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"DESIGN OF MULTI-ROTOR WITH MISSILE DROPPING MECHANISM"

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ABSTRACT

This project presents the design and development of a multirotor unmanned aerial vehicle (UAV) integrated with a precision payload-dropping mechanism. The system utilizes a six-spoke star wheel operated by a geared motor to achieve controlled and sequential payload release. The UAV consists of a lightweight F450 frame, BLDC motors, ESCs, GPS module, flight controller, and remote-control system to ensure stable flight performance and accurate operation. The developed mechanism enables one-by-one payload deployment while preventing accidental release due to vibration or external disturbances. Experimental testing demonstrated reliable flight stability, efficient payload handling, and satisfactory endurance under various operating conditions. The system offers a lightweight, cost-effective, and modular solution suitable for defence surveillance, tactical support, and supply delivery missions. The results indicate that the proposed UAV platform can significantly enhance mission effectiveness by providing accurate payload deployment and improved operational safety.

Key Words: *UAV, Multirotor Drone, Payload Release Mechanism, Defence Applications, GPS, BLDC Motor*.

I. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have emerged as an important technology in modern defence, surveillance, logistics, and disaster management applications. Their ability to access remote and hazardous locations while reducing human risk has significantly increased their adoption worldwide. Multirotor drones are particularly popular due to their vertical take-off and landing capability, flight stability, and maneuverability. Conventional drones primarily focus on surveillance and monitoring functions; however, many defence operations require accurate payload delivery systems capable of releasing objects at specific locations. Existing systems often suffer from limitations such as uncontrolled dropping, single-use deployment, or reduced accuracy. Therefore, there is a need for a reliable and lightweight mechanism that enables precise and sequential payload release. The present project focuses on the development of a multirotor UAV equipped with a gear-motor-driven payload-dropping mechanism. The proposed system enhances operational flexibility by enabling controlled payload deployment while maintaining stable flight performance. The project aims to improve mission effectiveness, reduce operational risks, and provide a practical solution for defence-related applications.

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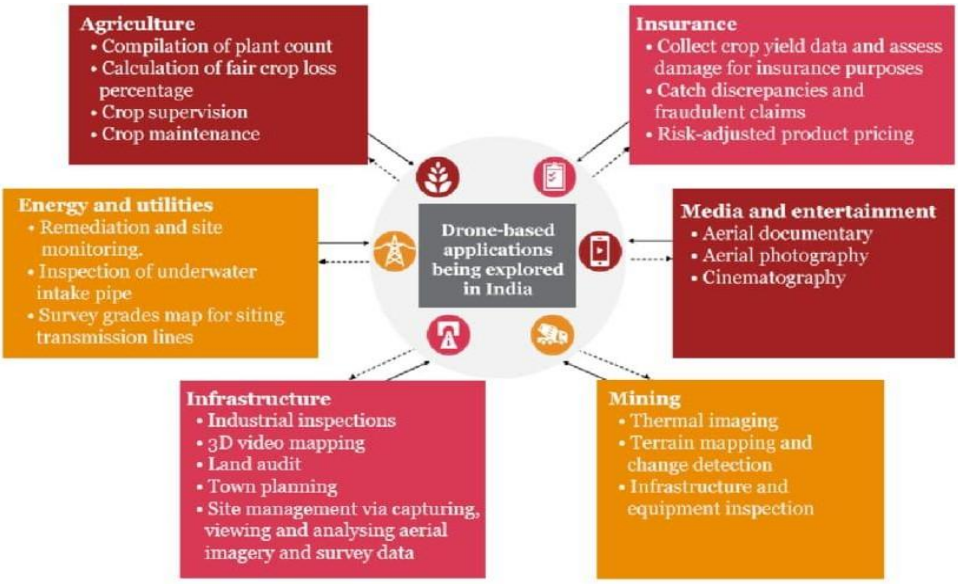

Figure 1: Drone Use in India

II. Literature Review

Several researchers have investigated UAV-based payload delivery systems to improve accuracy and operational efficiency. Aditya Vadduri et al. (2023) proposed a deep-learning-based vision system that significantly improved payload delivery precision compared to conventional GPS-based methods. Rodolfo Faglia et al. (2022) explored embedded payload solutions for UAV delivery systems and emphasized safety, usability, and quick-release mechanisms. Frederik Stendahl Leira et al. (2020) developed an autonomous delivery system that utilized machine vision and target recognition for accurate payload deployment. Their results demonstrated reliable target identification and delivery performance. Rohan Pratap Singh et al. (2016) designed an autonomous payload-drop system using modified Pixhawk firmware, achieving approximately 70% delivery accuracy under practical conditions. Gaurang Gupta (2014) introduced a controlled multiple-object-dropping mechanism using a single radio channel. His work addressed the limitations of conventional systems by enabling sequential payload release without requiring multiple control channels. The reviewed literature indicates that controlled payload-release mechanisms can significantly improve UAV mission capabilities. Building upon previous research, the present project develops a lightweight and reliable multirotor platform with a sequential payload-dropping system suitable for defence applications.

III. Methodology

The proposed system consists of a multirotor UAV integrated with a six-spoke star-wheel payload-dropping mechanism. The drone platform incorporates four BLDC motors, electronic speed controllers (ESCs), a flight controller, GPS module, battery pack, transmitter, and receiver. The payload-release mechanism is driven by a geared motor connected to a spur gear arrangement. The working principle is based on intermittent rotational motion. When a release command is transmitted, the geared motor rotates the star wheel by a fixed angle, aligning one payload with the release position. The hinged spoke opens momentarily, allowing only a single payload to drop. After release, the spoke automatically returns to its original position and locks securely, preventing accidental deployment. The flight controller stabilizes the UAV using sensor feedback and GPS information, while compass calibration ensures accurate navigation and positioning. The combination of controlled payload indexing and stable flight enables precise deployment during missions.

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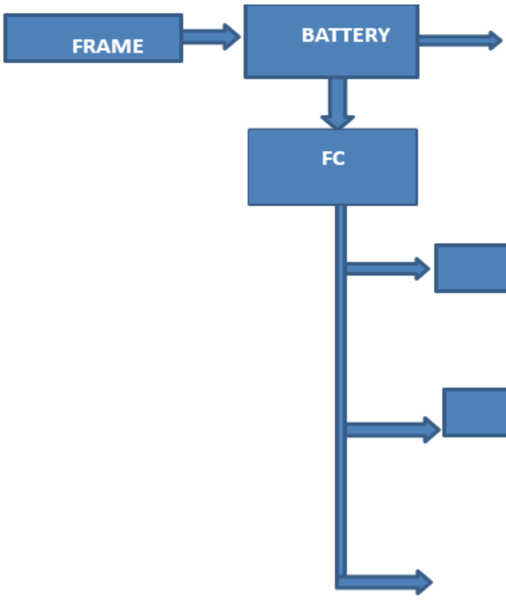

Figure 2: Component Schematic Representation

IV. Experimental Setup

The experimental setup consists of an F450 quadcopter frame equipped with four A2212 1000KV BLDC motors, four 30A ESCs, 6-inch propellers, an APM 2.8 flight controller, NEO-M8N GPS module, FlySky FS-i6 transmitter, and FS-iA6B receiver. Power is supplied by a 3S 4200 mAh Li-Po battery. The payload-dropping mechanism includes a six-spoke star wheel fabricated through 3D printing using PLA and ABS materials. A geared DC motor drives the spur gear arrangement responsible for rotating the star wheel. Each spoke contains a hinged arm designed to securely hold and release individual payloads. The complete system was assembled and subjected to compass calibration, flight testing, endurance evaluation, and payload-release experiments. Different operating conditions were considered to assess flight stability, endurance, and release accuracy.

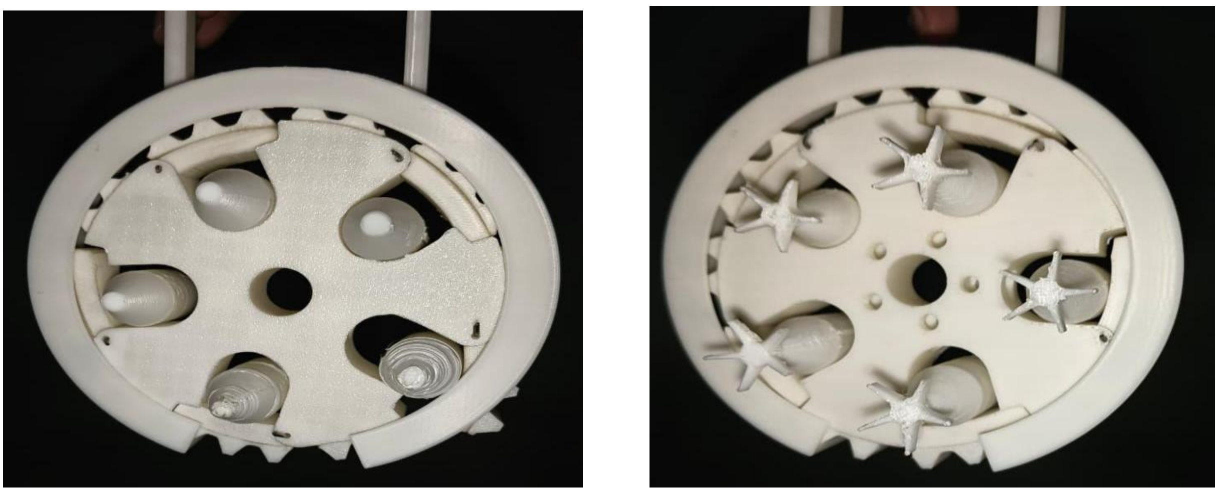

Figure 3 : Closed and Open Star Wheel

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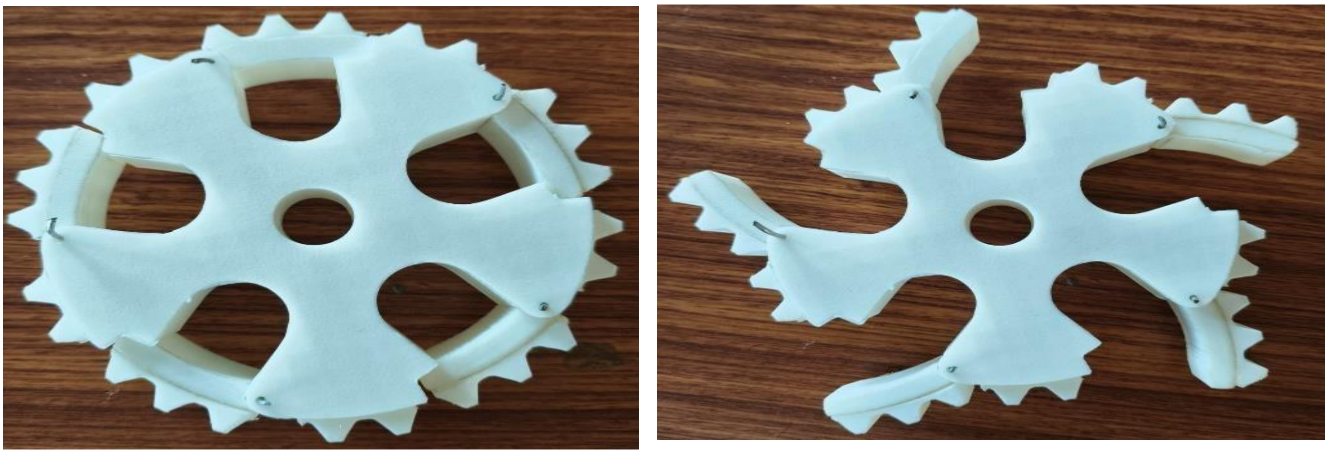

Figure 4 : Actual Experimental Setup

V. RESULT ANALYSIS

Experimental investigations confirmed the successful operation of both the UAV platform and the payload-dropping mechanism. Flight tests demonstrated stable hovering, smooth navigation, and reliable control under varying environmental conditions. The maximum tested altitude reached approximately 98 m, while endurance ranged from 4 to 6 minutes depending on operating conditions. The payload-release mechanism exhibited accurate one-by-one deployment through the six-spoke star wheel arrangement. Each rotation precisely aligned a payload with the release position, while the locking geometry prevented unintended release caused by vibration or motion. The mechanism operated with low friction and consistent reliability throughout testing. Material evaluation showed that PLA is suitable for prototype development, whereas ABS provides superior strength and flexibility for practical field applications. Overall, the developed UAV demonstrated satisfactory flight performance, reliable sensor operation, efficient power utilization, and precise payload deployment capability, making it suitable for defence and surveillance missions.

VI. CONCLUSION

The developed multirotor UAV with a precision payload-dropping mechanism successfully achieved its intended objectives of stable flight, accurate payload deployment, and reliable system performance. The integration of a geared-motor-driven six-spoke star wheel enabled controlled sequential release while maintaining operational safety and positional accuracy. Experimental results validated the effectiveness of the proposed design under different testing conditions. The mechanism demonstrated consistent operation without accidental drops, and the UAV maintained satisfactory stability and endurance throughout the trials. The lightweight and modular design further enhances its practicality for defence and surveillance applications. Future improvements may include autonomous target recognition, intelligent payload delivery algorithms, extended flight endurance, and integration with advanced navigation systems. The project establishes a strong foundation for future research in UAV-based payload automation and tactical support systems.

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