Inter IIT Tech Meet 11.0
IIT Kanpur

Name of the Project:
Reaper

High Endurance UAV used for surveillance

Participants:

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Problem Addressed

The current market needs higher endurance, mid-altitude, and cost-effective Unmanned Aerial Vehicles (UAVs) that can meet the demand for various outdoor operations, such as surveillance, terrain mapping, small cargo delivery, search operations during calamities, and other tasks. This gap in the market is hindering the growth of industries that require UAVs for their operations, leading to a need for cost-effective, reliable, and high-endurance UAVs.

Proposed Solution

Reaper

Reaper is a cost-effective solution for a reliable and high-endurance UAV for various outdoor operations. This MALE UAV system is designed to meet the demands of industries that require surveillance, terrain mapping, small cargo delivery, and search operations during disasters. It is a replica of the American strike drone MQ-9 Reaper and serves the same purpose as high-altitude surveillance.

Specifications

The proposed UAV has a flight time of around 40-50 minutes and can reach an altitude of 200 ft. It has a payload capacity of 1-2 kg, which includes a high-resolution camera and a high-end processor for data processing and lives feed streaming. The wing and vertical stabilizer were designed using the NACA 6412 airfoil, which was chosen after extensive research and analysis. The aerodynamic and stability analysis was conducted using tools like OpenVSP and XFLR5.

This UAV is equipped with advanced features such as a high-resolution camera and high-end processor, which allows for real-time monitoring and mapping of the external environment. The real-time live feed of the camera can be streamed, providing valuable information in real-time. This UAV system serves as a cost-effective solution for various industries and offers improved performance and reliability compared to existing UAVs in the market.

In order to increase its range of applications and cost-effectiveness, some additional upgrades can be considered:

Multispectral Sensors: Equipping the UAV with multispectral sensors will allow it to gather more detailed and accurate data, increasing its utility in agriculture, environment monitoring, and disaster management.

Increased Payload Capacity: By increasing the payload capacity of the UAV, it will be able to carry additional equipment, such as sensors, cameras, and communication devices, to increase its range of applications.

Autonomous Flight: Incorporating autonomous flight capabilities will increase the efficiency of the UAV, reduce the need for manual control and improve its reliability in remote areas.

Energy-Efficient Design: By designing the UAV to be energy-efficient, its flight time can be extended, making it more cost-effective and reducing the need for frequent battery replacement.

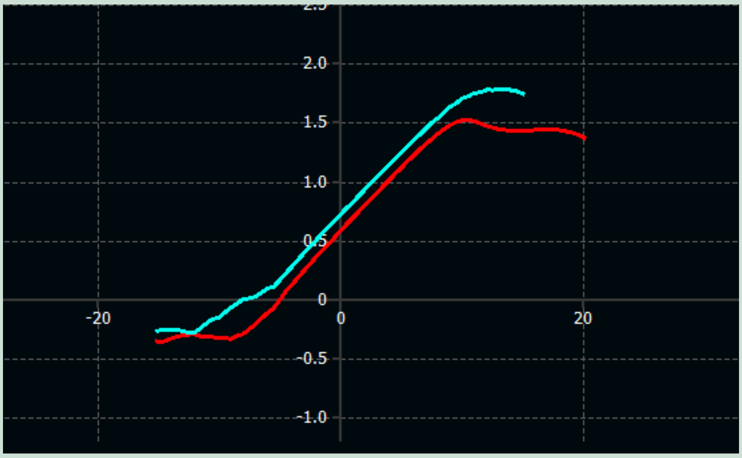
Customizable: Making the UAV customizable will allow it to be tailored to specific requirements, such as different payload capacities, camera types, and flight durations, making it more cost-effective for different industries and applications.

Artificial Intelligence: Integrating Artificial Intelligence into the UAV's software will allow it to make decisions and perform tasks autonomously, making it more efficient and reducing the need for manual control.

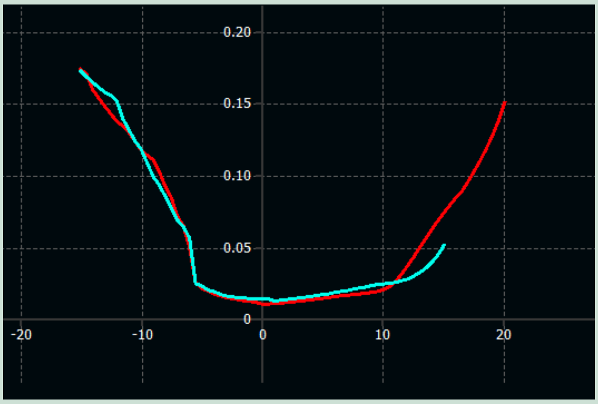
By incorporating these upgrades, Reaper UAV System will become a more versatile, efficient, and cost-effective solution for various outdoor operations, meeting the demands of a wider range of industries and applications.

Airfoil Analysis:
The objective was to select a foil with a minimum drag that maximizes lift and provides a prolonged flight time. To fulfill these objectives, extensive research was done using different analysis software such as XFLR5 and Ansys.

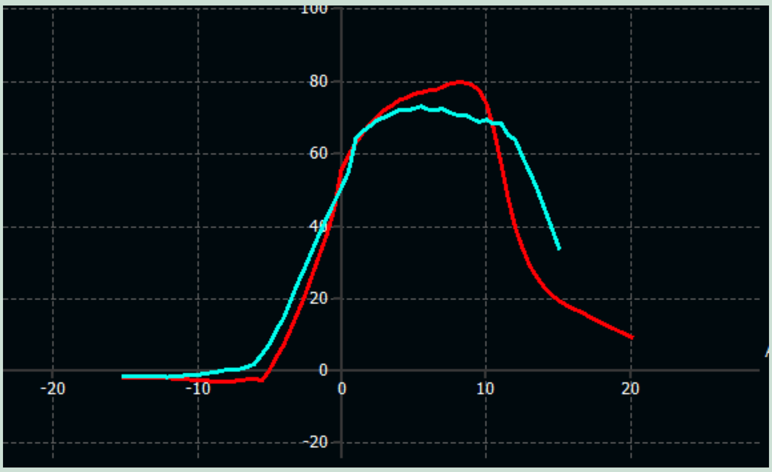
Cl vs Alpha:
We first analyzed the lift coefficient and tried to find which airfoil would give us the maximum lift.
We analyzed different airfoils, and NACA 6412 airfoil met our requirements after analysis.



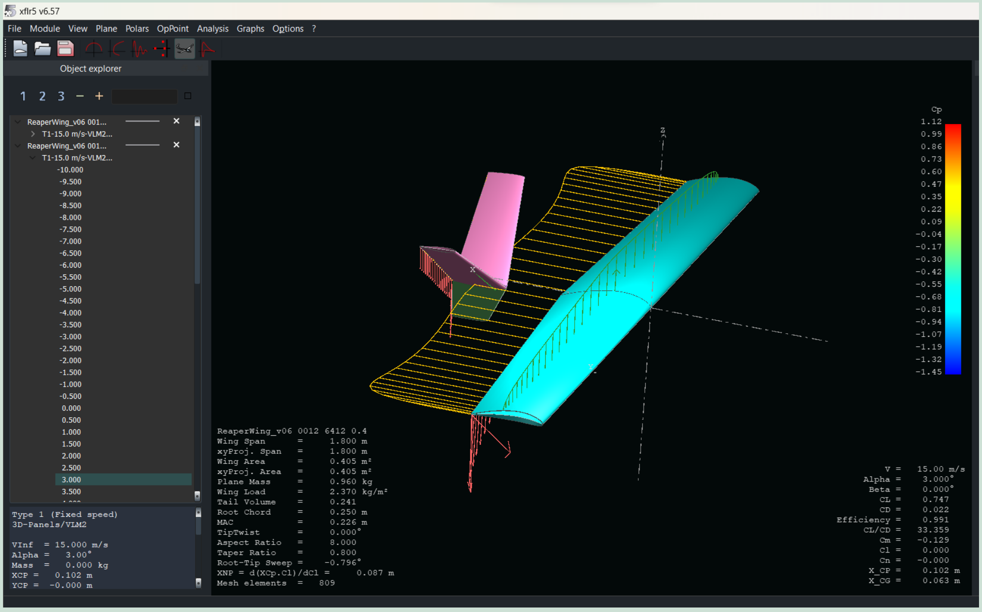
Cd vs Alpha:
NACA6412 also showed favorable results during the drag coefficient test



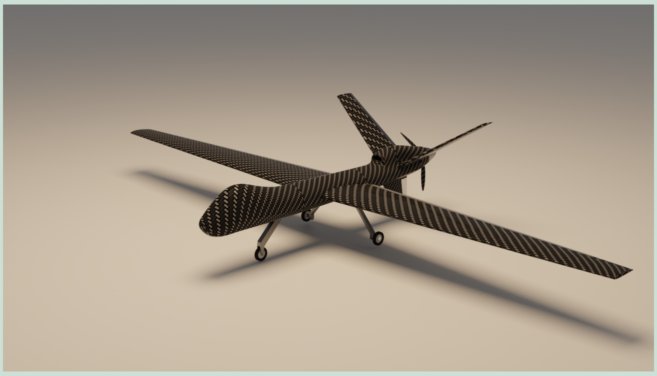
Cl /Cd vs Alpha :
NACA6412 airfoil also showed the maximum value for Cl/Cd vs alpha test.



Wing and tail analysis:
Wing and tail were jointly analyzed so that the best version and position of the tail and main wing could be decided with respect to the fuselage.



Conceptual design :



Prototype 1
A foam-based model of reaper was designed and built, and successfully tested.
Flight test video link:
https://drive.google.com/file/d/1GKmUs7eufTP2a0-A6R4FmPkJ1AK0LX2B/view?usp=share_link