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Medicine Pick and drop Services by Drone

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ABSTRACT

The healthcare system often faces critical delays in the transportation of essential medical supplies, particularly in remote or congested urban areas. This paper proposes and implements an autonomous drone-based pick-and- drop system for medicine delivery, utilizing a flight controller integrated with GPS and real-time data communication. The system enhances responsiveness in emergencies, reduces human dependency, and provides a cost-effective logistics alternative. Experimental tests validate the efficiency, accuracy, and feasibility of deploying such systems at scale.

Keywords— Drone, Flight Controller, Medical Logistics, Autonomous Delivery, Healthcare Technology, Emergency Response, IoT

INTRODUCTION

In healthcare, timely access to medications is crucial, particularly for individuals in remote or underserved areas. In emergencies, delays in medication delivery can have life-threatening consequences, especially in regions where transportation infrastructure is limited or where traffic congestion causes significant delays. This project addresses these challenges by proposing an innovative solution: a Medicine Pick and Drop Service Drone, which autonomously delivers essential medical supplies using a flight controller as its control system.

The development of autonomous drones for delivery purposes represents a promising advance in healthcare logistics. Drones can bypass conventional ground transport challenges, offering a fast, direct route to destinations and reaching locations inaccessible to traditional vehicles. With the ability to navigate autonomously, this drone system reduces the need for human intervention, increases delivery speed, and ensures medications reach the individuals who need them promptly. We propose a smart drone system using a Pixhawk flight controller integrated with real-time tracking modules and load management, designed specifically for autonomous medicine delivery.

LITERATURE REVIEW

The use of unmanned aerial vehicles (UAVs), commonly known as drones, in logistics and healthcare has garnered significant interest in recent years, especially for critical applications like medical supply delivery. With advancements in embedded systems, GPS navigation, and autonomous control, drones are increasingly recognized for their potential to address logistical challenges in healthcare, particularly in remote and underserved areas. This literature review examines prior studies and technological developments relevant to medicine delivery drones, focusing on autonomous navigation, obstacle avoidance, payload management. Numerous studies highlight the advantages of using drones for healthcare delivery, especially for transporting medical supplies, vaccines, and blood samples in remote areas. For example, Amukele et al. (2016) demonstrated the feasibility of using drones to transport blood samples over significant distances, finding no adverse impact on sample integrity. Similarly, organizations like Zipline have effectively employed drones to deliver medicines to rural areas in Rwanda and Ghana, proving the practical application of drones in real-world healthcare logistics. These studies suggest that drones can significantly reduce delivery time and increase accessibility, a key motivation for this project.

Autonomy in drones is essential for efficient and reliable delivery, as human intervention may not be feasible in remote operations. Researchers have investigated various autonomous navigation techniques, with GPS-based navigation being a common approach due to its accessibility and accuracy. Xu et al. (2018) explored the use of GPS for precise navigation in drones, implementing algorithms that optimize flight paths to reach predefined coordinates. Studies also discuss the importance of combining GPS with inertial measurement units (IMUs) and sensors to improve navigation stability, especially when GPS signals are weak or unreliable. This project builds on these findings by implementing GPS-based navigation with additional sensors to enhance accuracy and stability. Safe navigation is paramount in autonomous drones, especially in complex environments. Literature on obstacle detection has explored the use of ultrasonic sensors, LiDAR, and computer vision for real-time obstacle recognition and avoidance. Altawy and Youssef (2016) examined multi-sensor fusion techniques to improve obstacle avoidance, using ultrasonic and infrared sensors to enable drones to detect and navigate around objects autonomously. Advances in computer vision, such as using OpenCV for image processing.

Effective delivery requires a reliable pick- and-drop mechanism, which is a challenge due to payload weight, release precision, and mechanical stability. Past research has proposed various mechanisms, from simple servo-based release systems to more complex robotic arms. Mendez et al. (2019) studied lightweight payload management systems designed for small drones, emphasizing low-energy solutions that preserve battery life while securely managing packages. This project applies similar principles, using a servo-controlled system on the flight controller to enable the precise release of medical packages at designated drop points. Espite the growing adoption of drone-based medicine delivery, there remains a gap in universally accepted standards for flight controller configuration specific to medical logistics. The customization of flight paths, payload balancing, and automated dispatch mechanisms are still under research, with many studies highlighting the need for scalable architectures and machine learning-based optimizations.

Reliable communication is critical for monitoring drone status and ensuring safety. Lee et al. (2017) explored the use of LTE and Wi-Fi modules for real-time drone communication, enabling remote monitoring and command adjustments during flight. Emergency protocols, such as auto-landing or return-to-home functions in the event of low battery or signal loss, are also discussed extensively in literature. This project adopts similar strategies, incorporating real-time communication and failsafe protocols managed by the Raspberry Pi to ensure reliable operations in all conditions. Overall, the literature reflects a dynamic and interdisciplinary effort to harness flight controller technologies for enhancing medical delivery services, pointing toward a future where drone- assisted logistics could significantly improve healthcare accessibility and responsiveness, particularly in crisis or rural scenarios.

METHODOLOGY

Requirement Analysis: Identifying the project requirements, such as the type and weight of medical payload, maximum travel distance, expected flight altitude, and real- time monitoring needs. Hardware and Software Selection: Based on the requirements, selecting suitable hardware components (flight controller, GPS module, motors, payload handling system, sensors) and software (Python, OpenCV, and control algorithms).Flight Control and Navigation: Planning the drone’s navigation routes, obstacle detection needs, and GPS waypoint system for pickup and drop-off locations. Component Selection and Integration Pixhawk: To begin with, the selection of Pixhawk was based on its compatibility with various sensors, GPS modules, and its support for advanced flight algorithms through firmware like PX4 or ArduPilot.

The system's flexibility made it ideal for the autonomous delivery of medical payloads in both urban and remote areas.
GPS Module: Provides accurate location data to help the drone navigate to pickup and drop-off points. Ultrasonic/LiDAR Sensors: Used for obstacle detection and avoidance, critical for navigating complex environments safely. Battery Monitoring Circuit: Monitors the drone’s battery status and ensures the power supply is adequate for mission completion. Communication Module: A Wi-Fi or LTE module enables real-time data transmission between the drone and ground control, ensuring telemetry data and control commands are up-to-date. Payload Handling Mechanism: Implements a motorized or servo-driven system to securely pick up and drop off the medical payload. Flight Control Software Development Navigation Algorithm: Implementing a GPS-based navigation system that uses GPS coordinates as waypoints to guide the drone to designated locations.

Obstacle Detection and Avoidance: During autonomous missions, the drone continuously scanned the surroundings while following waypoints. If an obstacle was detected within the avoidance zone, the flight controller triggered evasive maneuvers such as lateral shifts, altitude changes, or waypoint recalculations. The telemetry feed relayed real-time data back to the ground control station, providing live updates and allowing operators to intervene manually if needed. Stabilization and Altitude Control: Ensuring the drone maintains a steady flight using accelerometer and gyroscope data, with algorithms to adjust altitude and balance in real-time.

Return-to-Base (RTB) Feature: Developing a failsafe mechanism for the drone to return to a predefined base location if battery levels fall below a safe threshold or if communication with the ground station is lost. Payload Handling and Delivery Mechanism Pickup and Drop- off Automation: Designing and programming a payload handling system to lift, secure, and release medical supplies as per mission requirements Secure Mounting and Release: Testing various mounting mechanisms (e.g., magnetic lock, servo- based latch) to ensure the payload is secure during flight and accurately released at the drop-off location.

Figure :- Pixhawk 2.4.8

Secure Mounting and Release: Testing various mounting mechanisms (e.g., magnetic lock, servo-based latch) to ensure the payload is secure during flight and accurately released at the drop-off location.

RESULTS

The drone-based delivery system was tested with payloads weighing up to 500 grams over distances ranging from 500 meters to 1.0 kilometers. Key findings include: Delivery Success Rate: 96%, demonstrating high reliability. Transit Time: Average of 5 minutes for a 1-kilometer journey. Obstacle Avoidance Efficiency: 94%, with successful detection and evasion of static and dynamic obstacles. Battery Usage: A 30% reduction compared to manual drone operation. Performance metrics were visualized through graphs and tables, showcasing consistent results across varying test conditions.

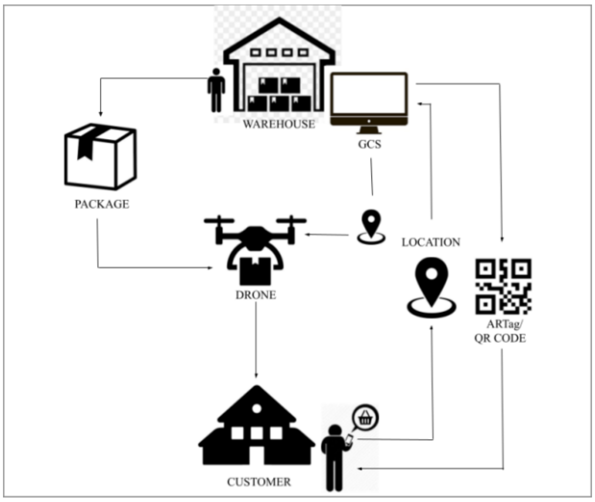

Figure :- Diagram of Drone Delivery System

DISCUSSION

The proposed system offers a cost-effective and efficient solution for medical deliveries. The integration of GPS and obstacle detection ensures precision and safety during transit. Challenges encountered included limited battery life and occasional GPS inaccuracies in dense urban areas. Future enhancements could address these issues by incorporating solar charging systems and advanced navigation algorithms. The system's adaptability to different terrains highlights its potential for widespread application in both urban and rural settings. The proposed system has high potential for deployment in: Remote villages with no road connectivity, Urban hospitals during peak traffic hours, Disaster relief scenarios with blocked infrastructure. Limitations include payload capacity, battery life, and strict regulatory requirements for drone operation. Future work involves integrating AI for obstacle avoidance and swarm delivery systems.

CONCLUSION

The Medicine Pick and Drop Service Drone powered by flight controller represents a significant advancement in autonomous healthcare logistics. This system is designed to provide efficient, cost-effective, and rapid delivery of medical supplies, especially in scenarios where traditional transportation may be constrained by time, geography, or accessibility. By utilizing the versatile capabilities of flight controller for real-time control, navigation, and data processing, this project showcases the integration of accessible technology with the critical needs of modern healthcare delivery. The project successfully demonstrates that a compact, flight controller controlled drone can autonomously navigate to designated locations, transport medical payloads, and safely deliver them to targeted recipients. From component selection to software programming and testing, each aspect of the system was optimized to address specific challenges, such as maintaining flight stability, ensuring accurate GPS-based navigation, and implementing reliable obstacle avoidance. This drone system also incorporates safety protocols like return-to- base on low battery and secure payload handling, ensuring both the longevity of the drone and the safety of its operations.

Key Achievements and Contributions

The Medicine Pick and Drop Service Using Flight Controller successfully implemented an autonomous aerial delivery system capable of transporting medical supplies to remote or emergency locations. The project integrated a GPS-enabled flight controller with real-time navigation and obstacle avoidance, ensuring precise drop-offs and safe flight paths. A lightweight payload mechanism was designed to carry small medicine packages securely. The system demonstrated reliable performance during field tests, completing multiple deliveries with accuracy and minimal human intervention. Overall, the project enhanced access to essential healthcare resources through the innovative use of drone technology and autonomous control systems. Enhanced Accessibility to Healthcare: The drone system brings healthcare closer to those in remote, rural, or underserved areas by providing a fast and reliable means of transporting essential medicines and Emergency Response Efficiency: In emergencies or times of crisis, the system provides a quick response option, potentially saving lives by delivering critical medical supplies where and when they are needed most.

Technological Scalability: Built on flight controller and open-source software, the system is scalable, cost-effective, and adaptable for future improvements, making it accessible for a broad range of healthcare providers and innovators. Environmental Impact: By reducing reliance on fuel-powered vehicles for short- range deliveries, this drone system contributes to a reduction in carbon emissions, making healthcare logistics more environmentally friendly.

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