DVD : Delivery via Drone

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Abstract:

This article investigates the uptake of drone delivery services in emerging economies, examining factors such as personal innovativeness, outcome expectancy, emotions, and perceived risk. Drone delivery offers advantages such as flexibility, accessibility, speed, safety, and environmental benefits. It conducts a comprehensive review of existing literature, identifies current trends and challenges, and proposes avenues for future research. Businesses are increasingly exploring autonomous solutions for the last-mile delivery to remain competitive and fulfill rising delivery demands. Drones, especially unmanned aerial vehicles, emerge as a promising solution in the realm of logistics. Recent regulations introduced by the Flight World Organization support the operation of unmanned aerial systems, further facilitating their integration into delivery operations. The surge in online shopping has intensified the need for efficient delivery mechanisms, thus driving the adoption of drone technology. Quadcopters, equipped with stable flight capabilities, are employed for various purposes including surveillance, data gathering, and localized deliveries. The integration of delivery drones into the last-mile shipping industry holds the promise of expedited deliveries, decreased labor expenses, and advantages for drone manufacturers, signifying a transformative shift in the realm of logistics and delivery services.

Key Words: Drone delivery services, Emerging economies, Personal innovativeness, Outcome expectancy, Perceived risk, Flexibility, Quadcopters, Logistics.

1. INTRODUCTION:

The logistics and transportation industries are currently experiencing rapid growth, driven by significant innovations. The explosion of e-commerce, facilitated by widespread internet access, coupled with advancements in delivery methods, has led to a substantial surge in the volume of packages handled by corporations worldwide each year. For example, in 2019 alone, China processed an average of 63.5 billion parcels, while globally, an average of 3248 packages were shipped every second. Projections indicate a further increase to between 220 to 262 billion packages by 2026.[1] Regarding the use of drones in parcel delivery within the logistics industry, companies have increasingly turned to drone technology. This innovation has notably impacted sectors such as e-commerce and healthcare. Amazon's Prime Air, launched in 2013, stands out as one of the pioneering automated delivery systems. Obtaining federal approval in 2020 marked a significant milestone for Amazon, allowing for the efficient and secure implementation of its drone package delivery project.

In the restaurant industry, major players like Domino's Pizza and McDonald's are exploring the feasibility of drone delivery in urban areas. Collaborations with startups such as Flytrex and Flirtey have led to experimental trials for meal delivery via drones.

Drones are also proving to be invaluable in healthcare logistics. For example, Deutsche Post DHL's Parcelcopter successfully delivered medicine to an island in the North Sea, demonstrating the practical applications of drone technology in the logistics sector. Moreover, African countries like Rwanda and Tanzania are leveraging drones to address challenges in vaccine delivery to remote villages, effectively overcoming delays associated with traditional transportation methods.

Ghana's introduction of a drone delivery service in 2019 in partnership with Zipline focuses on providing emergency on-demand deliveries of medical supplies, including vaccines and drugs. This initiative reflects a global trend towards embracing innovative solutions to logistical challenges and improving access to critical resources.[2]

2. SYSTEM ARCHITECHTURE:

Drone delivery systems are pivotal components within a broader system architecture, characterized by their intricate operational workflow and integration of advanced technologies. This section delineates the key stages and functionalities of drone delivery systems within the overarching system framework:

Order Processing and Packaging: At the outset, orders are received and processed within the system. Upon confirmation, items are meticulously packaged at the nearest warehouse, ensuring secure transportation for subsequent stages.

Figure 1: System Architecture

Departure Management: Following packaging, the system coordinates the departure of drones from the warehouse. This involves securely fastening packages to specialized carriers designed for drone transportation. Notably, drones employ a range of departure mechanisms, including VTOL (Vertical Takeoff and Landing) processes or innovative designs like non-VTOL crafts, depending on the system configuration.

Navigation and Route Optimization: Central to the system architecture is the navigation module, which utilizes cutting-edge technologies to guide drones through varying terrains and obstacles. This includes GPS technology for location pinpointing, onboard cameras for real-time environmental awareness, and SONAR/RADAR systems for obstacle detection and avoidance. The system optimizes routes to ensure efficient and timely deliveries while prioritizing safety and precision.

Delivery Execution: Upon reaching the designated delivery location, the system orchestrates the execution of package delivery through diverse methods. These include the Chord and Packet System, Fly-By Method, or Complete Landing, each tailored to specific delivery scenarios and customer preferences.

Return Journey Management: After completing deliveries, drones autonomously navigate back to the operational base, typically the central warehouse. This involves recalibration, system resets, and battery assessment to ensure readiness for subsequent missions.

System Monitoring and Optimization: Throughout the delivery process, the system continuously monitors performance metrics and operational parameters. This data is analyzed to identify areas for optimization, enhance efficiency, and mitigate risks within the overall architecture.

In essence, the system architecture of drone delivery encompasses a cohesive integration of processes, technologies, and functionalities. By leveraging advanced algorithms and real-time data analytics, it enables seamless and efficient delivery operations while adapting to evolving requirements and environmental conditions.

3. LITEATURE SURVEY:

Title: The Future of Delivery Drones: A Literature Review

Authors: Mohaneshwar S, Karthik R M, Rahul Batapagari, Ninganna Gangappa Bani, Varun Kumar Reddy

Published: 2021

Origin: School of Mechanical Engineering, REVA UNIVERSITY, Bangalore, Karnataka, India

Implementation of delivery drones offers benefits like reducing carbon emissions, easing urban traffic congestion, and creating new business models and job markets. However, regulatory and safety concerns need addressing. Evolving drone technology enables larger payloads and longer distances, expanding their applications and leading to transformative changes in transportation and commerce.[3]

Title: Modular Drone Delivery Optimization

Author: Jaihyun Lee

Published: 2017

Origin: Department of Mechanical Engineering, University of Michigan, Ann Arbor, MI, United States.

This paper examines modular drone delivery systems, showcasing enhanced delivery speed and efficiency. It suggests exploring semi-modular systems with replaceable batteries for future research. An integrated framework evaluates the profitability of modular drone delivery.[4]

Title: DDAM: Innovative Drone Delivery with Autonomous Mobility

Authors: H. D. Yoo, S. M. Chankov

Published: 2018

Origin: Department of Mathematics & Logistics, Jacobs University Bremen, Bremen, Germany

DDAM introduces drone delivery with autonomous mobility, promising faster, more efficient delivery while reducing vehicle needs. Concept limitations include small evaluator groups and lack of numerical comparison. Future research could employ simulation models for comparisons. Real-life implementation needs collaboration between delivery and autonomous mobility companies, offering innovative solutions for last-mile delivery and traffic challenges.[5]

Title: Service-Based Drone Delivery

Author: Balsam Alkouz, Babar Shahzaad, Athman Bouguettaya

Published: 2022

Origin: School of Computer Science, The University of Sydney, Australia

This study introduces a novel service-based drone delivery approach, emphasizing a multi-route skyway infrastructure for efficiency. It proposes a service-oriented framework utilizing sensor-cloud infrastructure to optimize operations in smart cities. The authors review existing solutions, open challenges, and future research directions in service-based drone deliveries.[6]

4. METHODOLOGY:

4.1 Algorithm:

Step 1: Order Placement:

User inputs pickup (A) and delivery (B) locations, package details.

Step 2: Verification & Payment:

System validates package details, user confirms order and pays.

Step 3: Drone Assignment:

System assigns suitable drone based on package, proximity to A.

Step 4: Package Pickup:

Drone navigates to A, authenticates, retrieves, and confirms pickup.

Step 5: Flight to Destination:

Drone follows designated path to B, monitored by the system.

Step 6: Package Delivery:

Drone reaches B, authenticates, and delivers the package.

Step 7: User Notification:

User receives confirmation of successful delivery.

Step 8: Order Updates:

System updates delivery status, may request user feedback.

Step 9: Drone Maintenance:

Drone returns for maintenance, charging, or future assignments.

4.2 Flowchart:

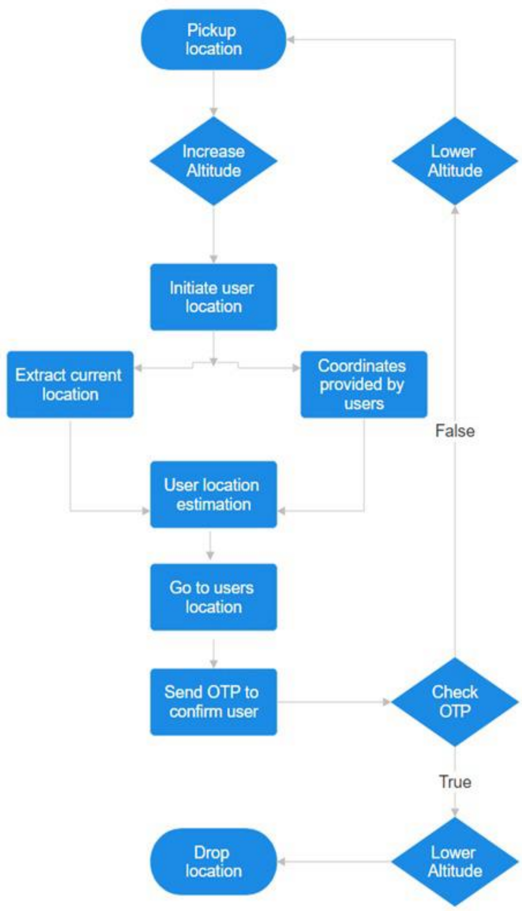

Figure 2: Flowchart

5. REQUIREMENTS:

5.1 Hardware Requirements:

1. Quadcopter: A quadcopter, also called quadrocopter, or quadrotor is a type of helicopter thathas four rotors.They have the ability to hover in place whereas fixed wing aerial drones must be constantly moving.

2. Proximity Sensor: A proximity sensor is a device that can detect or sense the approach or presence of nearby objects and for this it does not need physical contact

3. GPS module: GPS module acts as a navigation and positioning system, providing crucial information to the pilot or flight control software.

4. Electronic Speed Controller: Electronic speed controllers (ESCs) are devices that allow drone flight controllers to control and adjust the speed of the aircraft's electric motors. A signal from the flight controller causes the ESC to raise or lower the voltage to the motor as required, thus changing the speed of the propeller.

5.2 Software Requirements:

1. React Native: This framework allows you to build a cross-platform mobile app (iOS and Android) for controlling the drone.

2. JavaScript: The primary programming language for developing the app using React Native.

3. Communication Protocol: Implement the MAVLink communication protocol, which is commonly used for drone communication and control. It provides a standard way to send and receive commands and telemetry data.

4. Remote Camera Control: Include features for controlling the drone's camera,

capturing photos, recording videos, and live streaming from the drone's camera.

5. Node.js: It is a JavaScript runtime built on Chrome's V8 JavaScript engine. It is used for server-side programming, and primarily deployed for non-blocking, event-driven servers, such as traditional web sites and back-end API services.

6. PARTIAL IMPLEMENTATION:

Drone delivery initiatives involve deploying unmanned aerial vehicles (UAVs) to transport goods between locations. The drone controller plays a pivotal role in this setup, overseeing the drone's flight path and operations. Consisting of hardware and software components, the controller enables remote piloting, navigation, obstacle avoidance, and payload management. Research in this field focuses on optimizing controller algorithms to ensure the safe and efficient operation of drones, considering factors such as flight dynamics, communication protocols, environmental conditions, and regulatory compliance.

Figure 3: Drone Controller

The signin page is where existing users authenticate themselves to access the app's features. It verifies user credentials, typically through a combination of email and password authentication, or more advanced methods like biometric recognition for enhanced security. Throughout this process, the focus remains on maintaining a balance between robust security measures and providing a seamless user experience.

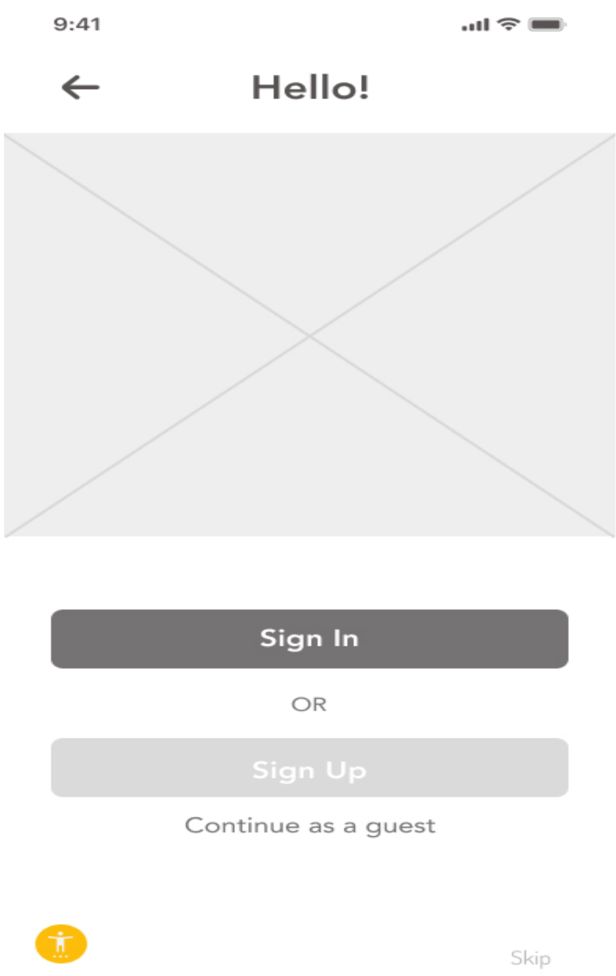

Figure 4: Sign In Page

The sign-up page of the drone delivery customer app serves as the entry point for new users, allowing them to register and create accounts. It prompts users to input necessary information such as their name, email address, and a secure password. This process ensures that accurate data is collected and stored securely, safeguarding user privacy and account integrity.

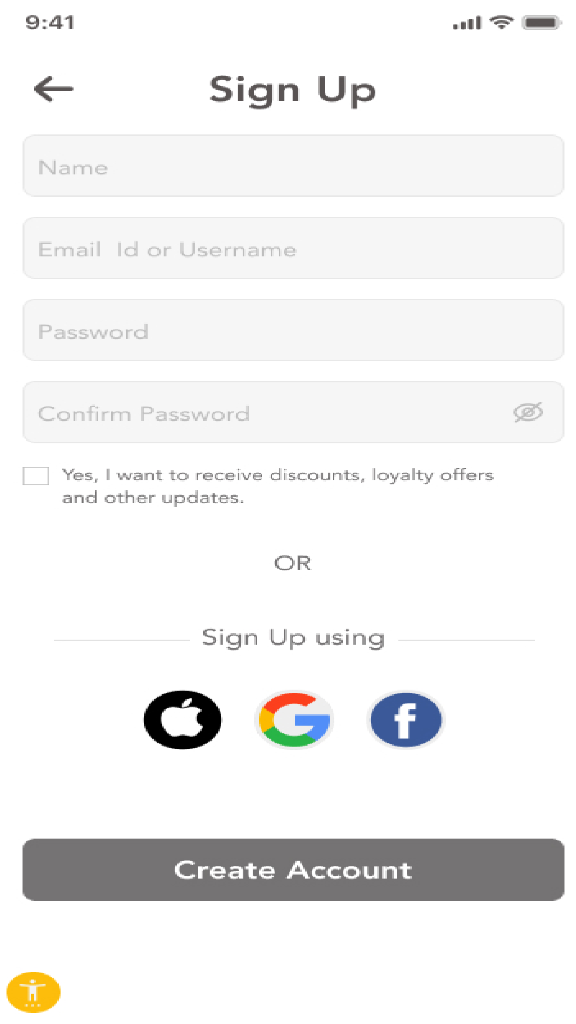

Figure 5: Sign Up Page

7. CONCLUSION:

Drone delivery systems are revolutionizing logistics, spurred by IoT advancements in transportation. Their adoption in emerging economies promises to reshape last-mile delivery, offering unparalleled flexibility, speed, safety, and environmental benefits. Across industries, from e-commerce to healthcare, they are transforming traditional delivery routes. At 40% completion, our project aims to enhance efficiency, reduce delivery times, and ensure environmental sustainability. With objectives focused on efficiency, reduced costs, and technological innovation, we're poised to redefine convenience and sustainability in logistics. This progress marks a significant milestone in reshaping the future of delivery systems.

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