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Medical Product Transportation UAV Drone

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Abstract— Drone delivery has recently drawn the attention of numerous scholars and business professionals due to rising urbanization and the growth of the E-commerce sector. Customer expectations, delivery urgency, and flexibility, to mention a few, are some of the elements that are either directly or indirectly responsible for the adoption of drone delivery. Unmanned aerial vehicles can be used as an alternate delivery method as the conventional method has certain potential problems for delivering medical supplies in both rural and urban environments. In this research, the main aim was to construct a reliable medical emergency delivery system called MediFly that helps clients buy medicine and other health-related services. MediFly consist of automated UAV and an android application. The e-commerce android application takes order from user and utilizes Quick Response code (QR-Code) for payment. A quadcopter had been developed using Pixhawk flight controller with onboard Arduino Mega 2560 microcontroller along with multiple ultrasonic sensors for the UAV to avoid crashing into obstacles., The drone was designed to take all instructions from Ground Control Station (GCS); the communication between the quadcopter and the GCS is established through MAVLink protocol (Communication Protocol for drones). Server is utilized for communicate with the android application and UAV, which makes delivery efficient and secure.

Keywords—Quadcopter, Unmanned arial vehicles, Arduino Mega, First aid delivery, Delivery service, Ground Control Station, MAVlink

1. Introduction

While other innovations have been considered in (A. Li et al., 2022), (Ranieri et al., 2018), (van Duin et al., 2020) delivery by Unmanned Aircraft Vehicles (UAV), or drones, is increasingly seen as an integral part of the future solution for urban freight movement to provide fast, point-to-point deliveries. FedEx Express and Wing Aviation have accomplished their first planned commercial-to-

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residential drone deliveries in the United States, as have established logistics organizations and startups(Norman, 2019). Amazon has gotten certification for their Prime Air drone delivery fleet (Moshref-Javadi & Winkenbach, 2021), with delivery costs projected to be two-thirds or less of typical ground vehicle-based delivery costs (Sudbury & Hutchinson, 2016).

1.1 Unmanned aerial vehicles (UAVs)

The term "Drone" (Moshref-Javadi & Winkenbach, 2021) refers to as an unmanned aircraft in a technological context. A drone is more officially referred to as an unmanned aerial vehicle (UAV). In essence, a drone is a flying robot. With software-controlled flight plans and onboard sensors, aircraft can fly autonomously or through remote control. Unmanned aerial vehicles (UAVs) of different configurations have the potential to outperform human aircraft and provide new capabilities in such complicated circumstances. Drones, which are intended as fixed-wing aircraft that resemble normal human airplanes, were formerly used primarily for long-range and long-duration surveillance operations. Later variants were armed, allowing for quick precise strikes.

In the 30s, the very first aircraft with a reusable radio control mechanism was invented, which served as a model for all new advances in today's world. Later, throughout World War II, UAVs were used for military purposes, and that technology has been improved. As UAV technology improved in the military sector, using the same technology for the commercial and private sectors also came into being. The Wall Street Journal (Pasztor, 2006) reports that mini-UAVs for non-military purposes began in 2006 and that governments have used them for disaster relief, wildfire prevention, border security, etc.

Besides UAVs used for photography and video recording in the commercial sector, the agriculture sector employs UAVs for various uses such as measuring water content in the soil, spraying pesticides, and detecting pests and bugs using computer vision techniques.

1.2 Ground Control Station (GCS)

Ground Control Stations (GCSs) are often understood to be fixed or transportable hardware/software units that monitor and command unmanned aircraft. Ground Control Station is designed for flight control and monitoring, as well as visual receiving and real-time picture capture. The communication between the quadcopter and the GCS is established through MAVLink protocol. MavLink protocol will be used to move the drone autonomously towards the marked location on the map and through GPS module the location of the drone can easily be observed.

Ground control station also involves the GUI (Graphical User Interface) development to make the system user friendly, which includes embedding of map in the GUI on which the user can mark a location and command the drone to perform any of the specified tasks autonomously, also performed communication between mobile app and UAV

1.3 Objectives and Review Structure

With the rapid increase in usage of online ordering, whether it is online shopping, ordering food, buying gifts, grocery runs or personal packages, the consumer space is increasingly relying on fast and reliable doorstep delivery. The aim of this research is to provide a delivery service for medicine through UAV drones which include development of an Android application, a server for communicate between drone and application, object detection via sensors, facilitation of wallet payment by QR Code, and package security by electric lock. The quadcopter is developed using an onboard Arduino Mega 2560 microcontroller along with multiple HC-SR04 ultrasonic sensors for obstacle detection, equipping it with an Arduino at a specified location and to track a particular point, automating the quadcopter and collaborating it with a server. Server is a platform used to communicate with the Application (Android) and UAV that makes delivery efficient and secure.

The research also encompasses the development of a Ground Control Station (GCS) with a map. The communication between the quadcopter and the GCS is established through MAVLink (communication protocol for drones). Therefore, this research utilizes the Drone-based technology, which allows accelerated delivery time, improved accuracy and reduced human cost.

The remainder of this paper is organized as follows: Section 2 describes the compilation of the literature review. Section 3 discuss the system design followed by Section 4 methodology. The findings of the analysis are provided in Section 5. Section 6 summarizes the key findings and draws a conclusion.

2. Literature Review

Many researchers have been driven to utilize UAVs for data collection in the recent decade because of technical developments, continual decreases in cost, size, and weight, the evolution of connected sensors, high-tech cameras, and flexibility in their usage rule. In 2010 an open-source software named Mission Planner was used to control the drone developed by Michale Oborne (*Mission Planner Home — Mission Planner Documentation*, 2010). Mission Planner provides the fastest delivery of medical facility in rural and urban areas using Android Application for ordering medical requirements. The research conducted in 2017 proposed an online medical system that provides online treatment to the patient along with the home delivery of medicines (Nandagawali et al., 2017). In 2018, (Mangtani et al., 2019) the author designed a drone to provide the fastest delivery to medical facilities. They developed an Android Application for ordering medical requirements. Medkwick - An E-commerce Mobile Application based on online medicine shopping was developed in 2019. The proposed framework consists of an android application that helps clients buy medicine and other health-related services through Chatbot idea is also intended to give basic online consultation. There are some different modules of work such as database, administrator, client, item, user, order, cart, etc (Rane et al., 2019). In 2020 author proposed Online Medical Booking Store with different modules such as administrator, visitor, user, payment, & shopping cart (Gupta, n.d.). In (Meier et al., 2011) , (Tahar & Kamarudin, 2016), (Kusriyanto & Putra, 2016), and (Can et al., 2020), authors work on building a quadcopter depending on various components like Pixhawk flight con-troller (Meier et al., 2011) , Arduino Mega 2560 (Kusriyanto & Putra, 2016) , s500 frame etc. (Can et al., 2020), and Acrylic box, a framework for the local use of custom-made medical devices (Turner et al., 2020). For GPS the author examines "uav onboard gps in positioning determination" (Tahar & Kamarudin, 2016), the main goal was to evaluate the accurateness of UAV onboard universal positioning system in location determining purpose. It includes four fundamental stages, namely preparation, observation, processing, and analysis. The preparation consists of the setup and UAV installation, where the DJI F450 framework model (Ahmed et al., 2020) for certain adjustments.

Object detection is classifying and locating objects in an image or a video. This technique has risen in prominence over the past few years because of its various uses. Object detection is classified into two primary techniques i.e one-stage and two-stage. In a one-stage technique, inference speed is the primary concern, which Single Shot Detectors exemplify (SSDs) (Liu et al., 2016). You Only Look Once (YOLO) (Redmon et al., 2016) and RetinaNets (Lin et al., 2018), where two-stage techniques aim to improve detection accuracy; for instance, Mask Region-based Convolutional Neural Network (R-CNN) (Hao et al., 2021), Faster R-CNN (Y. Li et al., 2022), and Cascade R-CNN (X et al., 2021). In (Zaidi et al., 2021) author survey modern deep learning-based object detection models. Today most of the world moved to electronic payments, which have been developed within the payment system around the globe. They include electronic checks, e-cash, credit cards, and electronic funds transfers because they are very reliable for customers and service providers (Kabir et al., 2015) and the author of (Ruslan et al., 2019) investigate "QR Code Payment in Indonesia and Its Application to Mobile Banking.

2.1 Comparison with available work

The comparison of research related to UAV drone transportation is presented in Table 1

Table 1- Comparison of Research work

Reference	Objective	Limitation
(Claesson et al., 2017)	Out-of-Hospital Defibrillator Delivery Using a Drone	the small number of flights over short distances in good weather
(Thiels et al., 2015)	The goal is to describe the need, potential, and risks associated with the use of tiny UAVs to transfer blood and pharmaceutical items to hospitals.	Use of UAVs could be a viable mode for the transport of medical products in times of critical shortage
(Amukele et al., 2017)	The goal is to improve the transportation of blood products using UAVs.	Time constraint
(Poljak & Šterbenc, 2020)	Drones in clinical microbiology and infectious diseases	Drones may significantly increase access to healthcare for individuals who might otherwise not benefit from appropriate care due to remoteness and lack of infrastructure or funds
This work	Update our delivery system(medicine) to save the time and lives of people. Also utilize QR-code for payment to make delivery fast	Large payload will be an issue for this research as the designed drone is limited to small payload.

3. System Design

This research comprises of software and hardware components shown below in Figure 1.

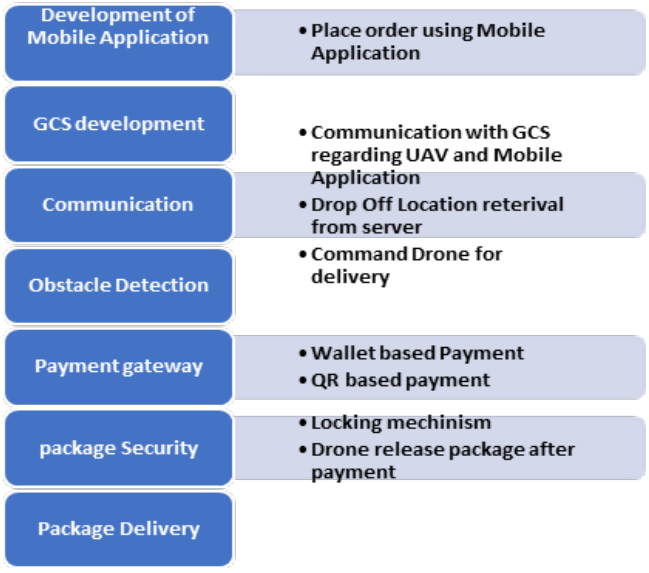

Fig.1- Components used in MediFly

The hardware part i mbling of drone components such as Pixhawk (Meier et al., 2011), Global Positi n (GPS) (Tahar & Kamarudin, 2016), Kilovolt (KV) motors & Electronic speed con), Arduino (Kusriyanto & Putra, 2016), s500 frame (Can et al., 2020), sensors (Rai d., 2017), telemetry, etc. The drone is designed to take all instruc de were obtained via GPS. An Android App is develo ing an order. as developed to communicate with the Mobile Applic AV. The comm ween the quadcopter and the GCS is established throug ink protocol (2017). Object detection is done using Arduino d indicate signals to Arduino. Facilitation is secured through Electric lock which is

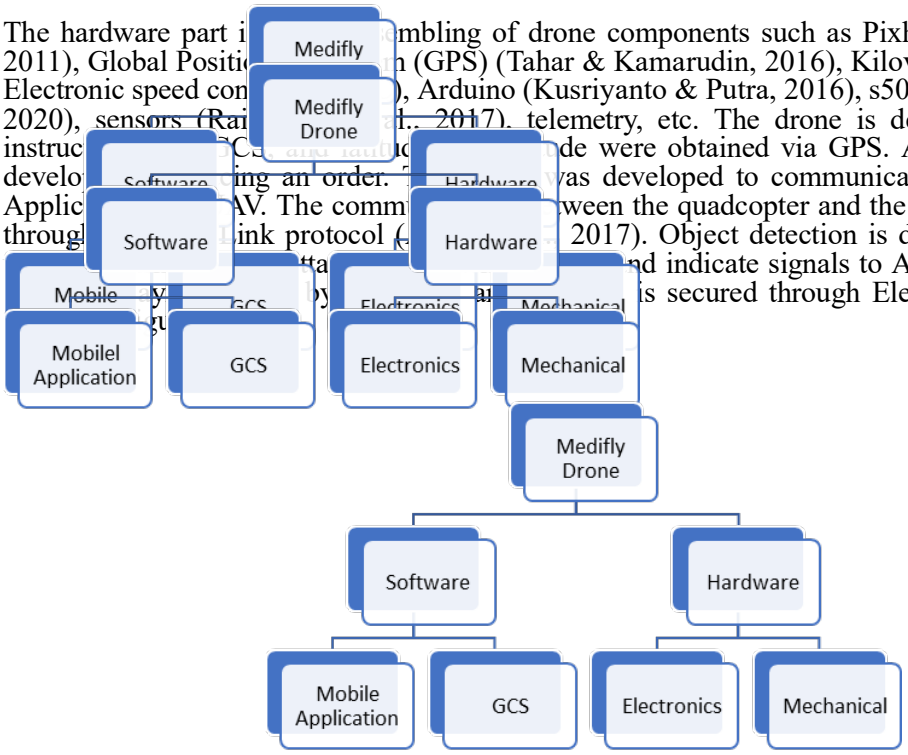

Fig.2- Process Diagram of Medifly

3.1 Hardware: Unmanned Aerial Vehicle

UAVs are aircraft with no pilot on board and can be remotely controlled or flown predictably based on pre-programmed waypoints. There are many different sizes of UAVs, depending on their usage. Yet, multi-copters are generally the most popular UAVs for outdoor surveillance. For multi-copters to maintain stability in the air, they have multiple rotors and are aerodynamically unstable. Figure 3 shows the designed quadcopter

Fig. 3- Unmanned Aerial Vehicle

The UAV drone uses S500 frame which is an extremely flexible to accommodate or mount various components such as the flight controller, battery, etc. Flight controllers are circuit boards that control the torque / RPM (Rotation per minute) of motors. They usually incorporate multiple sensors for more data. The devices range from gyroscopes to barometers and GPS receivers. This research utilizes the Pixhawk 2.4.8 flight controller. The radio control system is used for drone operation. It consists of two parts, a transmitter and a receiver. The transmitter is a device used by the pilot to remote control the UAV, while the receiver is attached to the flight controller that receives the signals. This research utilizes FlySky's FS-i6X transmitter and IA6B receiver. Global Positioning System (GPS) is a satellite navigation system that measures the position and speed of an unmanned aerial vehicle using signals received from orbiting satellites. Several flight modes can be used, including Auto mode, Position Hold, Return to home etc. It serves an important purpose for automation, waypoint navigation,
and utilizing various flight modes. This research was conducted using the Ublox M8N GPS (Tahar & Kamarudin, 2016) with a compass.

3.2 Software

As a result of covid-19, e-commerce applications are on the rise since no one wants to leave their homes in this situation. Everybody wants their necessities delivered to their doorstep. Through the Internet, several aspects of society have been transformed, from business to recreation, communication to technology, and even shopping and travelling. Technological advancements have facilitated new forms of communication that have helped businesses do business. E-commerce is the new way to shop and manage a business. With the help of technology, companies can now promote and sell their products in new markets, overcoming geographical barriers like never before. Thanks to wireless and internet technologies, consumers can access a wider range of products. Companies have reached consumers in more diverse ways thanks to mobile devices with broad access to the Internet, ensuring deep market penetration (Saleh & Goodwin, 2012).
The present work is based on developing an Android application in Java that will allow customers to place orders. It is compatible with different Android versions ranging from Android 3.0 (Honeycomb) to the current update of Android 10 as shown in Figure 4

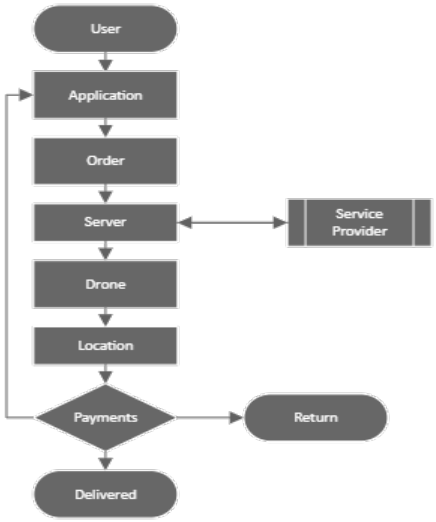

Fig. 4- System Flow Diagram

The android application consists of a registration form for authentication. After login, users/customers can select the desired product to be purchased and checkout by paying the amount from their available wallet via QR code. QR Code is a very convenient method of deducting payments in the modern era, as it allows companies to deposit payments instantly. The system flow diagram is shown in Figure 4.

The research also encompasses the development of a Ground Control Station (GCS) with a map. The communication between the quadcopter and the GCS is established through MAVLink (communication protocol for drones).

4. Methodology

The methodology is divided into four main parts.

4.1 Development & automation of GCS:

An initial connection between the UAV and GCS is crucial. For connecting with the UAV, the following C-sharp programming language (C#) code snippet is needed. Changing the port on which telemetry is connected:

```
Ser_port.open();
packet = mavlink.ReadPacket(serialPort1.BaseStream);
Reading packet from the port.
MAVLink.MAVLinkMessage packet;
packet = mavlink.ReadPacket(serialPort1.BaseStream);
```

Code snippet for connection between GCS and UAV

The Heartbeat Message provides some basic information about the UAV. This method is used to read the UAV's heartbeat messages (read some data is an Application Programming Interface (API) function for reading UAV messages)

```
var hb = (MAVLink.mavlink_heartbeat_t)packet.data;
 Getting the flight mode of UAV
```

Code snippet for UAV Heartbeat message

The UAV can be armed by using the MAV COMPONENT ARM DISARM command.

```
MAVLink.mavlink command_long t req=new MAVLink.mavlink command long t()
 req.command=(ushort)MAVLink.MAV CMD. COMPONENT ARM DISARM
```

Code snippet for Arming the Quadcopter

To make the quadcopter move autonomously, the user must input the latitude and longitude of a particular location on the map. The coordinates obtained can then be used in MAV CMD WAYPOINT commands to make the quadcopter move automatically to that location.

```
MAVLink.mavlink_mission_item_int_t req2 = new MAVLink.mavlink_mission_item_int_t();
req2.target_system = sysid;
req2.target_component = compid;
req2.command = (byte)MAVLink.MAV_CMD.WAYPOINT;
```

Code snippet for waypoint navidation

4.2 Communication between Application & UAV by Server

It involves the following steps.

1. The server is a platform used to communicate with the Application and UAV.
2. The customer scans QR codes through the mobile app, GCS receives the message through API, and then sends commands to unlock the payload on the drone.
3. Using GPS and drone coordinates to fly towards the given location and drop the parcel
4. UAV drone movement is guided by a hardcoded waypoint only.
5. By using MAV CMD NAV WAYPOINT command, the UAV autonomously moves to the location of user.

4.3 Payment Gateway

Nowadays, people are so busy that they don't have time to stand in line to pay bills, or debit amounts in other accounts, or write a check, or use credit cards because some methods are slow, others are not safe and secure, but here a QR + Digital wallet is the solution. Users just need to scan the QR to complete their payment. This system is thus the most secure, reliable, and fast method of payment.

The payment system utilizes the QR-Code along with wallet system. In the modern era, many companies use QR-Code (Ngo & Nguyen, 2021) to deduct payments because it is very convenient. Just need to scan the QR-Code to complete the transaction. It takes less time this way. QR-Code utilization significant is shown in Table 2. Wallet system is also in-cooperating with QR-Code for secure payment processing. Wallet systems are widely used today in apps because they are a most significant feature. Wallet systems allow users to easily transfer money between their bank accounts and apps. The amount can also be added by paying an app representative.

Table 2- Payment methods

Payment System	Reliable	Secure	Accuracy & Fast
Credit Card	✓	✖	✓
Cheque	✓	✖	✖
Hard Cash	✖	✖	✖
QR+ Digital Wallet	✓	✓	✓

4.4 Object Detection

In this research HCSR04 Ultrasonic sensors were connected to the Pixhawk 2.4.8 via the Arduino Mega 2560. By using the sensors, the UAV can determine the distance to an obstacle. To avoid the obstacle, we set the distance to 3.3 feet through testing and experimentation. Controlling an unmanned aerial vehicle while avoiding distance is done via the MAVLink library in the C++ language. The sense and avoid algorithm were modified slightly from the one used in [7] presenting as follows.

1. From the front, back, left, and right the UAV continuously measures distances from

obstacles
2. A user's manual control of the UAV is disabled as soon as the measured distance is less than 3.3 feet because the Arduino microcontroller set for breaking mode disables manual control from the user.
3. A mavlink RC CHANNELS OVERRIDE command allows the UAV to move in the opposite direction until a secure range is observed, typically greater than 3.3 feet.

4.5 Package Security

4.5.1 Acrylic Box:

In order to secure the package, the acrylic sheet has been utilized. Acrylic is a transparent plastic material with outstanding strength, stiffness, and optical clarity. Acrylic sheet is easy to fabricate, bond well with adhesives and solvents, and is easy to thermoform. It has superior weathering properties compared to many other transparent plastics.

A servo motor is used to operate a package lock, or a latch enables administrator/operator to remotely lock and unlock an acrylic box. The required circuit is a simple pulse generator based on Arduino, or peripheral interface controller (PIC) microcontroller.

5. Results and Discussion

A huge platform we are developing is "To deliver a product through the use of an unmanned aerial vehicle (UAV)". As part of our project, we developed both a software and hardware component. The first component we developed was an Android application. Then, we developed GCS, focusing on flight operation and controlling issues, obstacle detection, and payment system. We conducted several experiments and found some important results that are given below

5.1 Flight Operations

For starting and dropping off points, enter GPS coordinates on Mission Planner as shown in the following Figure 5 and 6:

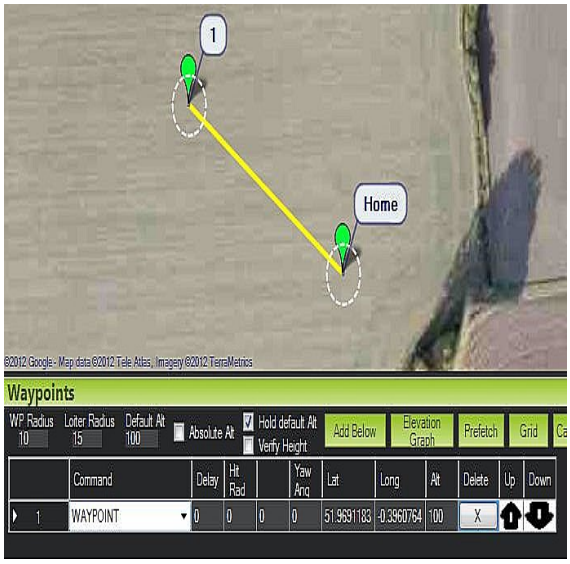

Fig. 5- Way points

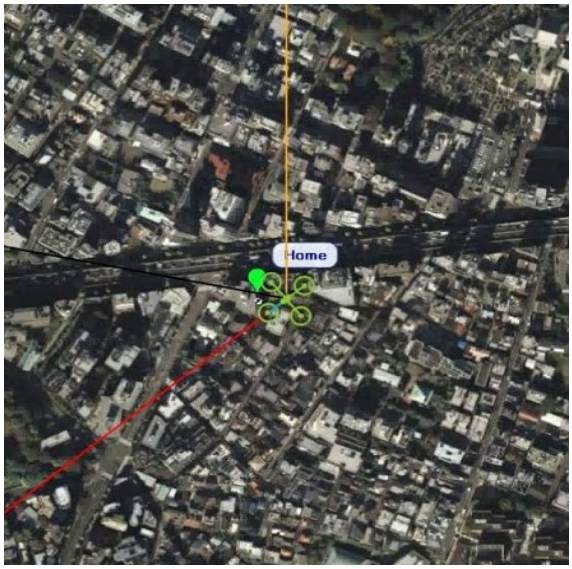

Fig .6- Way points

5.2 Obstacle Detection

It also used multiple HCSR-04 sensors and Arduino interfaces with Pixhawk flight controller in order for the UAV to avoid crashing into obstacles. The results are obtained as follows which is shown in Table 3.

Table 3- Obstacle Avoidance Results

Distance (Cm)(approx.)	Avoidance Accuracy
<20	Good
<80	Good
<100	Good
100	Average
>170	Bad

Furthermore, we measure the calculation of GPS points within a radius of 50 to 150 feet. We discovered that GPS is inappropriate for indoors and shows the UAV moving even after it has landed, but the Ublox M8N GPS with compass works well outdoors. However, our university ground is small-scale in order to get accurate results as shown in Figure. 7 and 8. The longitude and latitude points are presented in Table 4.

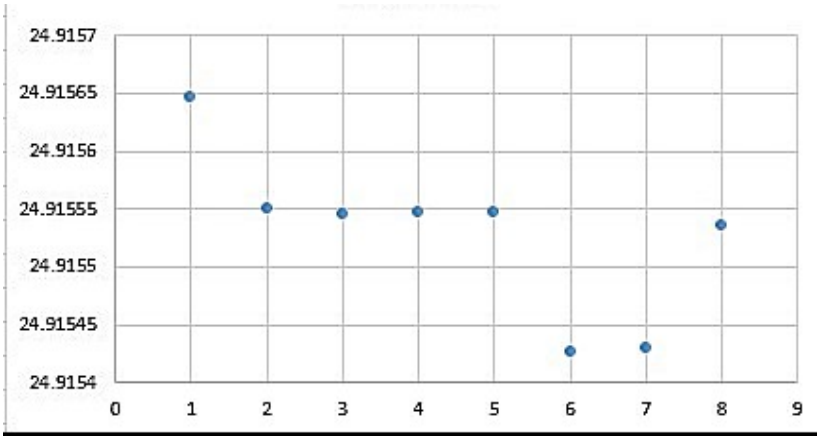

Fig. 7- Longitude

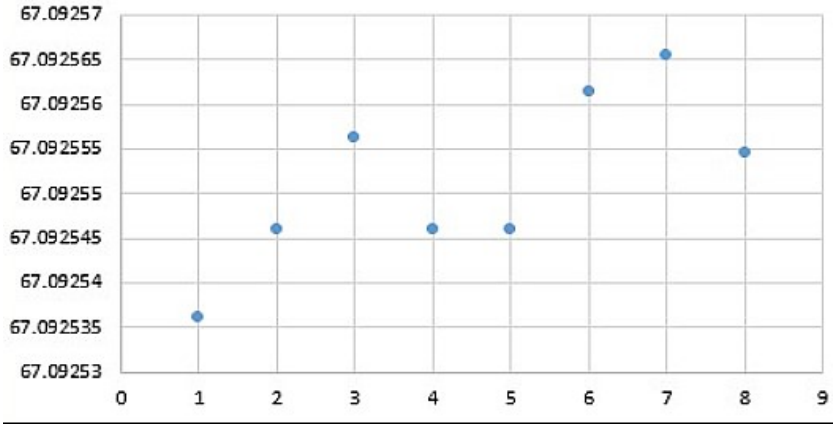

Fig. 8- Latitude

Table 4- Longitude and Latitude points

Points	Longitude	Latitude
1	24.91565	67.092535
2	24.91555	67.092545
3	24.91555	67.092555
4	24.91555	67.092545
5	24.91555	67.092545
6	24.9154	67.09256
7	24.9154	67.092565
8	24.91555	67.092555

5.3 Controlling issue

During testing to move drones from one location to another founds a few challenges, such as the effect of the environment and weight issues. In addition to these issues, another problem that sometimes arises is when the drone is out of contact with the centralized control system. As a result, drones often crash and cause damage. The priority is high to remove all issues by taking precautions to fly drone carefully within the range and put suitable weight in UAV.

6. Conclusion

In this research, the main aim was to construct an automated UAV with GCS specific to security system requirements in order to increase their effectiveness along with the integration of autonomous features of UAV with computer vision techniques and to collaborate the more modernized technology of UAVs with an E-Commerce application. Also, it is important to use appropriate equipment for a project in which hardware is also incorporated to run properly. UAVs can be used to deliver goods from one end to another using the quad copter S500 frame, however, Octocopter can be used for improved stability. Octocopter utilizes more motors and propellers than a quadcopter, therefore it provides more power to lift weights.

Hence, this work provides a strong foreground for other researchers who wish to develop their UAV systems that incorporate computer vision techniques to improve both the safety & security systems and the domains where autonomous UAVs can be used for the sake of assisting people in making their lives easier and more convenient.

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