RC Hovercraft

The aim of this project was to design, analyse and manufacture a fully working small scale model of a remote controlled hovercraft.

Step 1
- Design the geometric model for the hull.

Step 2
- Calculate the aproximate weight of the model.
- Calculate the lift required.
- Calculate required CFM of propeller.

Step 3
- CFD analysis to verify if momentum curtain is being formed
- CFD analysis to gauge possible effects of using Plenum theory

Step 4
- Designing the RC circuit
- microcontroller programming

Step 5
- Fabrication and testing of Design proposed

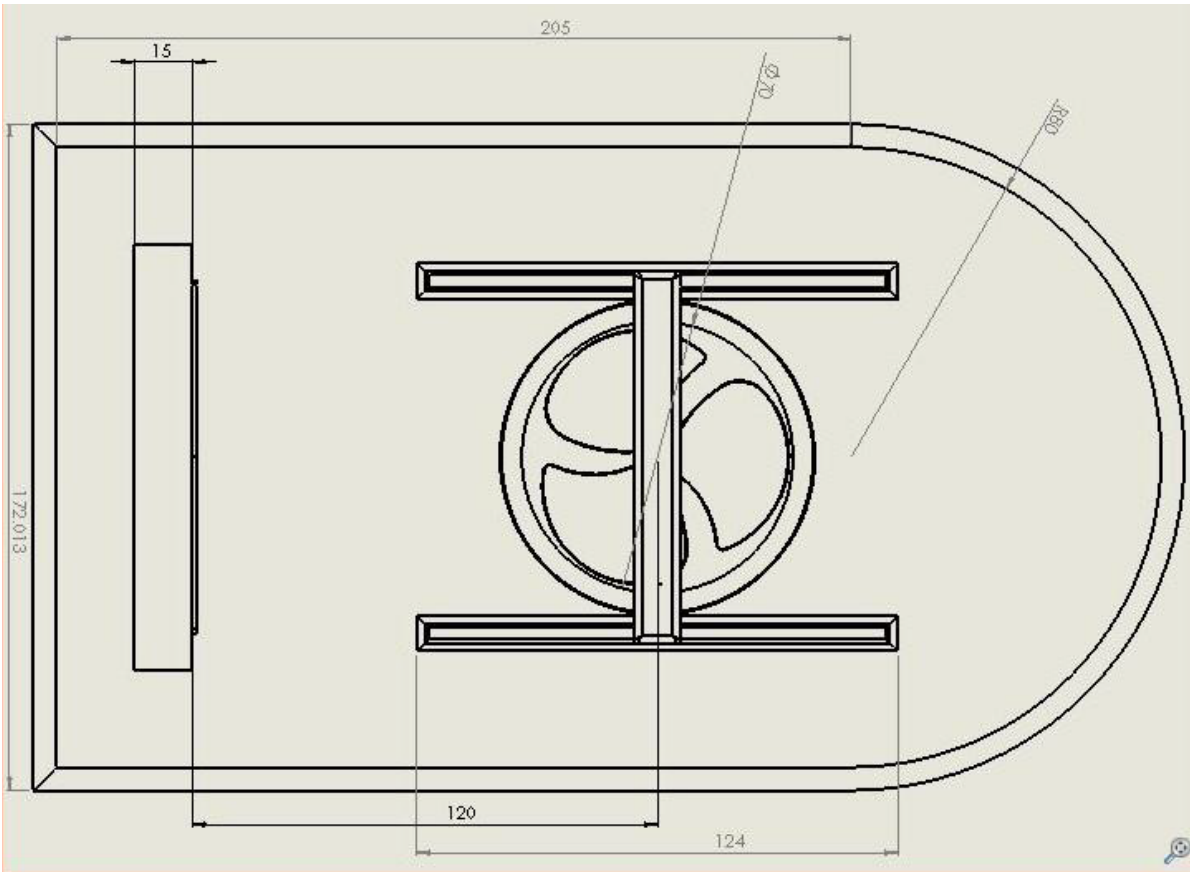
Functional Decomposition:-

Lift - Hull propeller is used to propel air in the nylon skirt thrugh the hull, which contains the air and forms an air cushion beneath the hovercraft

Thrust - A thrust propeller is bounted on the back of the body which is used to generate the thrust required for hovercraft movement

Steering - A rudder is installed behind the thrust propeller which is used to steer the hovercraft. The rudder is controlled using a microcontroller which can receive input remotely using a radio transmitter-reciever

Design and Analysis



Hull Design Dimensions

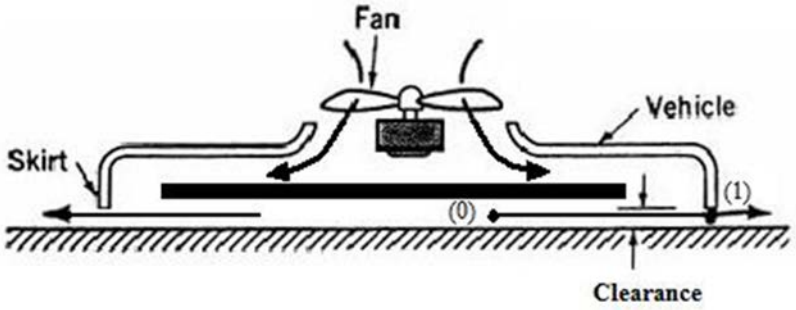
Calculations

Base Area= 45313 mm^2
Perimeter= 833 mm
Pressure required in air cushion for hovering= Weight/Area

If Weight=5kg,
Pressure=1081 Pa

If Weight=10kg,
Pressure=2163 Pa

Applying Bernolii's Theorm:-



$$\frac{P_0}{\rho} + \frac{{v_0}^2}{2g} + z_0 = \frac{P_1}{\rho} + \frac{{v_1}^2}{2g} + z_1 \quad \forall \quad v_0 = 0,\ z_0 \approx z_1,\ P_2 = 0$$

$$\therefore\ v_1 = \sqrt{\frac{2P_0 g}{\rho}} \quad \forall \quad \rho = 1.225\ kg/m^3$$

When weight=5kg
Leakage air velocity=132m/s

When weight=10kg
Leakage air velocity=186m/s

Leakage volumetric flow rate (LVFR) = Perimeter x Clearance x Leakage Air

If Clearance= .5 mm
Weight= 5 kg
LVFR= .055 m^3/sec

If Clearance= 2 mm
Weight= 5 kg
LVFR= .22 m^3/sec

If Clearance= .5 mm
Weight= 10 kg
LVFR= .0775 m^3/sec

If Clearance= 2 mm
Weight= 10 kg
LVFR= .31 m^3/sec

Inlet Area= 3850mm^2
Inlet velocity= LVFR/Inlet Area Inlet
Volumetric flow rate (Cubic Feet per min) = LVFR x 35.315 x 60

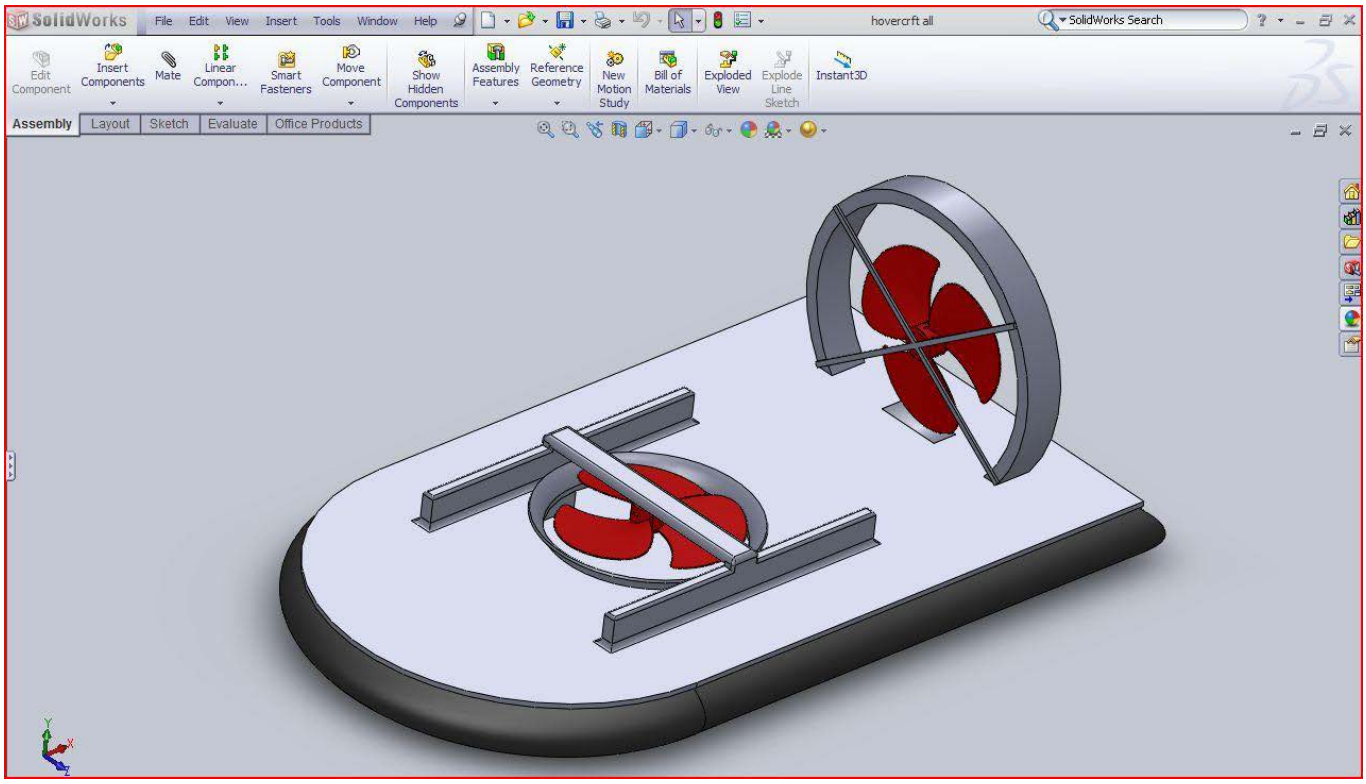
Inlet velocity= 14m/s
CFM= 117

Inlet velocity= 57m/s
CFM= 466

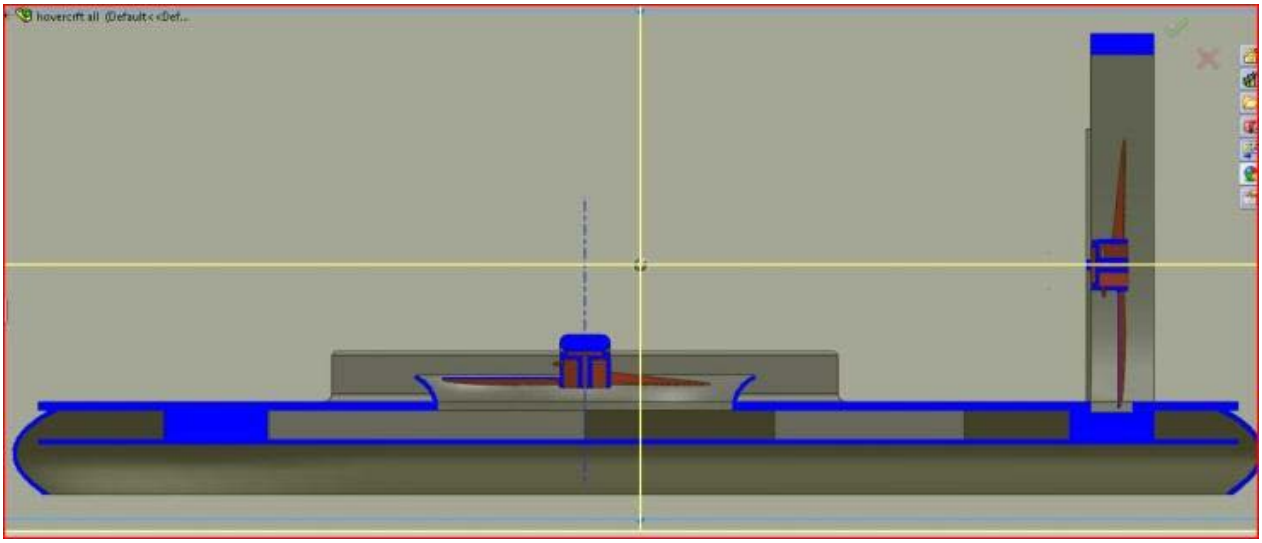
Inlet velocity= 20m/s
CFM= 164

Inlet velocity= 80m/s
CFM= 657

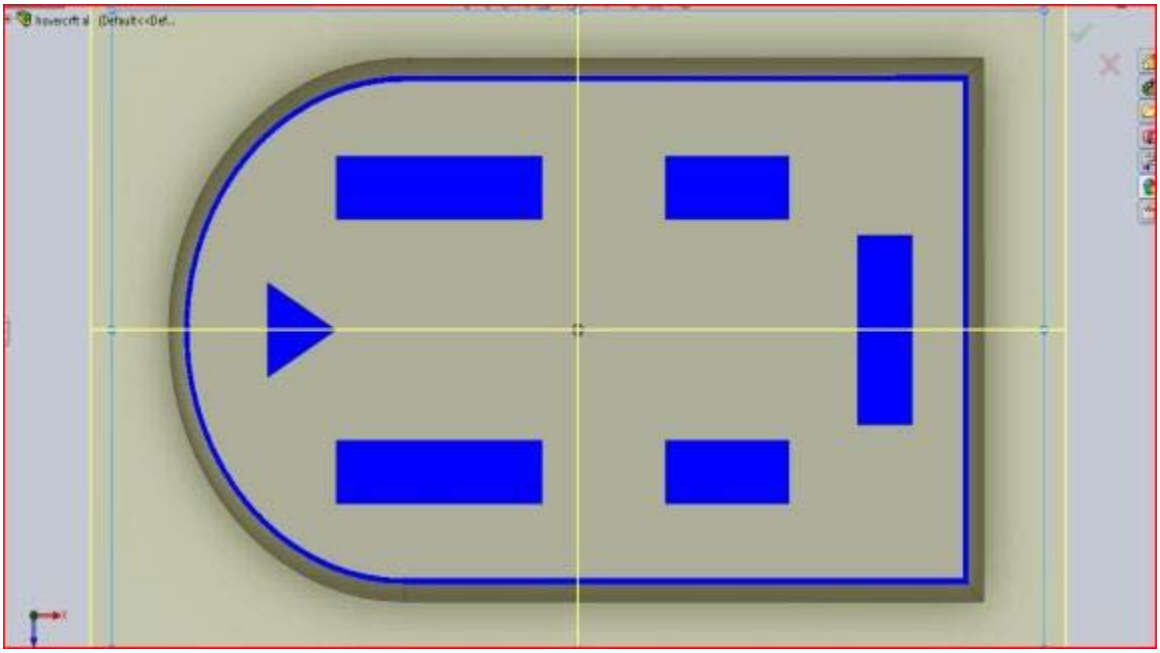
The CFM calculated was used to estimate the specifications of Lift Propeller and Motor.

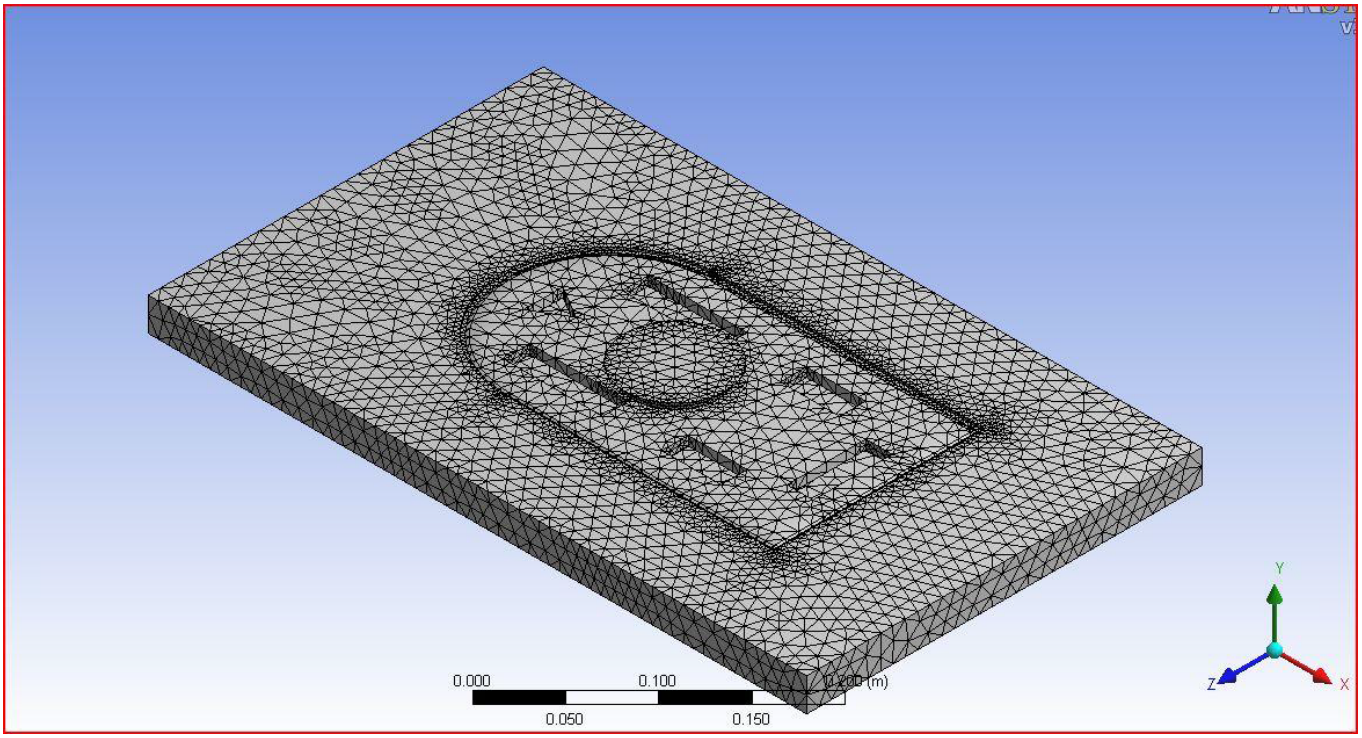


CAD model



Cut Section Views

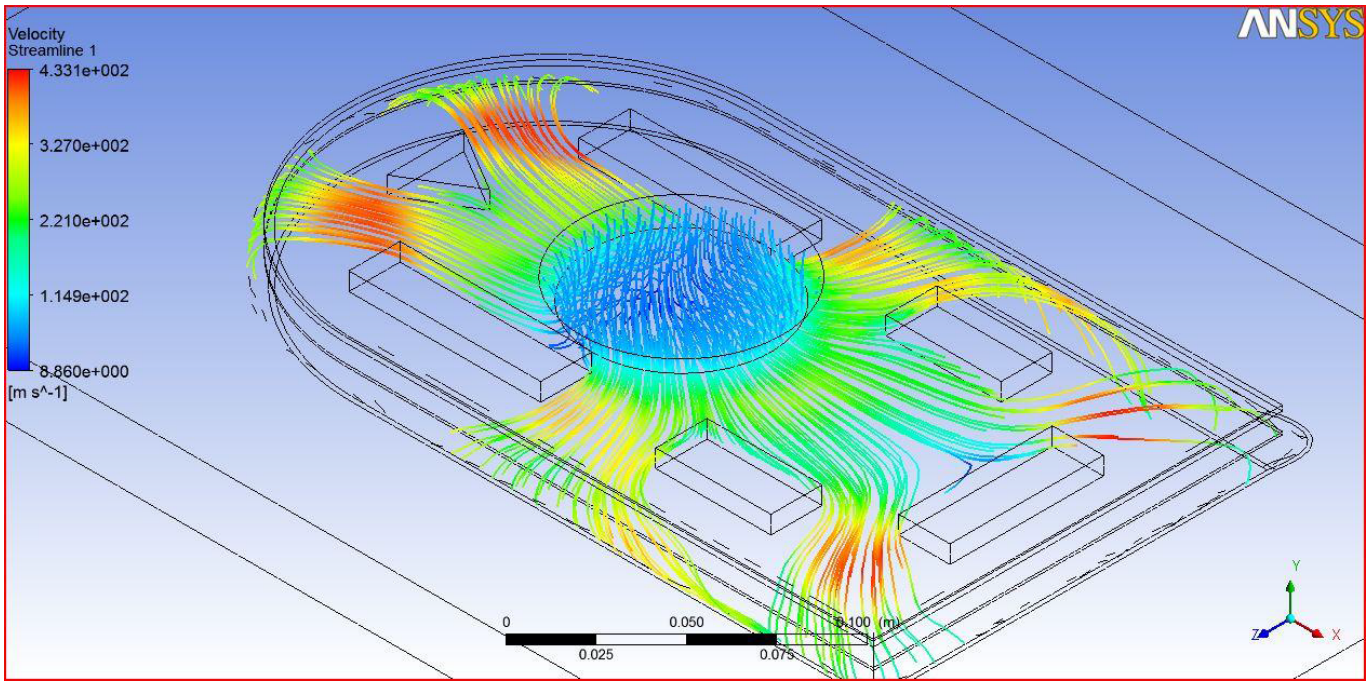




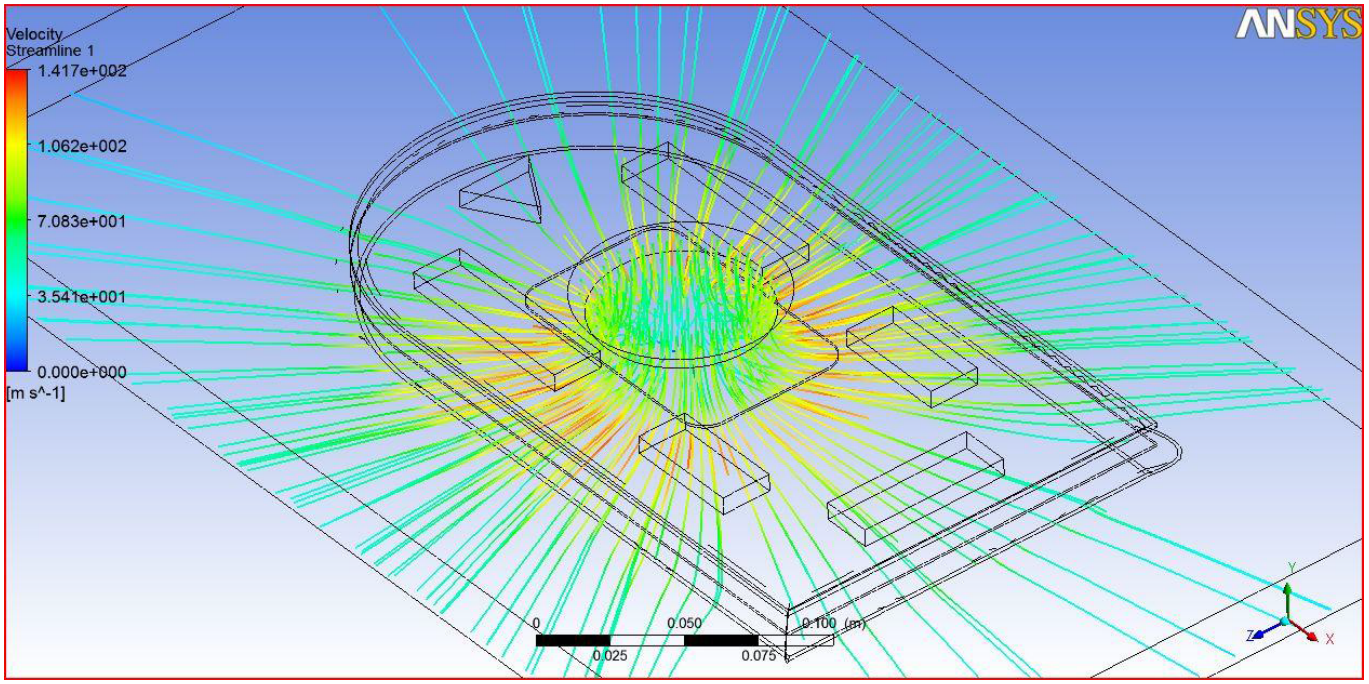
Meshed internal Air Volume of Hovercraft

Meshing conditions for Air Volume for Momentum Curtain Theory and Plenum Theory:-
Tetrahedral mesh with boundary prism elements
Default body spacing (maximum)- 0.01
Default face spacing (minimum & maximum edge length)-0.001 and 0.02

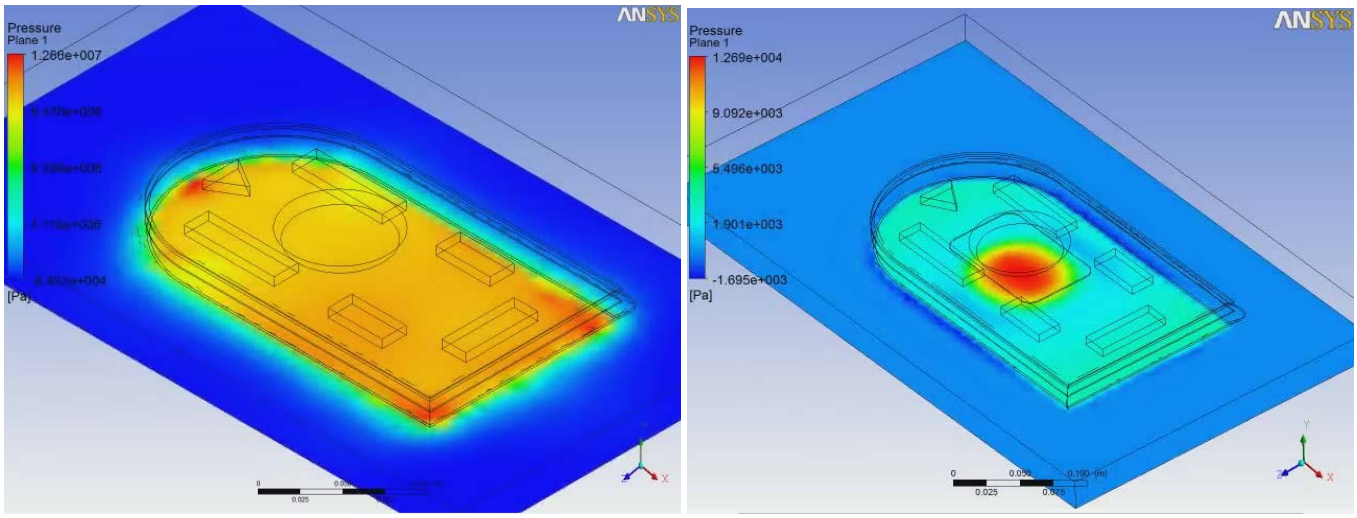
Boundary conditions to model CFD analysis for Momentum Curtain Theory and Plenum Theory:-
Inlet – 0-60m/s transient state
Floor and hovercraft body – no slip wall condition
Surrounding – open to atmosphere



Plot of streamlines for Momentum Curtain Theory



Plot of streamlines for Plenum Theory



Pressure distribution contour for Momentum Curtain Theory and Plenum Theory

Fabricated model before installing Rudder, Microcontroller and Battery