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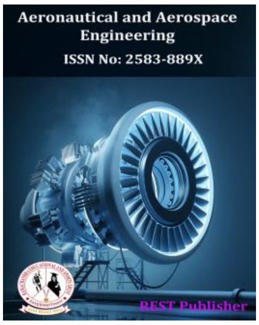

3D Printed Hybrid VTOL RC Plane for Effective Surveillance

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Abstract. *This mini-project focuses on the design, modeling, and simulation of a hybrid-powered remote-controlled (RC) aircraft, aimed at enhancing endurance and efficiency through the integration of electric-based propulsion systems. The project begins with the conceptual design phase, where key parameters such as wingspan, payload capacity, and power requirements are defined based on the intended application of the RC plane. The aircraft's design is meticulously developed using advanced CAD software, where aerodynamics, structural integrity, and weight distribution are prioritized. Computational Fluid Dynamics (CFD) emulations are employed to analyze airflow and optimize the design for minimal drag and maximum lift. Additionally, Finite Element Analysis (FEA) is conducted to ensure that the structure can withstand operational stresses. The project also explores the prototyping phase, where components are manufactured using 3D printing technology, followed by ground and initial flight tests to validate the design and simulation results. The outcomes of this project demonstrate the potential of hybrid propulsion in RC planes, offering a balance between performance* efficiency, and environmental impact.

1. INTRODUCTION

This project involves designing and prototyping a Hybrid RC plane with Vertical Take-Off and Landing (VTOL) capabilities, powered by an electric motor. The design focuses on optimizing flight performance, energy efficiency, and stability, while utilizing modern prototyping methods such as 3D printing. The final prototype will demonstrate smooth transitions between vertical and horizontal flight modes, showcasing the potential of electric propulsion in small-scale aircraft.

2. CHALLENGES

Limited Take-Off Flexibility: Conventional RC planes need runways for take-off and landing, restricting their use. This project introduces VTOL to enable operation in confined spaces. Short Flight Time in Electric RC Planes: Electric RC planes often have limited endurance. This project seeks to optimize energy management for longer flight durations. Smooth Transition Between Flight Modes: Ensuring a seamless shift from vertical take-off to horizontal flight is challenging. The project aims to achieve stable transitions through efficient design. Sustainable Aviation: The project addresses the need for eco-friendly aviation by focusing on electric propulsion to reduce emissions.

3. DESIGN AND PLANNING

The Hybrid VTOL RC Plane is a 3D printed kit, that offers unique advantages and considerations:

1. Battery strap slots
2. Adequate cooling intakes
3. Robust single-wall fuselage
4. Lightweight (for printing) single-layer printing and webbing
5. Universal attachments (for camera)
6. Plenty of space for different power plants, ESC's and batteries
7. V type Tail configuration
8. Modular construction
9. Servo covers and internal wire routing through the wingtips

Design Features: The design of the VTOL RC plane was created using SolidWorks, utilizing its robust 3D modeling tools to develop a lightweight, aerodynamic structure suitable for vertical take-off and smooth transition to horizontal flight. The model includes a streamlined fuselage, integrated wing structures for stability and lift, and tilting motor mounts to enable vertical lift and forward propulsion. SolidWorks' parametric design capabilities allowed precise adjustments to wing and body dimensions, optimizing the plane's balance and flight characteristics.

4. ASSEMBLY PLAN

- Organization: Organize all kit components, 3D printed parts, and required tools in a clean and clutter-free workspace. Label and sort components to ease access during assembly.
- Review Instructions: Thoroughly review the assembly instructions provided with the kit, if available. Ensure you understand the sequence of steps and any special considerations.
- Tools and Materials: Gather all the tools and materials you'll need, including screwdrivers, pliers, wrenches, and any specific tools recommended in the instructions.
- Safety: Prioritize safety by wearing appropriate protective gear, such as safety glasses and gloves, especially if using adhesives or other chemicals during assembly.
- Quality Control: Inspect all 3D printed parts for defects, warping, or printing errors before starting assembly. Address any issues before proceeding.
- Step-by-Step Assembly: Follow the assembly instructions meticulously, step by step. Pay attention to details like screw tightening torque and alignment.
- Testing and Calibration: After assembly, perform pre-flight
- checks and calibration to ensure that all components are functioning correctly. This may include checking control surfaces, electronics, and the balance of the aircraft.
- Safety Precautions: Adhere to safety precautions, especially during testing and calibration, to prevent accidents or damage to the model.
- Documentation: Keep a record of your assembly process, including notes, photos, and diagrams. This documentation can be valuable for
- troubleshooting and future reference.
- Maiden Flight: Plan for a controlled maiden flight in an appropriate location. Ensure that you have the necessary RC transmitter and receiver set up correctly and take safety precautions.

5. CALIBRATION

- Once your pre-flight check is complete, it's time to perform trim and calibration adjustments to optimize the performance and stability of your RC aircraft:
- Centering Servos: Use your transmitter to center
- all servos and control surfaces. This ensures that the aircraft starts from a neutral position.
  Trim Adjustments: Adjust trim settings on your transmitter to fine-tune the neutral positions of the control surfaces. Trim helps maintain straight and level flight without constant manual input.
- Flight Controller Calibration (if applicable): If your RC aircraft model includes a flight controller with gyros and accelerometers, follow the manufacturer's instructions to calibrate it. This calibration ensures that the flight controller accurately stabilizes the aircraft.
- Range Check (if applicable): Perform a range check to verify that your transmitter's signal reaches the aircraft without interference. Check for any radio signal dead spots or loss of control.
- Motor and ESC Calibration: If you have an electric motor and ESC, calibrate them as per the manufacturer's instructions to ensure smooth throttle response.
- Trim Tweaking: Make any necessary trim adjustments based on your observations after the test flight. Continue to test and adjust until you achieve stable and responsive flight characteristics.

6. APPLICATIONS

Hybrid VTOL RC planes are highly effective for surveillance across various domains. They are extensively used in border surveillance, offering long-range monitoring and hovering capabilities for detailed observation of illegal activities. In disaster management, they assist in assessing damage, locating survivors, and supporting rescue operations in remote or inaccessible areas. These planes are valuable in urban security and law enforcement, helping monitor crowds during events, protests, or track suspects in confined environments. For environmental monitoring, they facilitate the observation of wildlife, detection of illegal deforestation, and pollution tracking with minimal disturbance. Additionally, they are utilized in infrastructure inspection, enabling close monitoring of power lines, pipelines, and other critical assets, as well as in agriculture, where they survey large fields for crop health, pest detection, and irrigation needs. Lastly, they play a crucial role in search and rescue operations, locating missing individuals or vehicles in challenging terrains such as forests, mountains, and seas. Their versatility, efficiency, and ability to operate in diverse conditions make them indispensable for effective surveillance.

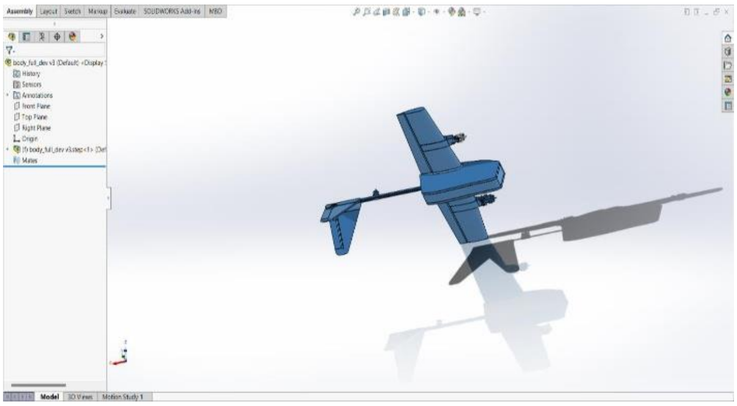

FIGURE 1.

FIGURE 2.

7. CONCLUSION

This project successfully designed and prototyped a Hybrid RC plane with Vertical Take-Off and Landing (VTOL) capabilities, powered by an electric motor. The primary objective was to create an aircraft that combines the agility of a multirotor for vertical lift with the efficiency of a fixed- wing plane for forward flight, all while leveraging electric propulsion for sustainability and efficiency. Throughout the project, several key aspects were prioritized: flight performance, energy efficiency, and stability. A combination of theoretical design principles and practical testing shaped the final prototype, which incorporated modern prototyping techniques such as 3D printing to produce lightweight, precise components. This method not only reduced the time and cost associated with prototyping but also allowed for customization and fine-tuning to meet the project's unique requirements.

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