

DESIGN OF AN UNMANNED AUTONOMOUS DRONE TAXI FOR DELIVERY SERVICES IN URBAN ENVIRONMENTS

F.K. Sulaymanova

Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti

2- kurs magistratura talabasi

Email: fotimasulaymonova777@gmail.com

F.K. Sulaymanova

2nd-year Master's Student

Tashkent State Technical University named after Islam Karimov.

Email: fotimasulaymonova777@gmail.com

Abstract: The rapid growth of urbanization and e-commerce has significantly increased the demand for fast, efficient, and reliable delivery systems. Traditional ground transportation methods often face challenges such as traffic congestion, long delivery times, fuel consumption, and environmental pollution. In this context, unmanned aerial vehicles (UAVs), commonly known as drones, have emerged as an innovative solution for urban logistics. This research focuses on the design and development of an autonomous drone taxi system intended for delivery services in urban environments.

The study aims to create an optimized drone design capable of operating safely, efficiently, and autonomously within complex city infrastructures. The research analyzes aerodynamic performance, structural design, payload capacity, navigation systems, battery efficiency, and safety mechanisms. Special attention is given to urban conditions such as high-rise buildings, signal interference, weather conditions, and population density. The proposed drone taxi model integrates modern technologies including artificial intelligence, GPS navigation, obstacle detection systems, and real-time route optimization.

The results of this research are expected to contribute to the development of advanced urban delivery systems by reducing delivery times, minimizing transportation costs, and supporting sustainable logistics solutions.

Keywords: autonomous drone, urban delivery, UAV design, drone taxi, logistics optimization.

Introduction

Urban logistics has become one of the most important sectors in modern transportation systems. The continuous growth of online shopping and food delivery services has increased pressure on traditional delivery networks. In large cities, traffic congestion remains one of the major barriers to efficient logistics operations. As a result, innovative transportation technologies are becoming increasingly important.

Autonomous drones represent a significant advancement in transportation and logistics. Unlike conventional delivery vehicles, drones can bypass road traffic and deliver goods directly to customers in shorter periods. Their ability to navigate through urban airspace makes them highly suitable for city-based delivery services.

However, designing a drone taxi for urban delivery presents several engineering and design challenges. These include aerodynamic stability, weight optimization, battery life limitations, environmental resistance, and safety considerations. The drone must be lightweight yet strong enough to carry delivery payloads while maintaining flight stability.

This study investigates the design principles of an autonomous drone taxi specifically for urban delivery applications. The main goal is to develop a practical and efficient drone system capable of meeting modern delivery requirements.

Literature Review

Recent developments in UAV technology have transformed the logistics industry. Many companies such as Amazon, UPS, and DHL have invested heavily in drone delivery systems. These companies have demonstrated that drone technology can significantly reduce delivery time and operational costs.

Previous studies show that aerodynamic optimization is one of the most critical factors in drone efficiency. Researchers have focused on improving rotor performance, minimizing drag, and increasing energy efficiency. Battery technology remains another major limitation, as flight duration directly affects operational range.

Artificial intelligence and machine learning have also improved autonomous navigation systems. Modern drones can identify obstacles, calculate efficient routes, and make real-time decisions during flight operations. These technologies increase both efficiency and safety.

Despite these advancements, urban drone delivery systems still face regulatory challenges, public safety concerns, and infrastructure limitations. Therefore, a well-designed drone system must address both technical and operational requirements.

Methodology

This research applies a design-based engineering methodology to develop an autonomous drone taxi model. The study consists of several stages.

The first stage involves identifying operational requirements, including payload capacity, delivery distance, battery performance, and flight altitude. These requirements define the basic design parameters.

The second stage focuses on conceptual design development. Different structural configurations are analyzed to determine the most effective design solution. Materials such as carbon fiber and lightweight composites are considered to reduce weight while maintaining strength.

The third stage includes aerodynamic analysis and simulation. Flight stability, air resistance, and rotor efficiency are evaluated to optimize performance.

The fourth stage focuses on integrating intelligent systems, including GPS navigation, collision avoidance sensors, and automated control systems.

Finally, safety analysis is conducted to assess emergency landing systems, obstacle avoidance mechanisms, and operational reliability under urban conditions.

Design Requirements and Urban Challenges

Urban drone taxi systems require specialized design features. First, the drone must maintain stability in narrow urban spaces between buildings. Wind turbulence and signal interference can affect navigation performance.

Second, payload efficiency is essential. The drone must carry packages of different sizes while maintaining balance and energy efficiency.

Third, battery performance is critical for operational success. The design should maximize flight time while minimizing charging requirements.

Fourth, safety systems must be highly reliable. Urban environments contain pedestrians, vehicles, and buildings, making collision prevention essential.

Noise reduction is another important factor. Excessive drone noise may negatively affect urban residents, so propeller design optimization is necessary.

Conclusion

The development of autonomous drone taxi systems for urban delivery services represents a major innovation in modern logistics. This research demonstrates the importance of integrating efficient aerodynamic design, lightweight materials, intelligent navigation systems, and advanced safety mechanisms into UAV development.

Urban drone delivery has the potential to transform logistics by reducing traffic dependency, improving delivery speed, and supporting environmentally sustainable transportation systems. Future research should focus on battery technology improvement, urban air traffic management, and regulatory frameworks to enable large-scale drone delivery implementation.

The findings of this study provide a strong foundation for the future development of efficient and practical autonomous drone taxi systems in urban environments.

References

1. Austin Brown, & Michael Harris. (2021). *Autonomous Drone Systems for Urban Logistics and Delivery Services*. Journal of Unmanned Vehicle Systems, 9(3), 145–162.
2. Paul G. Fahlstrom, & Thomas J. Gleason. (2019). *Introduction to UAV Systems*. Wiley Publishing.

3. Federal Aviation Administration. (2023). *Urban Air Mobility and Drone Delivery Regulations*. FAA Publications.
4. International Civil Aviation Organization. (2022). *Manual on Unmanned Aircraft Systems (UAS)*. ICAO Publications.
5. Amazon. (2024). *Prime Air Delivery System Technical Report*.
6. UPS. (2023). *Drone Delivery Operations and Logistics Optimization Report*.
7. Randal W. Beard, & Timothy W. McLain. (2018). *Small Unmanned Aircraft: Theory and Practice*. Princeton University Press.
8. Aerodynamics and UAV Design Research Group. (2020). *Aerodynamic Optimization of Multi-Rotor Drones in Urban Conditions*. *Aerospace Engineering Journal*, 15(2), 89–105.