Solar-Assisted Charging System for Autonomous Medicine Delivery Drones

Prathmesh Sushil Bhoir
Mechanical Engineering Department Vishwakarma Institute of Technology, Pune

***Abstract*—The rapid growth of drone technology has created new opportunities in healthcare logistics, especially for emergency medicine delivery in rural and underserved areas. One of the major limitations of autonomous medicine delivery drones is restricted battery life, which reduces flight duration and operational efficiency. This paper proposes a solar-assisted charging system for autonomous medicine delivery drones to improve endurance, sustainability, and reliability.**

The proposed system integrates lightweight solar panels with lithium polymer batteries to provide supplementary charging during standby operations and partial flight conditions. The system aims to reduce dependency on conventional charging methods while increasing the operational range of the drone. The research discusses the working principle, components, advantages, limitations, and future scope of integrating renewable energy with healthcare drone systems. The proposed model demonstrates the potential of solar-assisted drones to support eco-friendly and efficient last-mile medical logistics.

I. INTRODUCTION

In recent years, drones have become an important part of logistics and transportation systems due to their speed, flexibility, and ability to access difficult terrains. Healthcare logistics is one of the most promising applications of drone technology, particularly in the delivery of medicines, vaccines, blood samples, and emergency medical equipment.

In many rural and remote regions, delayed access to medicines can lead to severe health complications and even loss of life. Autonomous medicine delivery drones can significantly reduce delivery time by bypassing traffic congestion and geographical barriers. During emergencies, drones can quickly transport medicines to patients without relying on road infrastructure.

Despite these advantages, limited battery life remains a major challenge in drone operations. Most small and medium-sized drones rely on Lithium Polymer batteries that provide limited flight duration. Frequent charging requirements reduce operational efficiency and increase downtime. To address these challenges, this research proposes a solar-assisted charging system integrated into autonomous medicine delivery drones.

The use of lightweight solar panels can provide supplementary power generation and support battery charging during standby periods or low-power operation. By utilizing renewable solar energy, the system can improve drone endurance, reduce operational costs, and contribute to sustainable healthcare logistics.

II. LITERATURE REVIEW

Several researchers have explored the applications of drones in healthcare logistics and renewable energy integration.

Floreano and Wood discussed the future of autonomous drones and highlighted their potential in logistics, surveillance, and healthcare systems. Their work emphasized the importance of improving energy efficiency in drone operations.

Muñoz et al. proposed the use of deep reinforcement learning for drone delivery systems. Their study demonstrated how autonomous drones can optimize routes and improve delivery efficiency using intelligent decision-making systems.

Yoo and Chankov explored autonomous mobility-based drone delivery systems for solving last-mile logistics problems. The study highlighted the ability of drones to reduce delivery time and improve accessibility.

Recent studies on solar-powered unmanned aerial vehicles have demonstrated that lightweight photovoltaic panels can support battery charging and increase flight endurance. Researchers have suggested that renewable energy integration can significantly improve sustainability and reduce operational costs in UAV systems.

III. MATERIALS, COMPONENTS AND OBJECTIVES

The primary objective of this research is to design a solar-assisted charging system for autonomous medicine delivery drones in order to improve operational efficiency, flight endurance, and sustainability. The proposed system aims to reduce dependency on conventional charging infrastructure while supporting healthcare logistics in rural and remote regions.

The drone system consists of several important components:

- Lightweight and durable drone frame
- Four propellers for stable quadcopter operation
- Brushless DC motors for efficient thrust generation
- Electronic Speed Controllers for motor regulation
- Lithium Polymer battery for energy storage
- Lightweight solar panels mounted on the drone body
- Charge controller for regulating solar charging
- GPS module for autonomous navigation
- Ultrasonic and LiDAR sensors for obstacle avoidance
- Radio transmitter and receiver for manual control when required

The integration of these components enables efficient autonomous medicine delivery with supplementary renewable energy support.

IV. WORKING PRINCIPLE

The proposed solar-assisted medicine delivery drone operates through the integration of conventional battery power with renewable solar energy.

Solar panels mounted on the drone absorb sunlight and convert solar energy into electrical energy. The generated electrical energy is regulated using a charge controller. The regulated power is used to charge the LiPo battery during standby conditions or low-energy operation.

The battery supplies power to the BLDC motors, flight controller, GPS system, and onboard sensors. The drone autonomously navigates toward the delivery destination using GPS-based routing and waypoint tracking.

Obstacle avoidance sensors ensure safe navigation during flight operations. The medicine package is securely attached to the payload system and delivered to the target location. After delivery, the drone returns to the base station for recharging and further operation. The solar-assisted system reduces battery discharge rate and helps improve operational endurance while supporting eco-friendly healthcare logistics.

V. RESULTS AND DISCUSSION

.The proposed solar-assisted drone system was analyzed theoretically to evaluate its feasibility and efficiency in medicine delivery applications. The integration of lightweight solar panels provided supplementary charging support during daylight operations.

The system demonstrated the following expected improvements:

- Increased flight endurance due to reduced battery discharge
- Reduced charging dependency on electrical infrastructure
- Improved sustainability through renewable energy utilization
- Better suitability for rural healthcare logistics
- Lower operational costs in long-term deployment

The power generated by the solar panel can be estimated using the equation:

$P = \eta AI$

Where:

P = Power generated by the solar panel

η = Efficiency of solar panel

A = Area of the solar panel

I = Solar irradiance

However, several limitations were identified during analysis. Solar charging efficiency depends heavily on sunlight availability. Additional solar panels may increase drone weight and reduce aerodynamic efficiency. Weather conditions such as rain or cloud cover can reduce charging performance.

Despite these limitations, solar-assisted charging systems show strong potential for improving drone-based healthcare delivery systems.

VI. CONCLUSION

This research presents a solar-assisted charging system for autonomous medicine delivery drones aimed at improving healthcare logistics and operational sustainability. The integration of solar energy with conventional battery-powered drones can reduce charging dependency, improve flight endurance, and support eco-friendly operations.
The proposed system has strong potential for rural healthcare applications where transportation and electricity infrastructure are limited. Although challenges related to solar efficiency, weather conditions, and payload limitations remain, the study establishes a foundation for future advancements in renewable-energy-powered autonomous healthcare delivery systems.

Future advancements in lightweight solar panels, battery technology, artificial intelligence, and autonomous navigation can further improve the performance and efficiency of medicine delivery drones. The implementation of solar-assisted drone technology can play a significant role in the development of fast, reliable, and sustainable medical logistics solutions.

VII. ACKNOWLEDGMENT

I would like to express my sincere gratitude to my professors, mentors, teammates, friends, and family members for their continuous guidance and support throughout this research work. Their encouragement and valuable suggestions helped in the successful completion of this study.

REFERENCES

[1] D. Floreano and R. J. Wood, "Science, technology and the future of small autonomous drones," Nature, 2015.
[2] G. Muñoz et al., "Deep reinforcement learning for drone delivery," Drones, 2019.
[3] H. D. Yoo and S. M. Chankov, "Drone-delivery using autonomous mobility," IEEE Conference, 2018.
[4] A. Fotouhi et al., "Flying drone base stations for macro hotspots," IEEE Access, 2018.
[5] Y. Zeng et al., "Wireless communications with unmanned aerial vehicles," IEEE Communications Magazine, 2016.