The design of a precise control drone.

An unmanned aerial vehicle, commonly known as a Drone, is a remote-controlled flying vehicle with a vast potential in various sectors. Initially developed for military applications, drones are now advancing in sectors like agriculture, surveillance, security, entertainment, and aerial photography, promising a bright future for technology in Bangladesh.

In 2024 the revenue generated from the drone market is approximately $2.9 million USD and has an annual growth rate of 9.29%.

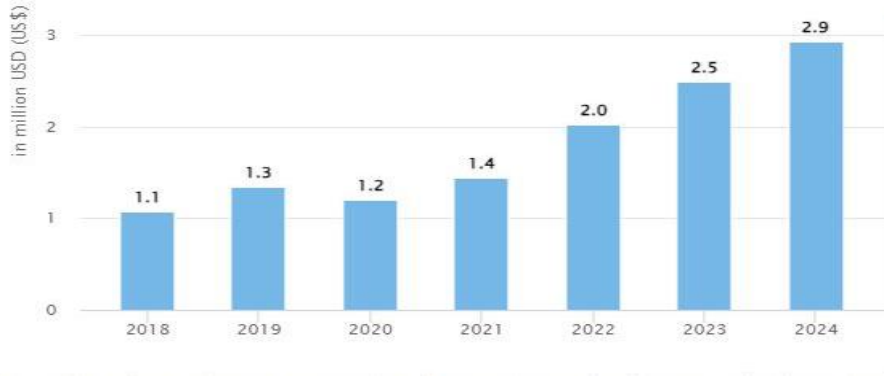

Figure: Revenue generated from drones (2018-2024)

This figure clearly states that the use of drones is rapidly increasing in Bangladesh. But unfortunately, we are lagging behind in manufacturing drones. The demand for drones in Bangladesh is mainly mitigated by importing drones from China. Several local importers import drones from companies like DJI, Parrot, Carrera, etc.

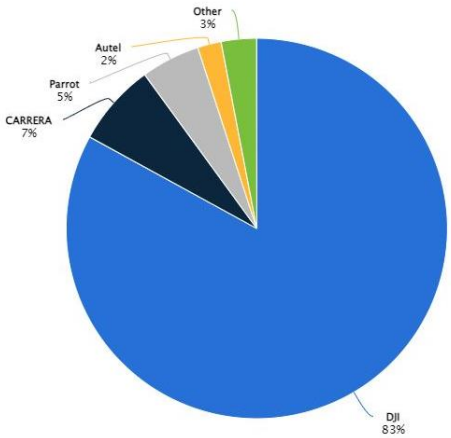

Figure: Market share of different Chinese companies in the Bangladeshi drone market.

The average cost of a professional drone ranges from 50,000 BDT to 300,000 BDT. However, it is possible to reduce the price of drones if produced locally. With the view of developing locally made drones at a comparatively cheaper price, we have redesigned the flight controller, radio control (RC) transmitter, and receiver, the First-Person view (FPV) camera module and found that it is truly possible to build a professional drone below 25,000 BDT. The price can be further reduced if different parts of the drone, such as the frame, BLDC motor, and ESC, are locally manufactured.

Features and design of flight controller: Designing a flight controller instead of purchasing one ready-made flight controller is the most challenging part of this project. It takes a lot of understanding and practical knowledge about the function of flight controllers deeply. We also need to know the basic principles of different sensors, processors, communication protocols, and transmitter pins. The sensors required for building the controller are:

a. U-Blox NEO 6M GPS
b. BPM 280 Pressure sensor
c. MPU-9250
d. HC-SR04 - Ultrasonic distance sensor
e. Arduino nano.

A GPS module is essential for navigation, tracking, mapping, surveying, etc. It allows to share the pinpoint location of the drone with its user, get the direction of its desired destination, and receive a real-time update about its flight. The NEO-6 module series is a family of stand-alone GPS receivers featuring the high-performance U-blox 6 positioning engine. We have selected this GPS module because it can operate in all weather conditions (from -40 to 85 degrees Celsius temperature), consumes low power (3.3V), and has a 5Hz position update rate that helps to deliver real-time information about the location and position of the drone. This GPS module is lightweight (12g) and smaller (in size 22x30x13mm) and delivers excellent performance in a compact design, which makes it the perfect choice for our flight controller.

However, there is a drawback of GPS technology. GPS doesn't function properly in indoor environments or if the signal strength is low. In order to remove that limitation, we have included an MPU-9250 sensor that is equipped with an accelerometer, magnetometer, and gyroscope. These

three values contribute to making the drone more stable. The accelerometer measures the angular velocity and helps in determining the position and orientation of the drone. The gyroscope measures the rate of rotation and helps in balancing the drone. A magnetometer helps to scan the area and know if there is any magnetic field surrounding the system. It also allows obtaining geo-referenced maps of the area. In order to boost drone flight performance and stability MPU-9250 is a good choice. It is the smallest motion-tracking device with a dimension of (3x3x1mm), consumes less power, and provides high performance at a reduced cost. Although three independent sensors can be used for doing the same, it makes the circuit design more complex.

We cannot ignore the air pressure during the flight time of a drone. For this reason, we have used a BPM-280 pressure sensor in our flight controller. It can measure temperature, pressure, and relative humidity with great accuracy. Drones utilize this pressure sensor to stabilize at an altitude allowing hovering capabilities. MPU-9250 and BPM280 combinedly help in achieving precision flight of the drone.

In order to implement object avoidance and collision avoidance, we have used the HC-SR04 - Ultrasonic distance sensor as a part of our flight controller. This sensor provides an operating accuracy of up to 3mm and gives non-contact measurement functionality from 2cm to 400cm. It helps in measuring the distance of an object from the drone and avoids any obstacle in the flight trajectory. The controller is programmed in a way that it will move in the opposite direction if any object gets detected within 1.5 meters to avoid a collision.

We have used two Arduino Nano development boards for integrating the sensor and designed PCB for installing the sensors. The cost of the flight controller is around 3000 BDT. This flight controller is cheaper in price, but it can compete with the most advanced flight controller available in the market.