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Autonomous Drone Delivery System

Simran Pathan[1], Harsh Pandey[2], Ajay Savare[3], Prof. Neha Dumne[4]

Department of Electronics and Telecommunications Engineering, Dhole Patil College of Engineering, Pune, India[1,2,3,4]

Abstract: This paper presents the design and development of Autonomous Drone based Delivery System to replace the traditional delivery system with Unmanned Aerial Vehicle (UAV). With rapidly growing technology automation have become the new normal and everyone is using it in their day to day work. The demand for faster delivery system which will be efficient, fast, conventional as well as environmentally sustainable have increased rapidly. Hence Autonomous Drone Delivery System serves as an alternative to all these things and provides a solution which is efficient and environmentally sustainable as well as will have minimal human interference in it. The core objective of this project is to implement a delivery system which is reliable, efficient and have a delivery system integrated claw mechanism that can carry lightweight package to a specific destination autonomously.

Keywords: Autonomous Drone Delivery System, environmentally sustainable, claw mechanism, UAV

I. INTRODUCTION

This Autonomous Drone Delivery System provides an innovative solution to the challenges faced in the traditional way of logistics deliveries. The project aims to provide reliable, efficient, cost-effective and environmental sustainability with minimal human intervention. It is designed in a way to carry light weight packages from one point to another, by autonomously navigating to predefined locations using GPS, while a secure gripping mechanism to ensure safe handling of the package and providing a reliable and efficient delivery of the package attached to it. The growing technological advancements, faster alternatives to traditional systems, implementation of AI into various fields today's generation wants everything to be as fast as it could be they want faster solutions to everything. Also, the demand for online ordering and e-commerce shopping has become the day-to-day activity and hence the demand for faster alternatives to traditional delivery system have increased. In the traditional delivery system, there were many challenges that were faced some of which are: Traffic congestion, carbon emission of the vehicle used for delivery, increased human efforts, less reliability and slower. This technology can be applied into many sectors including e-commerce, healthcare and disaster relief areas, offering faster delivery times, reduced human involvements and increased accessibility. This project majorly highlights the potential of UAV to redefine the logistic industry by increasing operational efficiency, reducing costs, and providing a sustainable alternative to the traditional delivery methods which is also ecofriendly and more reliable and eco-friendlier.

II. PROBLEM STATEMENT

In recent years, the logistic and delivery industry has faced growing challenges due to increasing demand for faster, more reliable, and efficient delivery services. Traditional ground-based delivery systems face many challenges like traffic congestion, limited access to remote areas and higher operational costs in sectors like e-commerce, healthcare and disaster relief areas, which also puts pressure on the existing infrastructure.

Current delivery methods struggle to meet the growing demand for rapid, flexible and secure deliveries particularly in densely populated urban areas, remote location and disaster relief areas. The limitations of this traditional delivery methods can lead to delays, higher costs and eventually customer dissatisfaction.

To solve these existing problems an innovative solution is required and we can get it by Unmanned Aerial Vehicle (UAV) or particularly by the drone technology. Drones have the ability to navigate freely and bypass the traffic, providing an ideal solution to revolutionize the logistic industry. Autonomous Drone Delivery System is a system capable of delivering light weight packages to the predefined locations efficiently. Ensuring faster deliveries, reduced costs and improved accessibility and thus meeting the demand of the modern logistics. It serves as an alternative to the already existing delivery model by making the future of deliveries more reliable, fast, cost effective and of course environmentally sustainable.

III. SYSTEM ARCHITECTURE

Autonomous Drone Delivery System designed in this project is a quadcopter drone i.e. it has four rotors for flight, each rotor is powered by a BLDC motor and controlled by the flight controller to ensure precise and stable movement of the

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drone. The quadcopter drone has multiple integrated subsystems, including control, communication, power distribution and propulsion. Below is the detailed implementation of the proposed system:

A. Transmitter (Remote Control Unit):
The radio transmitter is handheld devices used for operating drone manually. It sends wireless signals which represents as commands to the drone's flight.

B. Receiver:
This device is mounted on the drone to receive the signals sent by the transmitter or the control station to the drone. A receiver basically gets the data which it feeds to the flight controller and this data is then processed by the flight controller to achieve the desired flight plan.

C. Flight Controller and ESC:
The flight controller is said to be as the central processing unit (Brian of the drone) of the drone. It processes the input signal from the radio receiver and sensor data and translates pilot commands into control signals. On the other hand, Electronic Speed Controller (ESC) serves as the intermediary between the flight controller and BLDC motors

D. Motors and Propellers:
The BLDC motors installed on the drone provides lift by rotating propellers at high speeds and are required for precise speed control for stable flight. Propellers are paired with the motors to ensure thrust and torque are balanced. The opposite rotation cancels out the reactive torque and maintains the yaw stability

E. Working Principle of Drone:
Command Input: The inputs for flight commands of waypoints is fed to the drone via the ground station using the telemetry module.
Signal Reception: The signal transmitted is received by the receiver and then are passed to the flight controller.
Signal Processing: The Flight controller interprets the command and environmental data and calculates the flight plan.
Motor Control: Control signals are sent to each ESC, which adjusts the speed of the motor.

F. Flight Dynamics:

1. To ascend, all motors increase speed equally.
2. To pitch, the front or back motor pair speeds up or down.
3. To roll, side motors are adjusted.
4. To yaw, opposite pairs of motors spin at different speeds.

G. G. Figures and Block Diagrams:

Below diagram represents the basic bloc diagram used to build the Autonomous Drone Delivery System:
This block diagram helps us to understand the flow of the system's actual working and how is it implemented using the materials mentioned above and how will this ensure as an alternative to the existing model for deliveries and logistics.
- Transmitter: The transmitter is a handheld remote device that the operator uses to send control commands to the drone. It sends signals like throttle, yaw, pitch, and roll through a specific communication frequency.
- Receiver: The receiver on the drone gets commands from the transmitter and sends them to the flight controller. It keeps communication steady between the pilot and the drone during manual or semi-autonomous control.
- ESP32: A microcontroller with Wi-Fi and Bluetooth support provides wireless connectivity for data transfer. It allows real-time communication between the drone and both cloud and ground control systems.
- GPS Module: The GPS module gives exact location and navigation information to the flight controller. It supports precise waypoint tracking and enables self-directed route planning for delivery missions.
- Servo Motor: A small motor that precisely controls angular movement for mechanical operations. In the drone, it operates the gripper or claw mechanism for handling payloads.
- Claw Mechanism: A mechanical gripper picks up and releases the delivery package securely. It is powered by a servo motor, which helps manage the payload safely during mission.

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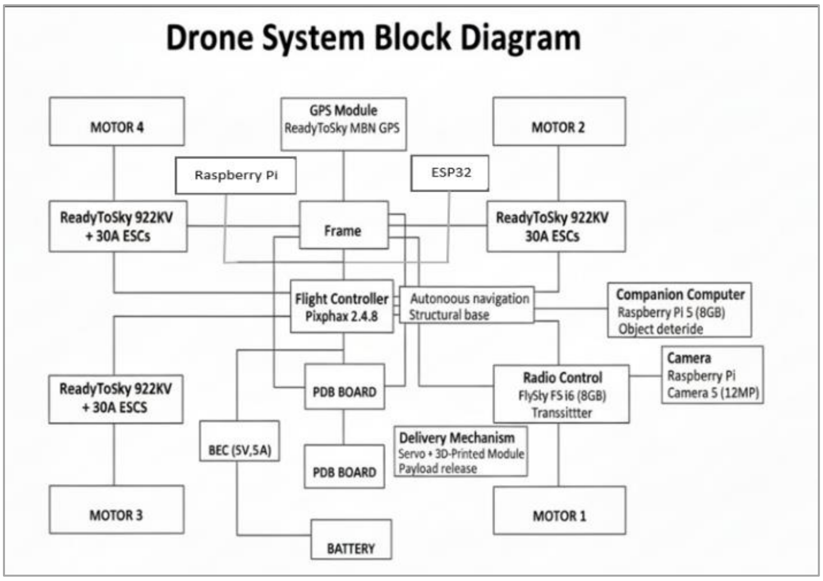

Fig. 1 Block Diagram for the proposed system

IV. RESULTS

1. Testing:

In testing of the designed and assembled autonomous drone delivery system, the following procedure was carried out:
Step 1: All the components were individually tested and defective or under performing components were replaced before the final integration.
Step 2: After the complete assembly the entire electrical system was verified to ensure safe power delivery and eliminated the loose or incorrect connections prior to the flight trials.
Step 3: The firmware was installed onto the flight controller and was configured using the mission planner software. All the flight modes were assigned.
Step 4: Initial flight test was carried out manually to check system's stability and verify the configurations which were putt on the flight controller board.
Step 5: For autonomous flight the AUTO function was planned and uploaded via the Mission Planner software. The drone was armed manually, switched to auto mode and was given a slight throttle input to initiate the mission.

2.Discussion of Results:

All the components gave the performance which was expected. Pre-flight verification confirmed electrical and mechanical integrity. The drone accurately traversed all the waypoints and returned back to the location from where it was launched without manual interference.
Overall, the drone demonstrated consistent and stable performance throughout the autonomous flight. The automatic disarms at the end of the mission verified correct firmware logic and safety handling. The results confirm that the system is ready for advanced mission testing and small-scale automation applications such as mapping or delivery simulation.

Fig: Autonomous Drone Delivery Model

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V. CONCLUSION

The Autonomous Drone Delivery System was successfully implemented and the model took successful flight under the required conditions. This project was designed and developed to overcome the limitations of the traditional delivery system such as high human dependency, urban traffic congestion, and inaccessibility of remote areas. The system integrated a Pixhawk 2.4.8 flight controller along with Ready to sky

This system can be effective and efficient for localized logistic applications, including small scale delivery transport, medical aid distribution in remote regions and contactless delivery during emergency scenarios.

It serves as a scalable and modular foundation for drone-based logistics solutions, emphasizing cost-efficiency, reliability and intelligent automation. The servo powered 3D printed claw mechanism enables precise, autonomous payload handling and accurate drop off on the specified location.

Overall, the project establishes a strong technological foundation in the field of autonomous UAV systems, showcasing the seamless fusion of embedded systems, wireless telemetry and flight control technologies. It contributes to the significantly growing domain of smart aerial logistics, and the future of Autonomous deliveries suing the Autonomous Drone Delivery Model.

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