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Design and Development of Fixed Wing Drone for Surveillance Purpose

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Abstract - *In today's modern era Drone is upcoming and multidimensional technology in the world. Fixed wing unmanned aerial vehicle (UAV) have become an integral part of modern surveillance and military operations. Fixed wing aircraft have proven to be an effective platform for surveillance operations due to their versatility, range, and endurance. In recent years, the development of advanced sensor technologies, such as high-resolution cameras and imaging systems, has further enhanced the capabilities of fixed-wing aircraft for surveillance applications. This research paper provides a comprehensive overview of the use of fixed-wing aircraft for surveillance applications and identification. Furthermore, we examine the advantages and disadvantages of fixed-wing aircraft over other surveillance platforms, such as drones and helicopters, and provide insights into their potential applications. The research findings demonstrate the exceptional stability and manoeuvrability of the fixed-wing drone across various flight scenarios, including straight-line flights, turns, and altitude changes. Control surfaces, including ailerons, elevators, and rudder, exhibited precise response and control authority throughout the flight. Additionally, the flight test confirmed the drone's extended endurance capabilities, allowing for prolonged airborne operation without performance compromise.*

Keyword: *Fixed wing (UAVS), Surveillance, Air foil, Performance analysis.*

1. INTRODUCTION

Surveillance operations play a pivotal role in maintaining public safety, safeguarding national security, and protecting various commercial interests. In recent years, technological advancements have brought about a paradigm shift in the field of surveillance, enabling more efficient and effective data collection. Among these advancements, the utilization of fixed-wing drones for surveillance purposes has gained significant attention. Fixed-wing drones, characterized by their aerodynamic design and extended flight endurance, offer a multitude of advantages over traditional surveillance methods, including the ability to cover large areas, collect high-resolution imagery, and conduct covert operations without arousing suspicion. This research paper aims to explore and analyse the potential of fixed-wing drones in surveillance applications, examining their operational advantages, technological advancements, and potential limitations.

1.1 Operational Advantages of Fixed-Wing Drones

Fixed-wing drones possess several operational advantages that make them highly suitable for surveillance missions. The aerodynamic design of fixed-wing drones enables efficient flight and extended endurance, allowing them to remain airborne for longer durations compared to rotary wing drones. The extended operational range of fixed wing drones makes them particularly well-suited for large-scale surveillance applications such as border patrolling, perimeter security, and monitoring expansive industrial sites [1]. Additionally, fixed wing drones can be equipped with advanced imaging technologies, including high-resolution cameras, thermal sensors, and even LiDAR systems. These capabilities enable the collection of precise and detailed surveillance data, facilitating better situational awareness and more accurate threat assessment [2]. The high-resolution imagery captured by fixed-wing drones provides operators with an in-depth understanding of the monitored area, enhancing their ability to identify potential security risks or suspicious activities [3]. Furthermore, fixed-wing drones offer the advantage of covert operations. With their streamlined design and low noise emissions, fixed-wing drones can conduct surveillance activities discreetly, minimizing the risk of detection and avoiding potential interference with ongoing operations. This covert capability makes fixed wing drones highly valuable in scenarios were maintaining secrecy and avoiding suspicion are critical aspects of surveillance missions [4].

1.2 Technological Advancements

The rapid advancement of technology has significantly contributed to the improved capabilities of fixed-wing drones for surveillance purposes. One notable technological development is the integration of artificial intelligence (AI) algorithms, which enables autonomous flight and intelligent data analysis. Through AI-powered object

recognition and tracking algorithms, fixed-wing drones can automatically identify and monitor specific targets of interest in real-time, thereby enhancing situational awareness for operators on the ground [5]. This automation not only reduces the cognitive load on operators but also improves the accuracy and efficiency of surveillance operations. Moreover, advancements in data transmission and storage have revolutionized the way surveillance data is collected, processed, and analysed. Fixed-wing drones can now transmit high-definition imagery and video footage from their onboard cameras to the control station in real-time. This capability allows for timely decision-making, facilitates real-time collaboration among surveillance teams, and enhances the effectiveness of response and intervention efforts [6].

2. Objective

1. Design of fixed wing drone and Simulation of Air foil wing.
2. Manufacturing of drone system, Testing and validation of drone system.
3. To explore the operational advantages offered by fixed-wing drones in surveillance applications.
4. To examine relevant case studies showcasing the successful utilization of fixed-wing drones in surveillance scenarios.
5. Evaluate the performance metrics and capabilities of fixed-wing drone systems in conducting aerial surveillance missions.

3. Theory

A drone is an unmanned aerial vehicle (UAV) or a Remotely Piloted Vehicle (RPV) that can fly autonomously or be remotely controlled for various purposes. The entire system is known as an Unmanned Aircraft System (UAS) or Remotely Piloted Aircraft System (RPAS) or Ground Control System (GCS).

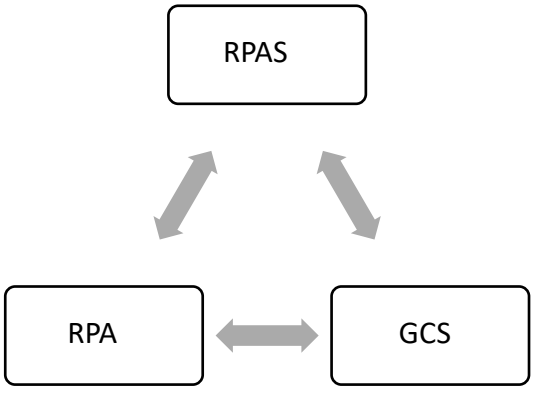

Figure No.01 Unmanned aircraft system

Figure No.02 Remotely piloted vehicle

4. Hardware Configuration

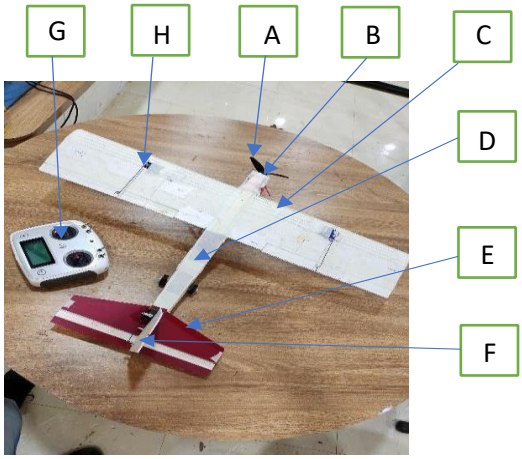

Figure No.03 Eagle Eye

Alphabet	Indication
A	Propeller
B	BLDC Motor
C	Main Wing
D	Fuselage
E	Horizontal stabilizer
F	Vertical stabilizer
G	Transmitter
H	Servo motor

Table No.01 Part list

- Motor: [BLDC Motor 1000kv]
- Battery: [3 Cells 2200 Mah]
- Weight: [AUW 800 grams]
- Wingspan: [800 mm]

5. Calculations

Parameter	Value
Wing Span	0.900 m
XY Proj. Span	0.900 m
Wing Area	0.147 m²
XY Proj. Area	0.147 m²
Plane Mass	2 kg
Wing Load	10.218 kg/m²
Root Chord	0.350 m
MAC	0.185 m
Tip Twist	0.000°
Aspect Ratio	5.518
Taper Ratio	0.257
Root-Tip Sweep	27.575°

Table No.02 Parameters

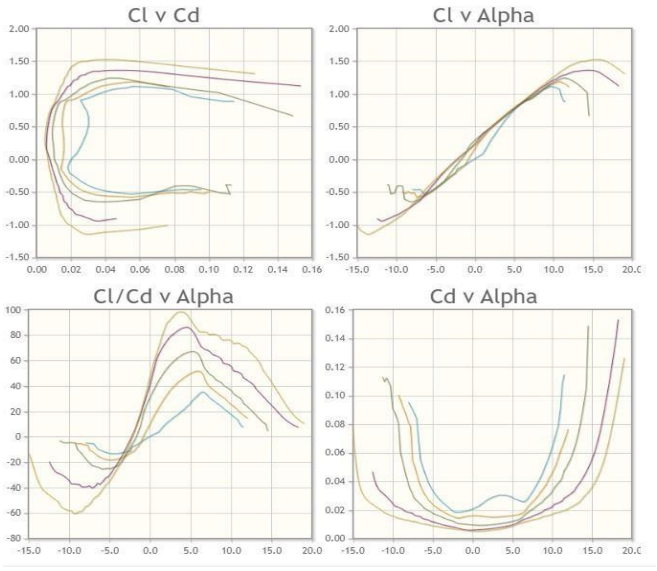

Fig No.04 CD, CL, CM Graphs

- Identify the specific requirements and objectives of the fixed-wing drone for surveillance applications, such as endurance, range, payload capacity, and flight stability.

- Determine the desired wing configuration, such as the wing aspect ratio, sweep angle, and air foil selection, based on the intended mission requirements. - Define the overall dimensions of the aircraft, including wing span, wing area, and fuselage length, while considering weight limitations and payload capacity.

- Assess parameters such as lift, drag, and stability derivatives to analyse the performance of the aircraft under various flight conditions.

- Design the tail section, including the horizontal stabilizer and elevator, to ensure proper stability and control during flight.

- Adjust wing parameters, such as wing area, aspect ratio, and air foil selection, to achieve optimal lift-to-drag ratios and desired flight characteristics. - Account for structural integrity and strength in the design process, considering the material selection, wing placement, and overall weight distribution.

- Construct a prototype of the fixed-wing drone based on the finalized design.

- Based on the analysis and research of various graph we designed a wing with air foil (NACA2410).

6. Result and Discussion

- The fixed-wing drone exhibited excellent stability during various flight manoeuvres, including straight-line flights, turns, and altitude changes.

- Control surfaces, such as ailerons, elevators, and - rudder, demonstrated effective response and control authority, ensuring precise control of the drone throughout the flight.

- The flight test verified the extended endurance capabilities of the fixed-wing drone, allowing it to remain airborne for a significant duration without compromising performance.

- The drone successfully carried the intended payload, including cameras, sensors, and other surveillance equipment without affecting its flight stability or manoeuvrability.

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Figure No. 05 Flight testing

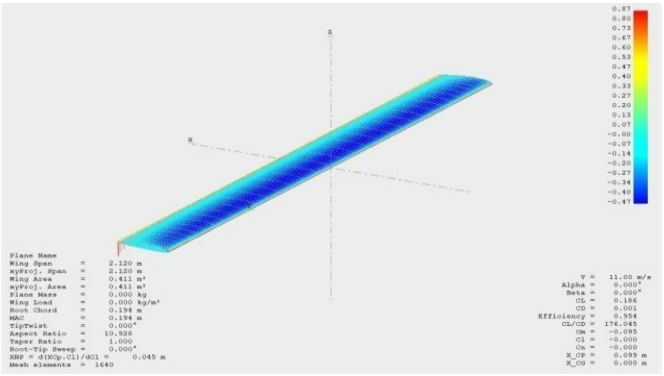

Figure No.06 Analysis of air foil

We've completed the iterative procedure using Xflr5 software and will choose the most efficient air foil possible. According to the theoretical and software calculations, we have reached the intended outcome with a 95.7% efficiency rate.

7. Conclusion

Fixed-wing drones have emerged as powerful tools for surveillance operations, offering operational advantages, technological advancements, and promising prospects for the future. Their extended flight endurance, ability to cover vast areas, and collection of high-resolution imagery make them valuable assets for various surveillance applications. However, careful consideration of legal and ethical frameworks, addressing challenges related to payload capacity and agility, and ensuring responsible deployment are crucial for their effective and ethical utilization. By harnessing the potential of fixed-wing drones, the realm of surveillance can be transformed, enabling more efficient and accurate data collection, improved situational awareness, and enhanced public safety.

8. Acknowledgment

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