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CFD Analysis of Drone Blade

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Abstract: *Drone technology is seen to be rapidly advancing in various fields and applications including photography, military, transportation, sports, and many more. Therefore, each drone design requires different aerodynamic requirements, which includes different types of propeller designs. By revolving and generating airflow, the propellers give drones or unmanned aerial vehicles (UAV) a lift force or thrust. This paper presents a novel integrated study of the aerodynamic performance and acoustic signature of different propellers with a specific focus on the blade twist angle effect. Designed using CATIA V5 and computational fluid dynamic (CFD) simulations were utilized to examine and compare the aerodynamic performance, Drag and Lift between different shapes of the drone propellers. Therefore, this work falls on the study of the aerodynamic effect of different drone blades*

Keywords: Computational Fluid Dynamics(CFD),Aerodynamics, CATIA V5, UAV

I. INTRODUCTION

Drones or UAVs have gained significant attention for them in recent years due to their versatility and potential applications across various industries. One crucial aspect of drone design is the aerodynamics performance of the propeller blades, as it directly affects the efficiency, stability and maneuverability of the drone. Traditional methods of aerodynamics analysis, such as wind tunnels, are often too expensive and time consuming. Computational Fluid Dynamics (CFD) has emerged as a powerful tool for simulating airflow around complex geometries offering a cost effective and efficient alternative for aerodynamics analysis. With the advent of Computational Fluid Dynamics(CFD), engineers can delve deeper into the intricacies of airflow around drone blades, leading to more refined design and improved flight characteristics.

II. SIMULATION METHODOLOGIES

Project Statement: This study centers on the comprehensive CFD analysis of drone blades to understand aerodynamic performance, including lift, drag, pressure to enhance the stability and the flight time of the drone.

CFD simulation of drone blade analysis typically involves the following steps.

Geometry Creations: The drone blade geometry is modeled using CATIA V5 software.

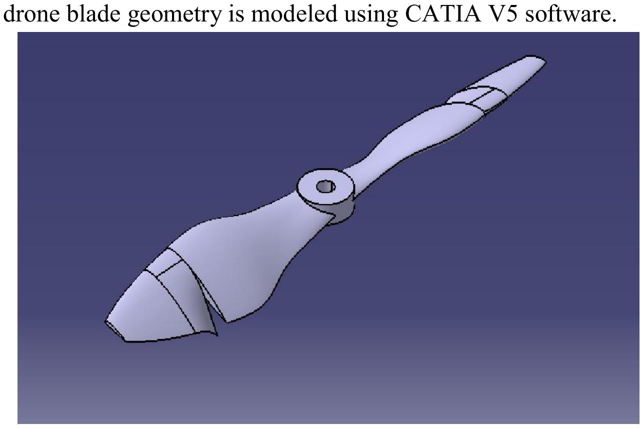

Fig1: Drone blade with a cut

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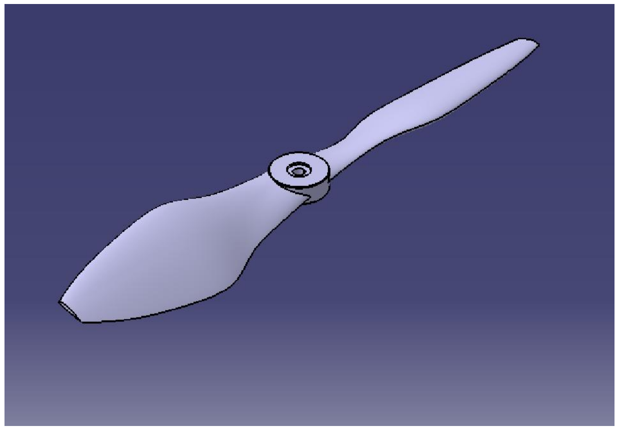

Fig 2: Drone blade Without a cut

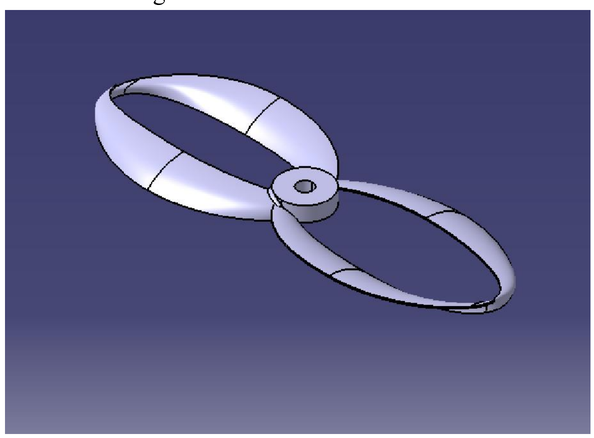

Fig 3: Toroidal blade or Infinity blade

Mesh Generation: Meshing is a critical step in CFD that involves dividing the computational domain into smaller, discrete elements. These elements form a mesh , which serves as a framework for solving the fluid flow equations.

A computational mesh is generated around the blade geometry, dividing the fluid domain into elements.

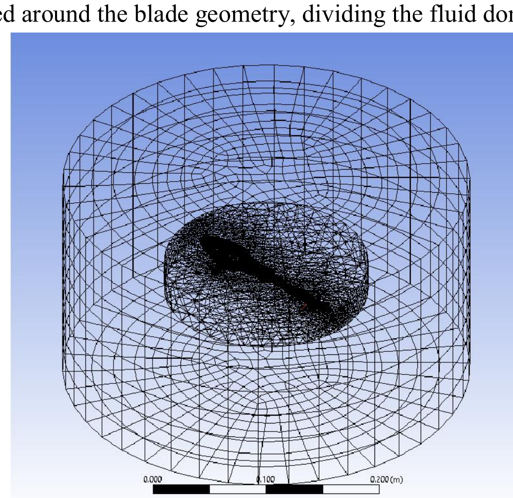

Fig4: Meshing of drone blade with a cut.

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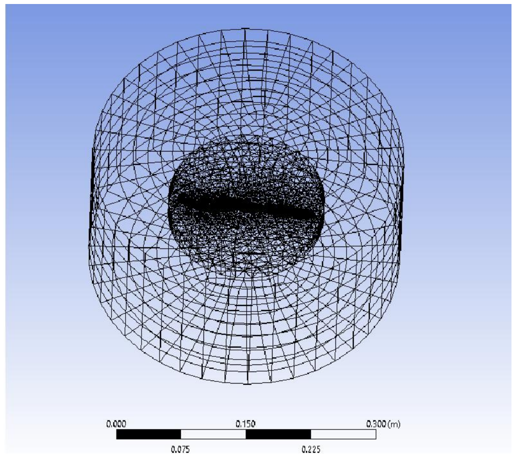

Fig 5: Drone blade without a cut.

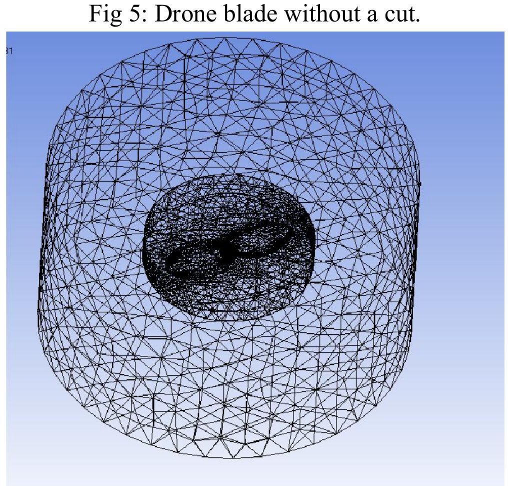

Fig 6: Toroidal blade or infinity blade

Boundary Conditions: Inlet and Outlet conditions are specified along with boundary conditions for blade surface.

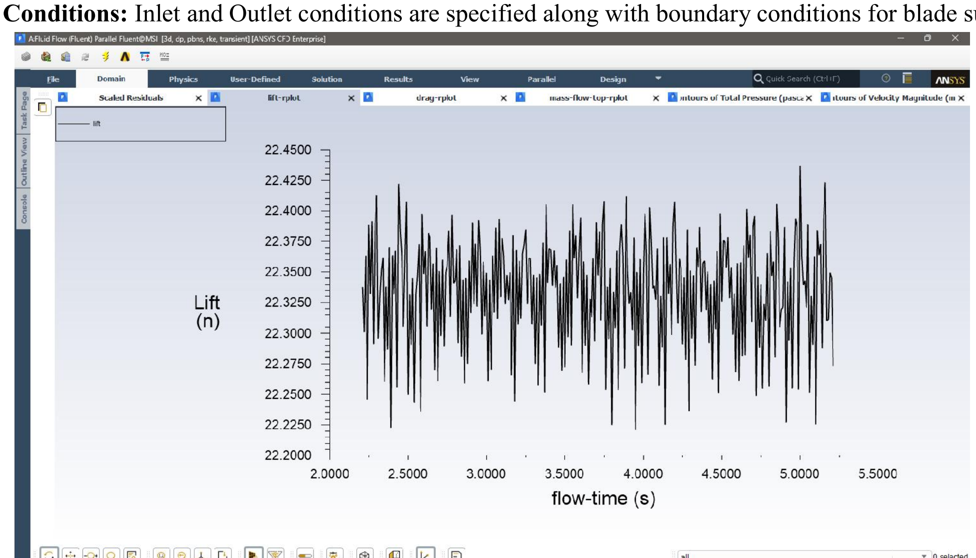

Fig 7: lift graph for blade without a cut

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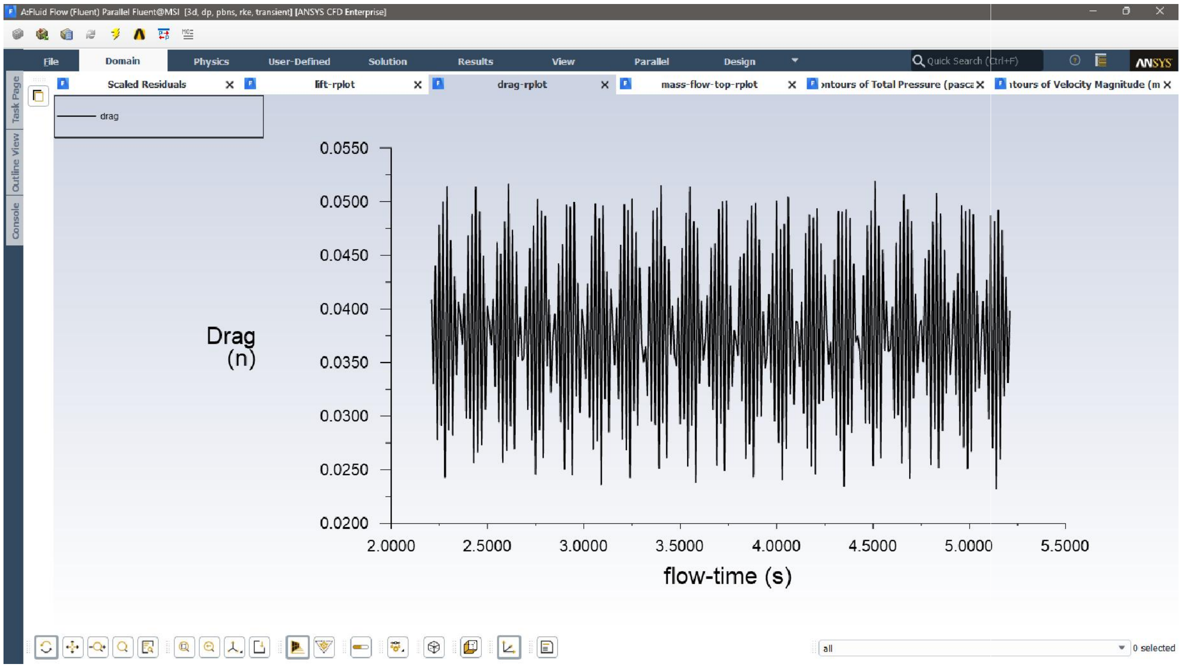

Fig 8: drag graph for blade without a cut

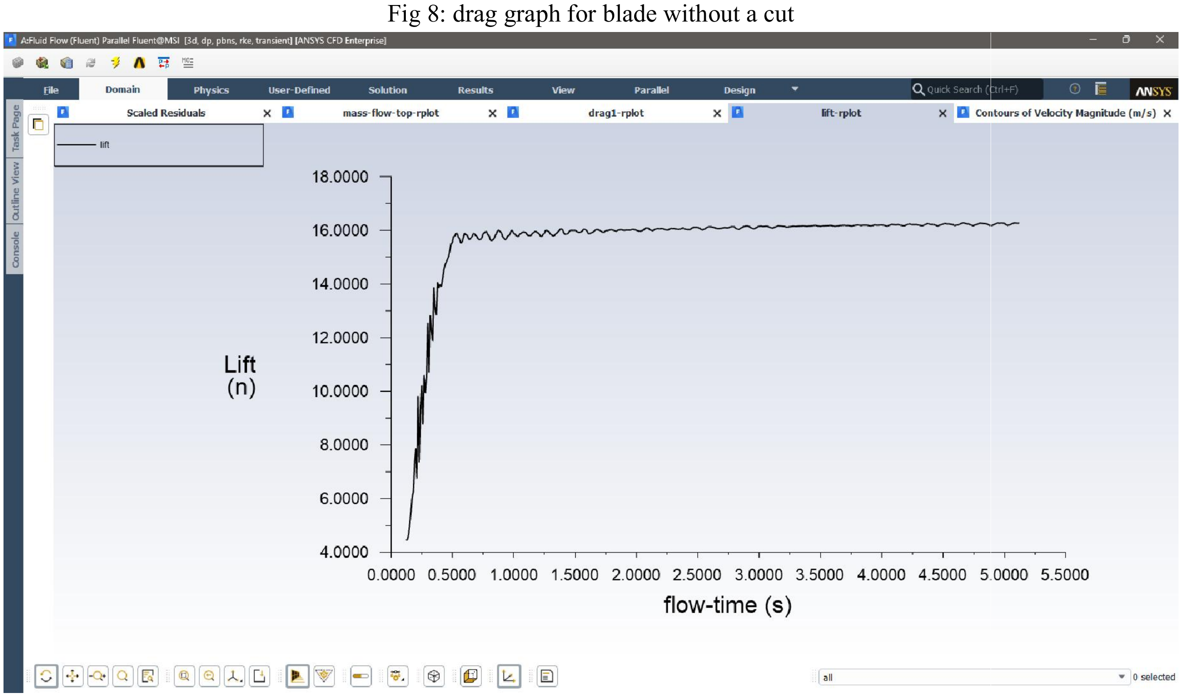

Fig 9: lift graph for blade with a cut

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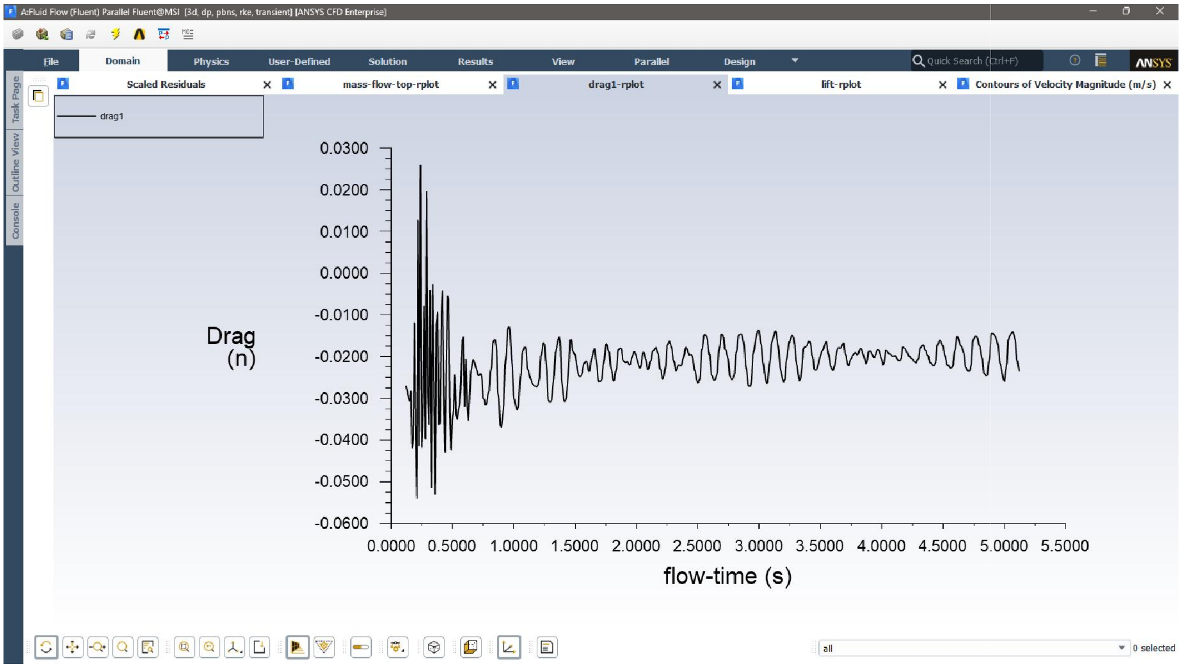

Fig 10: drag graph for blade with a cut

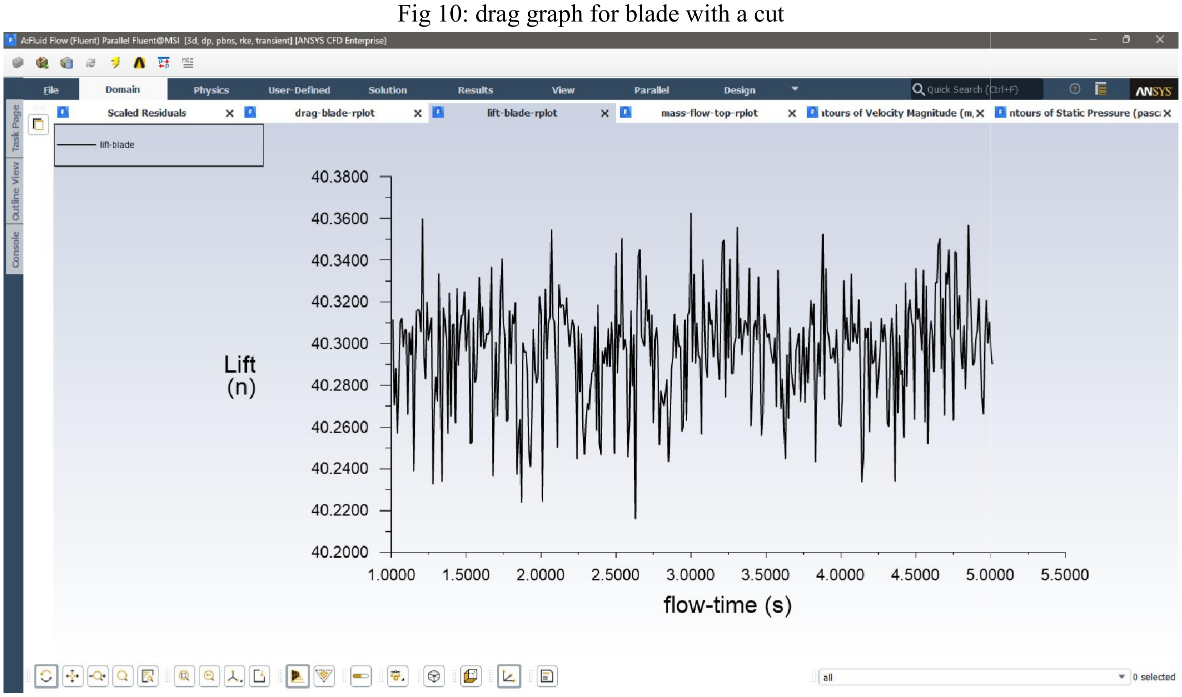

Fig 11: lift graph for infinity blade

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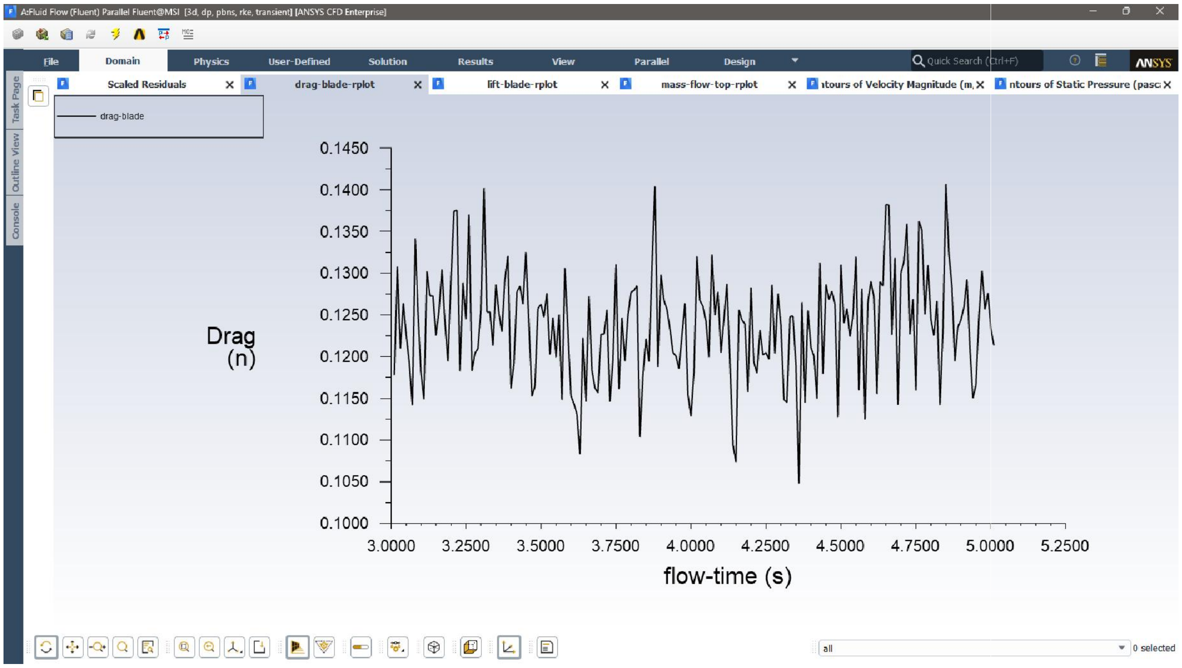

Fig 12:drag graph for infinity blade

Solver Setup: Appropriate solver setting is chosen.
Post Processing: Results such as lift, drag, pressure distribution, are analyzed to access the aerodynamic performance of the designed blade.

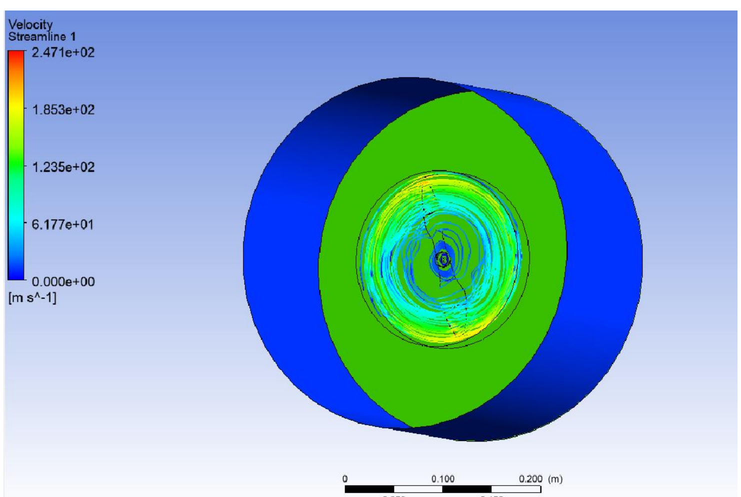

Fig 13: velocity streamline result for blade with a cut

Result values after the CFD analysis on blade with a cut are:
Drag: -0.0235509 [N]
Lift: 16.2638 [N]
Angular Velocity: 5000 rpm

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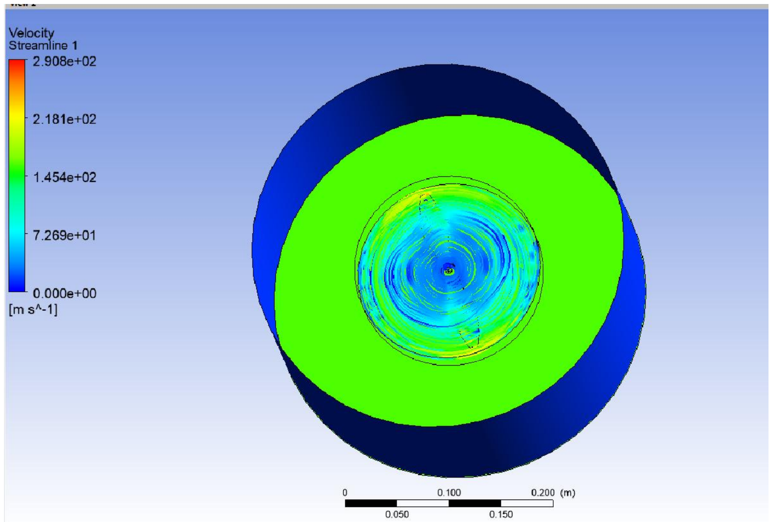

Fig14: velocity streamline result for blade without a cut

Result values after the CFD analysis on blade without a cut are:
Drag: 0.0395566 [N]
Lift: 22.3226 [N]
Angular velocity: 5000 rpm

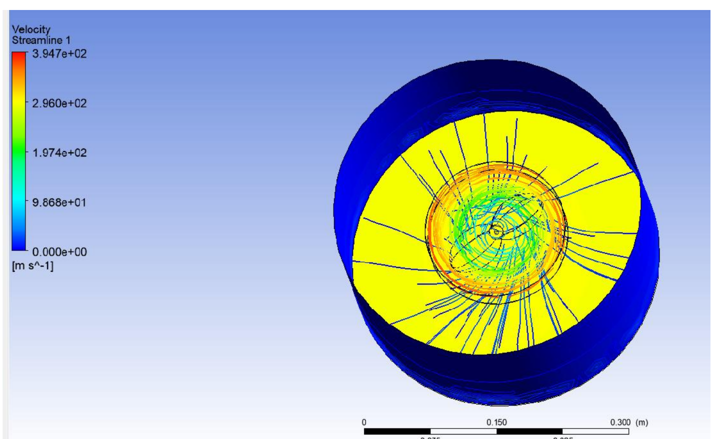

Fig15: velocity streamline result for infinity blade

Result values after the CFD analysis on Infinity blade are:
Drag: 0.121345 [N]
Lift: 40.2901 [N]
Angular Velocity: 5000 rpm

III. CONCLUSION

As from the current data we can conclude that the blades that we have designed are better and more efficient than the blades that are currently being used in the drone industry. The blade with a cut has less drag as compared to the blade without cut (i.e the blade which is currently being used in the drone industry). And the infinity blade has some mind blowing results which shows that the blade has very high lift upto 40N and has a very less drag. So per the data the blade with a cut can be used for small scale drone functions and the infinity blade can be used for heavy duties.

IV. ACKNOWLEDGMENT

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