Sky Cargo: Self-Navigating Delivery Drone

Sucheta Raut
Assistant Professor, ETC Department, GHRIET Nagpur)

Deep Ghoshal[1], Krutika Thakre[2], Abhijeet Singh Thakur[3], Samruddhi Zilpe[4], Himanshu Mendhe[5], Darshan Chaudhari[6]
G.H. Raisoni Institute of Engineering and Technology, Department of ETC, Nagpur, MH, India

Abstract:- The rapid growth of e-commerce and the increasing demand for efficient, sustainable, reliable, economical delivery solutions have driven the development of autonomous delivery drones. The "Sky Cargo Self-Navigating Delivery Drone," has a cutting-edge technology designed to revolutionize the logistics and transportation industry. The system has a predefined path between its starting point to its delivery location based. The system ensures the precision landing at the receiver end by verification at the delivery location by the uniquely generated Aruco marker. An optimal path is given to the drone by performing the mathematical calculations between the starting point to its delivery point

***Keywords**:- Autonomous drone, Self-Navigating, precision landing, Aruco marker, optimal path.*

I. INTRODUCTION

As the E-Commerce industry grows, more challenges arise for last-mile distribution, customers expect shorter delivery time from businesses, while demanding more orders

Considering that 65% of the world's population will live in urban cities by 2050, the logistics industry will also have to consider future city problems, such as insufficient transportation capacity.

The major problem of future delivery is not only limited to shortening delivery time and fulfilling customer demand, but also minimizing the use of on-road transportation.

Drone delivery is simultaneously conducted with vehicle-delivery, assuming that drones are faster than vehicles. Compared to the original drone-delivery method, the concept shortens drone route and delivery time. Delivery drones can operate 24/7, allowing for round-the-clock delivery services that meet consumer demands efficiently.

Beyond efficiency and social impact, delivery drones are environmentally friendly, as they produce zero emissions.

II. SYSTEM REQUIREMENT

A flight controller is the "brain" of the drone, responsible for stabilizing the aircraft, controlling motors, and processing sensor the data. Popular flight controller are Pixhawk, DJI A3/N3, and various open-source options.

A reliable communication system is crucial for real-time data exchange between the drone and the ground control station. This can include radio transmitters, receivers, and data links.

Motors, propellers, and Electronic Speed Controllers (ESCs) are essential for controlling the drone's movement and stability.

Drones require batteries to power the propulsion system and onboard electronics. Battery capacity and voltage depend on the drone's size and payload and other factor.

An onboard computer like (e.g., Raspberry pi) is necessary for processing data from sensors and running the control algorithms. A user-friendly interface on your GCS for mission planning, monitoring, and data visualization and GPS Provides accurate position information.

A. BLOCK DIAGRAM

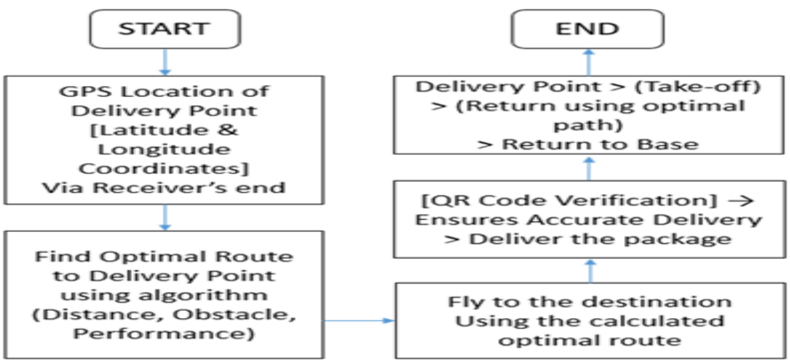

Fig. 1: Autonomous Delivery Drone Workflow

B. COMPONENTS DESCRIPTION

- *Flight Controller*

Fig. 2: Pixhawk 2.4.8

The Pixhawk 2.4.8 is an advanced flight controller module equipped with a 32-bit microcontroller, which serves as the brain of drone. It runs the PX4 autopilot firmware, facilitating autonomous flight and providing a wide range of sensor inputs.

- *1000KV Brushless Motor*

Fig. 3: Brushless Motor

These brushless motors are high-power, efficient motors designed for use in RC airplanes and quadcopters. They are capable of providing the necessary thrust for drone to lift off and manoeuvre.

- *Servo Motor*

Fig. 4: Servo Motor

A servo motor is a type of rotary or linear actuator that is used in a wide range of applications to control the position, speed, and movement of various mechanical systems. It is a device that converts an electrical signal into precise mechanical motion and widely used in projects.

➢ *GPS Module*

Fig. 5: GPS Module

The GPS module provides accurate position, coordinates and information, enabling drone to navigate autonomously, follow waypoints, and maintain stable flight during journey.

➢ *Raspberry pi*

Fig. 6: Raspberry pi 3B+

These single-board computers can be used for various tasks within the drone, such as interfacing with sensors, data processing, and implementing autonomous navigation algorithms in drone. We are using Raspberry Pi for precision landing in this project.

➢ *Camera Module*

Fig. 7: Camera

The Camera Module can be used to take high-definition video, as well as stills photographs. It's easy to use for beginners, but has plenty to offer advanced users if you're looking to expand your knowledge. There are lots of examples online of people using it for time-lapse, slow-motion, and other video cleverness. You can also use the libraries we bundle with the camera to create effects**.**

III. SOFTWARE

The operating system we use is Ubuntu 22.04.3 in with ROS 1 (Robot Operating System). A ROS package was developed by DJI, known as Onboard-SDK-ROS, is utilized to establish communication between the drone and Raspberry Pi device. This package enables the transmission of commands to the embedded control system and the reception of data from the drone's onboard sensors and other major parts, including GPS information and coordinates. It facilitates the real-time estimation of the drone's position and orientation and easily trackable on our system.

To identify and estimate the pose of Aruco markers and enable precision landing, specific algorithms from OpenCV are used. OpenCV is an open-source computer vision library used to process images or video streams from the drone's camera to detect and determine the pose of Aruco markers. Additionally, a serial connection is established between the Raspberry Pi and the drone flight controller for Aruco marker estimation and precise landing, allowing for seamless data exchange between the two devices.

Fig. 8: Aruco Marker for Precision Landing

IV. WORKING

A workflow for a self-navigating delivery drone used for sky cargo involves several steps. The process begins with the automated take off of the drone. This is typically based on a predetermined mission that has been programmed into the drone's flight control system using the Mission planner software for providing coordinates to drone.

The drone utilizes GPS coordinates to navigate to the delivery location. The longitude and latitude of the destination are used as reference points for the drone's flight path. The drone's onboard GPS system constantly updates its position, ensuring it stays and provide real time coordinates of drone where user can locate and track the complete progress of delivery.

To ensure precise delivery, the drone uses specially generated Aruco markers at the delivery location. Aruco markers are visual markers create using python with Open CV library that the camera system can recognize. The camera module is serial link with raspberry pi and raspberry is link with flight controller.

After successfully delivering the cargo, the drone initiates and starts its return journey. It follows a predetermined flight path or uses GPS coordinates to navigate back to its base or home location.

This automated cargo drone delivery process ensures that the drone safely and accurately delivers goods to the correct destination and parcel to be received by correct receiver end and ensure complete safety of cargo.

Fig. 9: Autonomous Delivery Drone

V. RESULT ANALYSIS

The integration of essential components, such as the Raspberry Pi for precision landing, and the utilization of Mission Planner for autonomous flight management, coupled GPS module, have collectively contributed to the drone's ability to execute flight missions.

Furthermore, the integration of the Raspberry Pi for precision landing, a pivotal aspect of our research, has empowered the drone to conduct accurate and controlled landings, a vital component for delivery applications. The synchronization of this hardware with Mission Planner, a robust ground control software, has facilitated the seamless execution of complex missions. The integrated GPS module further enhances the drone's ability to navigate and

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adhere to predefined waypoints, thereby ensuring the delivery drone's ability to autonomously perform its intended tasks.

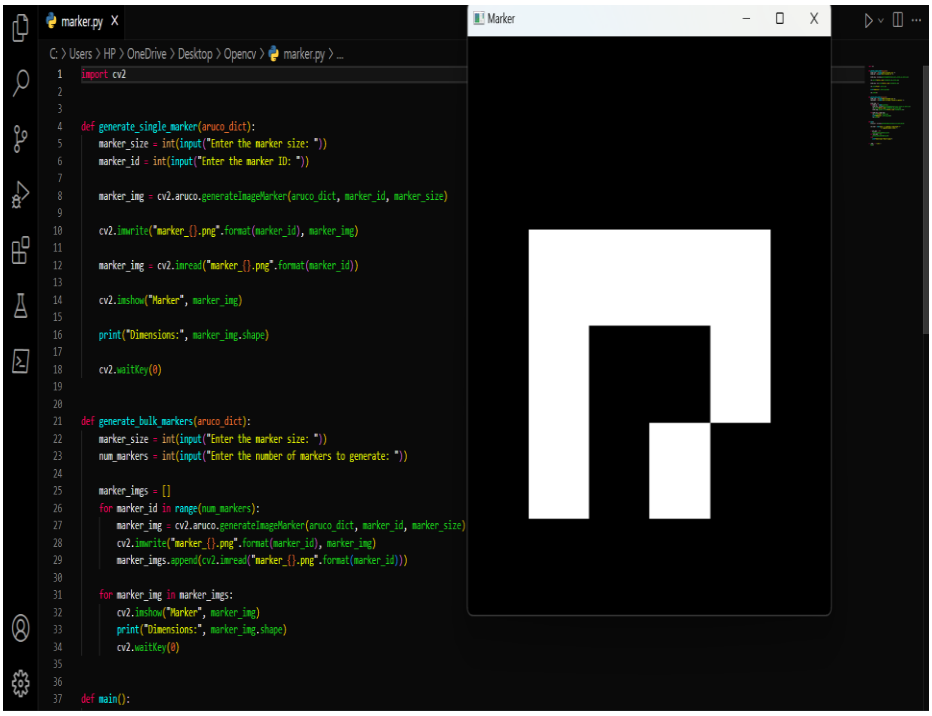

Fig. 10: Aruco generator code with output

For the use of the marker detection technique for localization, aruco markers were printed and placed on top of the landing platform. Aruco markers have features that facilitate their identification in the image, such as well-defined borders and high color contrast. OpenCV is an algorithms with using python language to identify the aruco marker, as well as estimate the relative pose of the marker with respect to the camera which installed in drone with serial link with raspberry pi computer. Before working on real drone we perform simulation of drone.

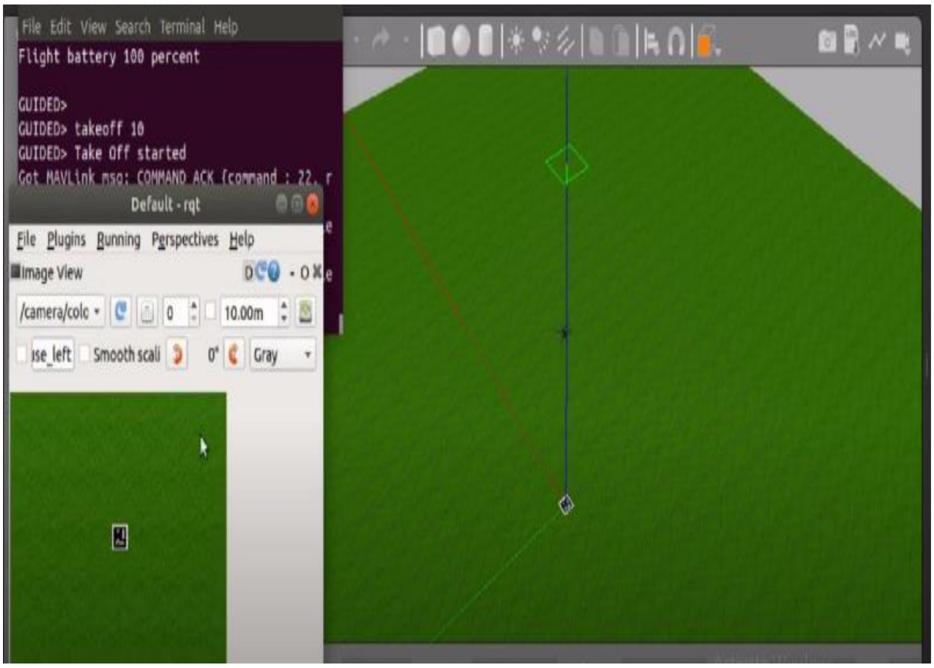

Fig. 11: Simulation of precision landing in Gazebo Simulator

Gazebo Simulator in Linux OS we used because it reduce the chances of any damage in Flight controller. Gazebo can simulate a wide range of environmental conditions, such as wind, rain, and turbulence. This allows you to test your drone's performance under different scenarios.

Fig. 12: Simulation of Optimal Path Using mission planner

These achievements mark a critical milestone in the field of drone technology, offering a valuable contribution to the ever-evolving landscape of autonomous aerial systems.

VI. CONLUSION

First and foremost, the creation of Sky Cargo represents a step forward in the field of autonomous drone technology. The drone's ability to navigate and deliver cargo autonomously showcases the potential for such technology to various industries, including logistics, healthcare, and e-commerce.

Secondly, the project has provided invaluable experience and knowledge to the team members involved. We have learned about the drone design, control systems and the importance of efficient route planning. These skills and insights are not only applicable to autonomous drones but can be applied to a wide range of engineering and technology projects.

Additionally, the successful development of Sky Cargo has opened up new possibilities for industries in need of efficient and cost-effective delivery solutions. The potential applications for this technology are extensive, ranging from last-mile deliveries in urban areas to remote regions where access is challenging. As a result, we believe that Sky Cargo can have a positive impact on both businesses and communities.

In conclusion, the autonomous delivery drone project, Sky Cargo, is a modern technology to transform the way we approach logistics and transportation. Our work showcases the capabilities autonomous drones in a practical setting and demonstrates the positive impact they can have on various industries.

VII. FUTURE SCOPE

"Sky Cargo" holds significant potential in the ever-evolving field of autonomous transportation. The future scope of this project could focus on enhancing the drone's efficiency and safety. Additionally, exploring the integration of AI-driven route optimization and real-time weather analysis to ensure reliable cargo deliveries. Furthermore, investigating the feasibility of scaling up the drone fleet for larger cargo loads and broader geographical coverage could open new avenues in autonomous logistics.

Researching the environmental impact and sustainability of drone-based logistics can also be a significant aspect, aligning with the growing focus on eco-friendly transportation solutions. Collaborating with industry partners and stakeholders to gather real-world data and feedback could further enrich research, ensuring that "Sky Cargo" contributes to the evolution of autonomous delivery drones and their integration into the future logistics landscape.

Drones are valuable tools for search and rescue operations. They can cover large areas, provide thermal imaging, and locate missing persons or disaster survivors in challenging conditions also cover major part in war like condition where drones can serve crucial delivery of cargos and other raw material and stuffs and drones are being explored for medical supply delivery in remote areas or during emergencies situations. They can transport and meet the supply demand of medical equipment, vaccines, and even conduct medical sample transport

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