

High Speed Fighter UAV with Electric Coil Gun

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Abstract: *The paper focus on "High-Speed Fighter Drone Using Electromagnetic Coil Gun and Dropping Mechanism" project represents a significant milestone in the realm of unmanned aerial vehicles (UAVs). This project aimed to design, develop, and demonstrate a cutting-edge high-speed fighter drone equipped with an electromagnetic coil gun and an advanced payload deployment mechanism. The primary objectives were to enhance drone maneuverability, achieve precision targeting capabilities, and enable efficient payload deployment, thus expanding the potential applications of UAV technology.*

This project involved an intricate blend of engineering, innovation, and technology integration. The drone's design and construction incorporated a lightweight yet durable frame, high-speed motors, and advanced flight control systems, ensuring exceptional agility and stability during flight. The electromagnetic coil gun, a pivotal component, was meticulously designed for precision targeting, delivering impressive accuracy and firing control.

Moreover, the payload deployment mechanism, a vital feature of the system, was developed to ensure the precise and reliable delivery of payloads, expanding the drone's versatility across various domains, including defense, surveillance, and emergency response

Throughout the project's lifecycle, rigorous testing, calibration, and data analysis were conducted to validate the drone's performance, accuracy of the electromagnetic coil gun, and efficiency of the payload deployment mechanism. The project yielded promising results, demonstrating the drone's exceptional flight performance, electromagnetic coil gun's precision targeting, and payload deployment's reliability.

This project report provides a comprehensive overview of the project's objectives, methodologies, results, and significance. It explores the intricate system design, integration processes, testing procedures, and detailed analyses of outcomes. Furthermore, it discusses the challenges faced during development and the potential impact of this high-speed fighter drone in various industries.

In conclusion, the "High-Speed Fighter Drone Using Electromagnetic Coil Gun and Dropping Mechanism" project represents a significant leap forward in UAV technology. Its successful realization opens up new possibilities for drone applications, promising advancements in precision targeting, payload deployment, and the overall versatility of UAVs in both civilian and military contexts

Keywords: Unmanned aerial vehicles (UAVs), Brushless DC motors (BLDC), Electromagnetic Coil Gun, Payload deployment, Carbon fiber, Propulsion System, Flight Controllers, Electronic Speed Controller.

I. INTRODUCTION

1.1 Overview:

Unmanned Aerial Vehicles, commonly known as drones, have witnessed a remarkable evolution in recent years, emerging as pivotal tools in various domains, including reconnaissance, surveillance, disaster response, and even recreational activities. Their versatility and adaptability have opened new frontiers, prompting innovative advancements in drone technology. In this context, the "High-Speed Fighter Drone Using Electromagnetic Coil Gun and Dropping Mechanism" project represents a significant stride in the pursuit of cutting-edge UAV capabilities.

The project's genesis can be traced to the growing demand for drones that transcend traditional boundaries, a demand driven by an evolving landscape of challenges and opportunities. Drones are no longer confined to the skies as passive observers; they are becoming active participants in missions that require agility, precision targeting, and efficient payload deployment. In response to these evolving needs, our project was conceived with a clear mission: to design,

develop, and demonstrate a high-speed fighter drone that leverages advanced technology, featuring an electromagnetic coil gun for precision targeting and a sophisticated payload deployment mechanism.

This project rests on a foundation of innovation, engineering, and meticulous integration of components and systems. At its core is the aspiration to enhance drone maneuverability, expand its operational scope, and provide real-world solutions for various industries, including defense, security, and emergency response. In a world where speed and precision are of the essence, the "High-Speed Fighter Drone Using Electromagnetic Coil Gun and Dropping Mechanism" seeks to redefine the capabilities of UAVs.

As we embark on this journey through the pages of this project report, we delve into the intricacies of the drone's design and construction, the development of the electromagnetic coil gun, the creation of the payload deployment mechanism, and the integration of advanced control and communication systems. Each facet of the project is a testament to the dedication and ingenuity of the project team.

This report encapsulates the project's objectives, methodologies, results, and their broader significance. It outlines the complex web of components and technologies that coalesce to form the high-speed fighter drone. It delves into the rigorous testing, calibration, and data analysis that validated the system's capabilities. Moreover, it offers insights into the challenges faced during development and the ways in which they were surmounted.

As we navigate through the detailed sections of this report, we invite you to join us on a journey of innovation and exploration. Together, we will uncover the potential of the "High-Speed Fighter Drone Using Electromagnetic Coil Gun and Dropping Mechanism" to redefine the landscape of UAV technology and its multifaceted applications in the modern world.

Motivation

The "High-Speed Fighter Drone with Electromagnetic Coil Gun" project aims to develop a fast and precise drone to address modern security challenges. It seeks to enhance surveillance, reconnaissance, and rapid response capabilities, catering to military, civilian, and emergency scenarios. By integrating precision targeting and payload deployment features, the drone aims to seamlessly transition between tasks. Additionally, it acknowledges the drone's potential across diverse sectors such as agriculture and infrastructure inspection. Leveraging cutting-edge technology, the project strives to maintain competitiveness and anticipate future requirements in the ever-evolving field of drone technology.

Problem Definition and Objectives

The problem addressed by this project lies in the need to enhance various sectors in India with advanced aerial capabilities to improve efficiency, safety, and responsiveness. The primary objective is to provide the Indian military with a high-speed UAV equipped with an electric coil gun and payload deployment system, thereby strengthening surveillance, precision targeting, and rapid response capabilities. For law enforcement agencies, the objective is to empower them with navigation, real-time situational awareness, and effective surveillance tools to maintain public safety and respond dynamically to evolving situations. Additionally, the project aims to facilitate the swift transport of medical supplies to remote areas during critical situations to enhance healthcare services. In disaster relief efforts, the goal is to support the delivery of essential supplies and conduct search and rescue operations efficiently. Furthermore, the project aims to improve the efficiency of emergency medical services by swiftly transporting medical equipment and supplies to inaccessible areas. Lastly, in transmission line maintenance, the objective is to utilize drones for inspecting lines, identifying issues, and performing minor repairs to enhance the reliability and safety of power transmission infrastructure.

Project Scope and Limitations

scope of this project is vast and promising. As technology continues to advance, there are opportunities for further refinement and enhancement of the drones' capabilities. This could include the integration of artificial intelligence for autonomous navigation and decision-making, as well as the development of more efficient and powerful electric coil gun systems. Additionally, expanding the project's focus to include collaborative efforts with international partners or other sectors, such as transportation or environmental monitoring, could unlock new possibilities for innovation and application. Overall, the project lays the foundation for continued research and development in the field of advanced

aerial capabilities, with the potential to revolutionize various aspects of national security, public safety, and emergency response in India and beyond.

Limitations As follows:

One limitation of this project is the potential challenge of regulatory approval and public acceptance, particularly regarding the use of drones equipped with electric coil guns in civilian settings. Concerns about privacy, safety, and misuse could hinder widespread adoption and implementation of the technology. Moreover, the effectiveness of the drones in adverse weather conditions or in highly congested urban environments may also pose limitations to their operational capabilities.

II. LITERATURE REVIEW

Drone Technology Advancements

Evolution of UAVs

The evolution of unmanned aerial vehicles (UAVs) from simple remote-controlled aircraft to sophisticated, autonomous platforms has been well-documented. Research in this area outlines the historical development, technological advancements, and the expanding role of drones in both military and civilian contexts.

Agile Maneuvering

Studies on drone agility, stability, and maneuverability are fundamental to our project. Research in this domain explores aerodynamics, propulsion systems, and control algorithms that enhance the agility of drones, enabling rapid changes in direction and precise positioning.

Payload Deployment Mechanisms

The importance of efficient payload deployment mechanisms is evident in applications such as cargo delivery, search and rescue, and scientific missions. Literature on this topic discusses various methods, including drop systems, winches, and robotic arms, used to deploy payloads with precision.

Electromagnetic Coil Gun Technology

Electromagnetic Acceleration

Electromagnetic coil guns have been the subject of extensive research in the context of launching projectiles with electromagnetic acceleration. Studies delve into coil gun design, magnetic field generation, and projectile dynamics.

Precision Targeting

Precision targeting with electromagnetic coil guns has significant implications in both military and civilian scenarios. Research explores targeting algorithms, projectile tracking, and electromagnetic coil gun accuracy.

Applications of High-Speed Fighter Drones

Defense and Security

High-speed fighter drones have gained prominence in military applications, offering rapid response, surveillance, and precision targeting. Existing literature discusses the role of drones in modern warfare and their impact on military strategies.

Emergency Response and Disaster Management

Drones equipped with payload deployment capabilities have proven invaluable in disaster relief and emergency response. Research outlines the use of drones for delivering medical supplies, locating survivors, and assessing disaster-affected areas.

Industrial and Commercial Use Cases

Beyond defense and emergency response, high-speed fighter drones have found applications in industries such as agriculture, forestry, and infrastructure inspection. Literature highlights the benefits of using drones for tasks like crop monitoring, forest management, and infrastructure maintenance.

Technological Challenges and Innovations

Challenges in Drone Technology

Studies on challenges faced in drone technology, including power management, communication reliability, and autonomous navigation, provide insights into the complexities associated with UAV development.

Innovations in UAV Technology

Innovations in UAV technology continue to push the boundaries of what drones can achieve. Research in this area showcases advancements in materials, sensor technology, artificial intelligence, and autonomous flight systems.

III. REQUIREMENT AND ANALYSIS

- **Indian Military & Defense:** Enhancing national security with advanced aerial capabilities, the project aims to provide the Indian military with a high-speed UAV equipped with an electric coil gun and payload deployment system, bolstering surveillance, precision targeting, and rapid response capabilities.
- **Indian Police:** Empowering law enforcement, navigation, real-time situational awareness, and effective surveillance. The electric coil gun and payload deployment system enhance its utility in maintaining public safety and responding dynamically to law enforcement needs.
- **Healthcare:** The drone, equipped with a payload deployment system, facilitates the swift transport of medical supplies, reaching remote locations during critical situations for enhanced healthcare services.
- **Disaster Relief:** In disaster relief efforts, delivery of essential supplies, and search and rescue operations.
- **Emergency Medical Services:** Payload deployment system improve the efficiency of emergency medical services by swiftly transporting medical equipment and supplies to inaccessible areas.
- **Transmission Line Maintenance:** inspects lines, identifies issues, and performs minor repairs, enhancing the reliability and safety of power transmission infrastructure.

IV. SYSTEM DESIGN

System Architecture

The below figure specified the system architecture of our project:

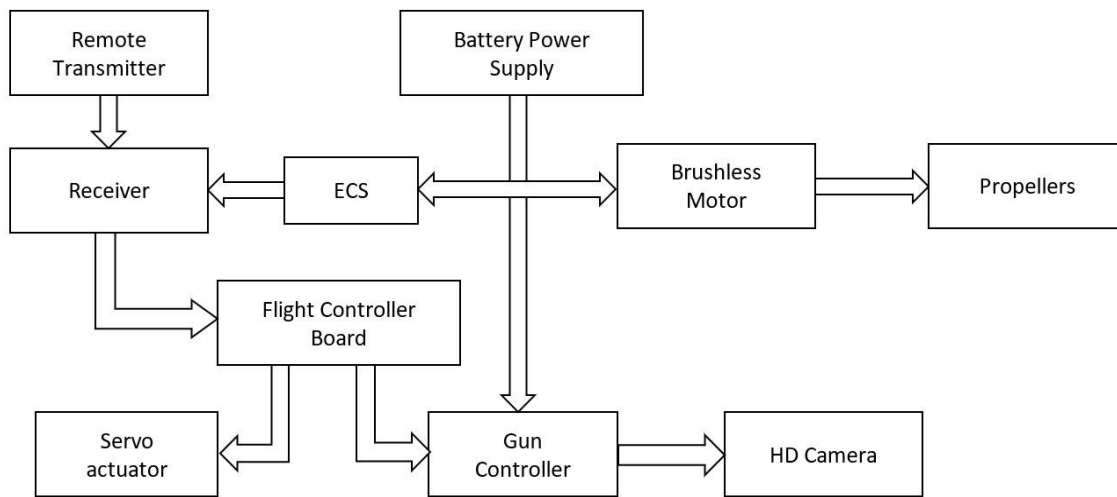


Fig. System Architecture

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Working of system

The system architecture for a high-speed fighter UAV with an electric coil gun is the blueprint that defines the organization and interaction of its various components. It encompasses the hardware, software, and their interconnections. In this project, the system architecture is pivotal for ensuring the effective integration and functioning of the UAV and its weapon system. Key architectural components may include:

- **Airframe and Propulsion System:** The physical structure of the UAV and the propulsion system that powers it. The architecture needs to facilitate aerodynamic efficiency and payload support.
- **Electrical and Power Distribution:** This aspect focuses on the design and layout of the electrical components, power sources (such as batteries), and distribution systems. The architecture should ensure efficient power management.
- **Sensors and Communication:** The system architecture should detail the sensors for navigation, targeting, and communication systems to enable autonomous operation and control.
- **Weapon System Integration:** Specifically, the architecture must outline how the electric coil gun is integrated into the UAV, including its power supply, control algorithms, and firing mechanism.
- **Flight Control:** The UAV's flight control architecture involves autopilots, control algorithms, and actuators that enable stable and maneuverable flight.
- **Data Processing and Analysis:** For both UAV control and targeting, algorithms for data processing, fusion, and analysis are crucial. This architecture dictates how data is collected and processed.
- **Safety Systems:** The architecture should include safety mechanisms and redundancy measures to ensure the reliability and safety of the system.
- **User Interface and Command Center:** If applicable, it should define how operators' interface with the UAV, control its movements, and deploy the electric coil gun.

Hardware Carbon Fibre Frame:

The foundation of our high-speed fighter drone is its frame. Extensive consideration went into the selection and design of the frame to ensure a delicate balance between lightweight construction and structural integrity. The primary design factors included: The frame was crafted using lightweight, yet robust materials such as carbon fiber composites and aluminum alloys. This choice aimed to minimize weight while ensuring the ability to withstand the stresses experienced during high-speed flight



Fig. 2. Carbon Fibre Frame

Motor

We opted for high-efficiency brushless electric motors capable of providing the required thrust-to-weight ratio for rapid acceleration and agile maneuvering. The selection considered factors like power output, efficiency, and compatibility with the frame.



Fig. 3. BLDC outrunner motor

Propellers:

Specially designed high-performance propellers were chosen to complement the motors. The choice of propellers was based on their ability to maximize thrust and optimize efficiency, especially during high-speed flight.

Fig. 4. Propeller



Flight Controller

We employed advanced flight controllers with state-of-the-art stabilization algorithms. These controllers provided real-time adjustments to motor speeds, ensuring stable flight even during rapid maneuvers.

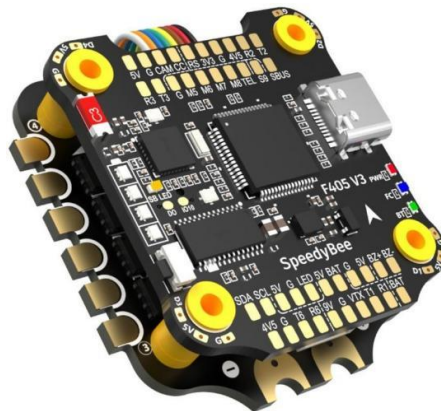


Fig. 5. On-board ESC & Flight Controller

Sensor Suite

The drone is equipped with a suite of sensors, including gyroscope, accelerometer, GPS, altimeter, and magnetometer. These sensors collect crucial data on orientation, altitude, position, and environmental conditions to facilitate precise flight control and navigation.

- Gyroscope: Provides data on orientation and angular velocity.
- Accelerometer: Measures acceleration and gravity forces, aiding in stabilization.
- GPS: Enables accurate positioning and navigation during flight.
- Altimeter: Measures altitude above sea level for precise height control.
- Magnetometer: Assists in determining the drone's orientation with respect to Earth magnetic field.

Transmitter for High-Speed Fighter UAV:



Fig. 6. Radio Transmitter

The transmitter for the High-Speed Fighter UAV is a state-of-the-art control interface designed to provide real-time communication with the UAV, enabling precise and responsive remote control. It offers a user-friendly interface for the pilot, allowing them to navigate the UAV, select targets, and execute mission-specific tasks with ease. The transmitter ensures low-latency, secure, and robust communication, even at high speeds and extended operational ranges, making it an essential component for effective UAV operations.

Receiver for High-Speed Fighter UAV:

The receiver for the High-Speed Fighter UAV is a highly sensitive and dependable communication module installed on the UAV itself. It is designed to receive commands and data from the ground-based transmitter, ensuring seamless and rapid communication. The receiver's advanced technology allows it to decode signals, enabling the UAV to execute complex flight maneuvers, engage targets accurately, and transmit vital mission data back to the ground control station. Its reliability and responsiveness are critical for the success of the high-speed fighter UAV's missions.



Fig.7. Radio Receiver

Power Sources: High-capacity lithium-polymer (LiPo) batteries with excellent energy density and power-to-weight ratios provide the drone's power supply for extended flight durations

Electromagnetic Coil Gun Development

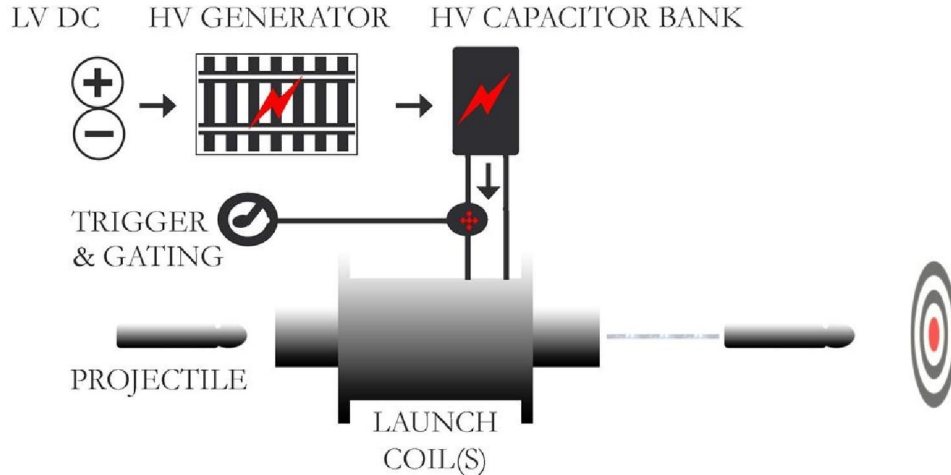


Fig. 8. Construction of Coil Gun

Electromagnetic Field Strength: The coil gun's electromagnetic field strength is critical for accelerating the projectile. Advanced simulation software was utilized to model and optimize the coil's design, ensuring that the magnetic field strength is sufficient for high-speed acceleration while minimizing energy losses.

Projectile Compatibility: The design accounts for the type and size of projectiles that the coil gun is intended to launch. Compatibility with various projectile types and sizes was achieved through modular coil designs and adjustable settings.

Barrel Materials: Materials for the gun's barrel were selected for their durability and ability to withstand the forces generated during rapid projectile acceleration. High-strength materials such as steel alloys and composite materials were considered.

Cooling Systems: To prevent overheating during rapid firing sequences, cooling systems were integrated into the coil gun design. These systems dissipate heat generated during firing and stepping up voltage ensure the coils remain within safe operating temperatures



Fig. 9. Heat Sink

Energy Storage: Developing a suitable power source is critical to the electromagnetic coil gun's performance. Super-Capacitor were chosen as the primary energy storage solution due to their ability to discharge high amounts of energy rapidly. The capacitors were carefully selected for their capacitance and voltage ratings to match the coil gun's requirements.



Fig. 10. Super capacitor

Charging Circuitry: High-power charging circuitry was designed to rapidly charge the capacitor banks between shots. Fast charging reduces the downtime between shots, enhancing the drone's firing rate.

Trigger Mechanism: A precise and responsive trigger mechanism was developed to control the timing of the coilgun's firing sequence. This mechanism ensures that the electromagnetic pulse is precisely synchronized with the projectile's position in the barrel for optimal acceleration.

Safety Features: Safety interlocks and fail-safe mechanisms were incorporated into the power source design to prevent accidental discharges and ensure safe operation. These measures include charge status indicators and safety protocols for handling charged capacitors.

V. CONCLUSION

5.1 Conclusion

The "High-Speed Fighter UAV with Electric Coil Gun" project signifies a significant advancement in unmanned aerial vehicles and combat technology. This innovative effort has successfully integrated cutting-edge components to create a powerful and versatile system. By addressing the limitations of existing fighter drones, we've developed a high-speed UAV platform that excels in speed, maneuverability, and operational flexibility. The inclusion of the electric coil gun adds a lethal dimension, providing high muzzle velocity, precision targeting, and extended range engagement capabilities. Our focus on environmental sustainability, with an efficient power supply system and secure communication protocols, further enhances the system's effectiveness. The intelligent control algorithm optimizes target detection, tracking, and execution of evasive maneuvers, setting new standards for modern warfare. Looking ahead, future enhancements in AI algorithms, communication systems, and power efficiency will continue to elevate the system's capabilities. In conclusion, this project underscores our commitment to technological innovation for national security, and we look forward to its impact on the future landscape of warfare.

5.2 Future Work

Future work for the "High-Speed Fighter UAV with Electric Coil Gun" project includes refining AI algorithms for enhanced autonomous operation, improving communication systems for seamless data transmission, and optimizing power supply efficiency for prolonged missions. Additionally, research will focus on further enhancing target detection and tracking capabilities, as well as exploring innovative methods to reduce the environmental footprint of the system. Collaboration with industry partners and continued testing and validation will be crucial for implementing these advancements and ensuring the project remains at the forefront of defense technology.

5.3 Applications

- **Indian Military & Defense:** Enhancing national security with advanced aerial capabilities, the project aims to provide the Indian military with a high-speed UAV equipped with an electric coil gun and payload deployment system, bolstering surveillance, precision targeting, and rapid response capabilities.
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