Ground Effect Vehicle for Transportation over Water

Aadithya R Pade[1], Ammi Reddy Laxminada Reddy[2], Chandan Raj R[3]
Jarreth Sajjan[4] & Sudhagara Rajan S [5]
[1,2,3 & 4] Department of Aeronautical Engineering,
Dayananda Sagar College of Engineering, Bangalore, India.
[5]Assistant Professor, Department of Aeronautical Engineering,
Dayananda Sagar College of Engineering, Bangalore, India.
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Abstract - *The project proposes using a ground effect vehicle (GEV) or a wing-in- ground-effect (WIG) craft to address transportation needs over relatively short distances on water. Currently, the options are limited to expensive and limited aircraft or slower ships. GEVs operate close to the ground or water, utilizing the aerodynamic interaction with the surface to reduce drag and improve lift- to-drag ratios, making them faster and more efficient than traditional aircraft or ships. The proposed GEV design aims to have a range of 300 miles, a cruise speed of 150 mph, and the capacity to carry 10 passengers and 1000 pounds of cargo. It will be powered by two ducted prop engines, which are more efficient and produce less noise than conventional aircraft engines.*
The success of this project could revolutionize water transportation, providing a more accessible and cost-effective option for passengers and cargo. The efficient and affordable GEV design has the potential to drive further advancements in GEV technology, leading to widespread adoption and implementation not only in India but also globally.
***Keywords**: Ground effect, Wing-in-ground effect vehicle, Ducted Propellers, Lift-to-drag ratio.*

I INTRODUCTION

In the context of fixed-wing aircraft, the ground effect refers to the phenomenon where the proximity of the aircraft's wings to a surface result in a decrease in aerodynamic drag [1]. The ground effect becomes apparent when an aircraft maintains a flight altitude equal to or below roughly half the length of its wingspan above the ground or water. During this condition, a noticeable decrease in induced drag occurs. The main cause of this phenomenon is the obstruction of wingtip vortices and disruption of the downwash behind the wing by the ground or water surface. When flying near a surface, the air pressure on the lower wing surface increases, often referred to as the "ram" or "cushion" effect, resulting in an improved lift-to-drag ratio for the aircraft.

India has a large number of surrounding the mainland. The mode of transport currently available to these islands are aircrafts and ships. Both of these modes have their disadvantages. The aircrafts are expensive to operate and are often operated infrequently in small number. Also, they are expensive compared to ships. On the other hand, ships are although economical compared to aircrafts, they are very slow.

This problem can be solved by using ground effect airplanes which are economical to operate compared to aircrafts as they require lesser power to operate, hence lesser fuel consumption [2]. GEV travel at higher speeds compared to cruise ships, hence the destination can be reached faster. GEVs are the best of both worlds, faster and also cheaper. With the development in the GEV industry, the cargo capacity, speed, and range of the aircrafts can be further improved leading to wide adoption of GEV for transport.

II OBJECTIVES

1. To estimate the weight of the ground effect vehicle
2. To design a wing to match the set specifications
3. To design a fuselage to accommodate the passengers, cargo, and the crew
4. To design an empennage to counter the moments produced by the wing
5. To design a hull that allows easier take off from water surface
6. To choose a power plant to meet the set performance characteristics

III METHOD

The design process started with setting specifications of the aircraft for a real-world application. Lakshadweep islands lie around 200 to 440 kms away from the coast of India [3]. Choosing this as the design range, a set of specifications were developed.

The design process followed was taken from the textbook named "Aircraft Performance and Design" by John D. Anderson. First the weight of the aircraft was estimated from the existing historical data [4]. Next the wing design was done by choosing the parameters such the ground effect is maximised. Fuselage was designed such that it can accommodate all the cargo, passengers, and the crew. Next, the approximate centre of gravity was estimated for the design of the empennage. The empennage was designed such that it complements the wing and helps in aircraft stability. Finally, hull was designed for easier take off from water surface. Powerplant was also chosen such that it helps in meeting the required performance characteristics set in the specifications [5].

Figure 1: Map of Lakshadweep Islands

IV RESULTS AND DISCUSSION

A conceptual design of a GEV was successfully completed during this research. This research was able to design an aircraft to the set specifications within the set time frame.

Challenges were faced during the literature survey to gather required information on ground effect aircraft as there are very limited number of papers available on this topic.

The wing design had to be changed during the design process as the earlier design would lead to an unstable aircraft. This change led to a wing with higher aspect ratio than the original design.

The tail of the fuselage was expected to be shorter than the achieved design but this problem was solved by using this larger tail space for storing cargo and hence making it useful.

Since this is only a conceptual design, it can still be further improved. The prospects may include stability and flow analysis of the aircraft. Further modifications can also be made such as a ram effect assisted take-off by making the airflow from propellers assist in lifting the aircraft off the surface.

Figure 2: Final Design of the GEV

V CONCLUSION

In conclusion, this report includes the conceptual design of a ground effect aircraft from nose to tail. This new aircraft which used ground effect to its advantage has the potential to revolutionize how we perceive transport over water and lead to a faster and more cost-effective method of travelling distances that are too short to be serviced by aircrafts economically and take longer time using boats or ships. This will lead to the increased flow of tourists and revitalize travel destinations on islands. Future research can be carried out and this design can be better by using the methods suggested above.

VI REFERENCES

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