommodating longer flight times and heavier loads. The industry comes with immense opportunities for businesses, [gradually becoming inevitable for them](https://www.allerin.com/blog/the-future-of-drone-technology). It is, therefore, important for organizations to study the scope of drone technology in their area of business, build the required infrastructure, and test their services across it.

Healthcare drone delivery is a revolutionary application of drone technology in the medical field, aiming to improve access to healthcare services, especially in remote or hard-to-reach areas. Drones are being used to transport medical supplies, such as vaccines, medications, and blood, to healthcare facilities, clinics, and even directly to patients. This innovative approach helps to overcome logistical challenges, such as inadequate infrastructure, long distances, and limited transportation options, which often hinder the delivery of essential medical supplies. Additionally, drones are being used to transport medical samples, such as blood and tissue, for laboratory testing, reducing the need for costly and time-consuming courier services. Healthcare drone delivery also has the potential to improve organ transplantation outcomes by rapidly transporting organs to recipients, increasing the chances of successful transplantation. Overall, healthcare drone delivery has the potential to transform the way medical supplies and services are delivered, improving healthcare outcomes, reducing costs, and saving lives.