CONTROL OF FLAPPING MAV PROTOTYPE

# DESIGN CREDIT

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# DESIGN/PRACTICAL EXPERIENCE [EEN1010]

## Department of Electrical Engineering

(End-Term Report)

Academic Year: 2022-2023
Semester: 3

Date of Submission of Report: 28-11-2022


1. Name of student: Anupam Verma
2. Roll number: B21EE007

3. Title of the project: Control of flapping MAV prototype
4. Project category: Category 3-Semester project

# Background:

Stage 1: Learned solid works, fusion 360, arduino and made several initial prototypes:

Stage 2: Study of literature/research papers:

Rigorously went through numerous research papers studying different parameters related to Micro Air Vehicle (MAVs). Understood the mechanism, flight controls, mathematics of the models and other aspects.

Stage 3&4:

By the end of semester, we decided upon the mechanism we would use, we also finalized different components required to fly like the batteries, PWM controller, servos, carbon rods and other components.

# AIM:

Control of flapping MAV(Micro Air Vehicle) prototype

# METHODOLOGY:

Decided upon the mechanism and dimensions of various components and started making it in Solidworks.

A collage of all the different components designed by us on Solidworks can be seen on the next page.

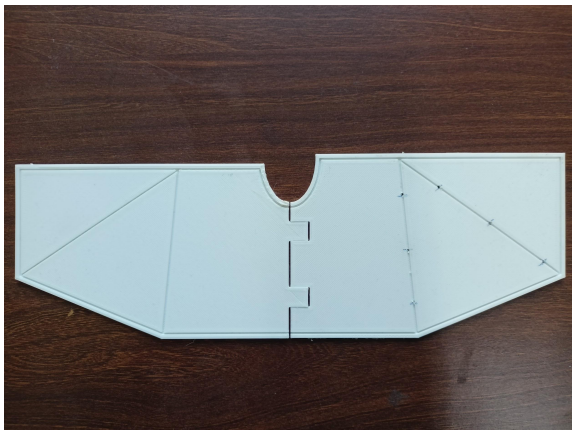
After the completion of designing components, the entire assembly was printed through a 3d printer and some parts are ordered and a number of simulations of the same were run.

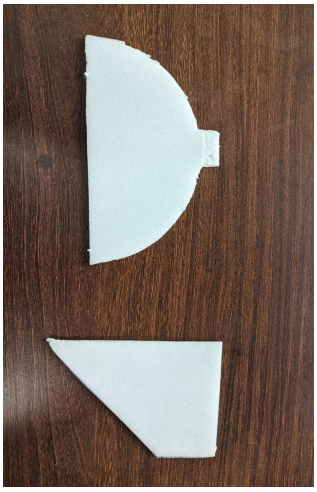
We then started making engineering drawings of each component, for the purpose of fabrication.

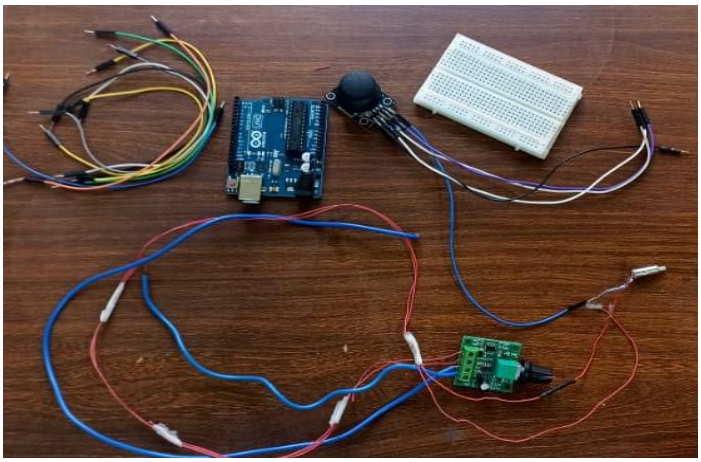
Further, all the parts were ordered and assembled at the Flapping Wing laboratory, IIT Jodhpur, and a real working prototype was made.

The work is shown on the following pages.

A collage of different components of our final assembly:

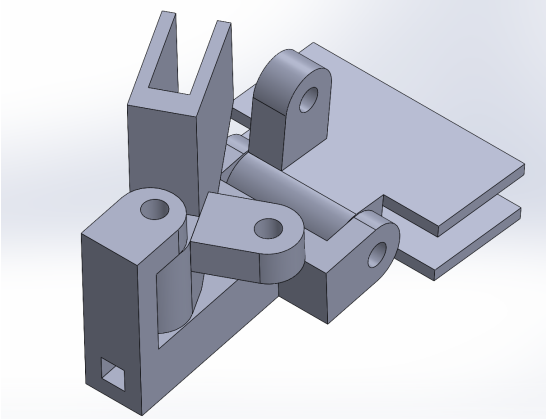


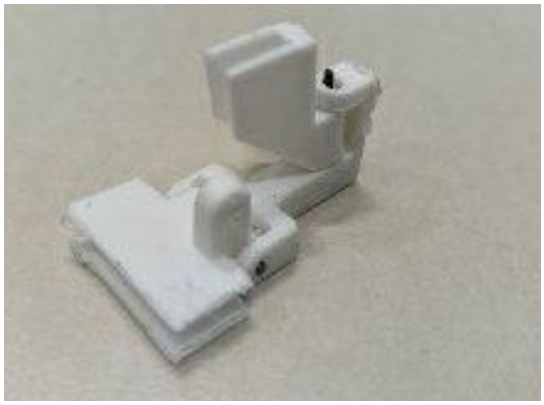




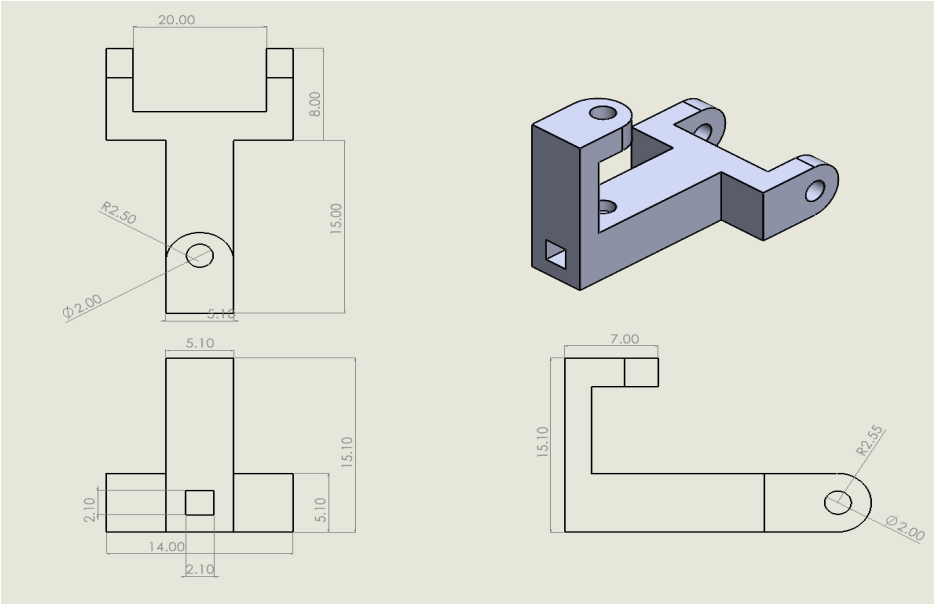
## Description of Tail

This is complete assembly of tail





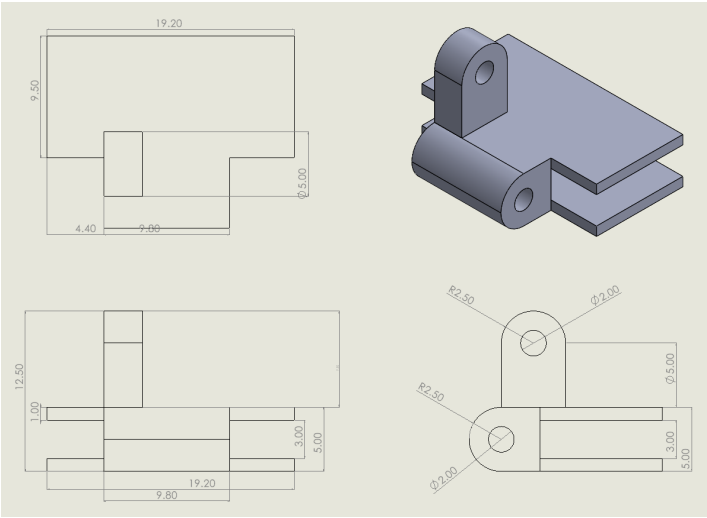
We have attached engineering drawings of components of final tail assembly, description and their functioning

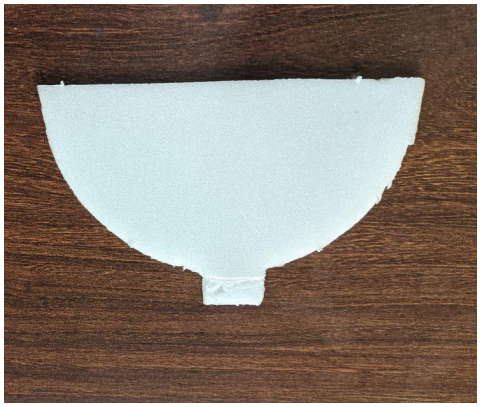



This is the part of assembly which is connects the flapping mechanism and tail mechanism

Tail

**Elevator:**



3D printed ElevatorSupport

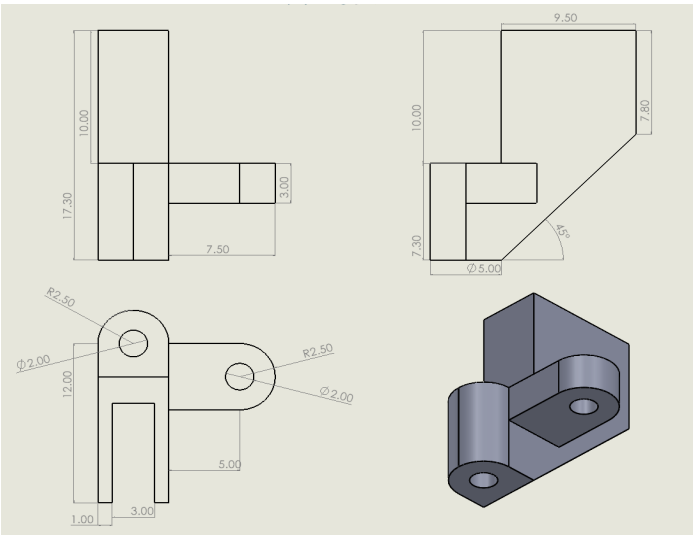
Elevator made up of Depron sheet

The Elevator is a primary control surface which is responsible for controlling rotation about the lateral axis of MAV (Responsible for pitch Movement)

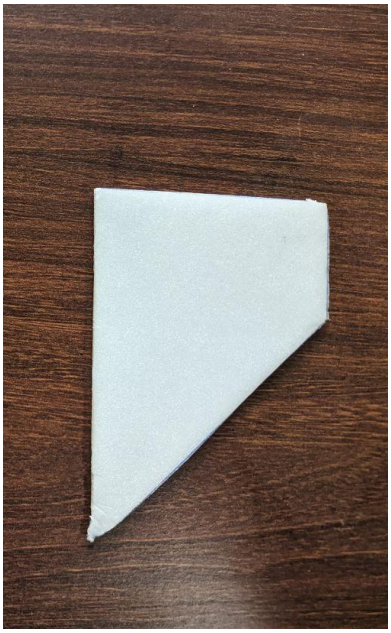
This is a movable surface that is fixed in the horizontal hinge of the connecting part shown above.

Eg. how shark uses its fin for changing its direction

**Rudder:**




3D printed rudder support



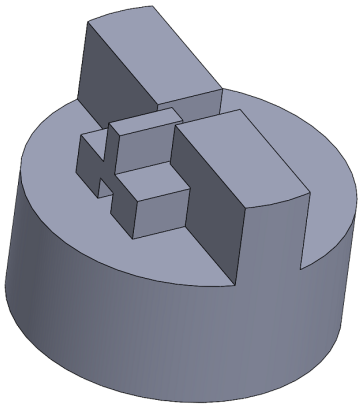
Rudder(Made up of depronsheet)

The rudder is a primary control surface which is responsible for controlling rotation about the vertical axis of MAV (Responsible for yaw Movement)
This is a movable surface that is fixed in the vertical hinge of the connecting part shown above.

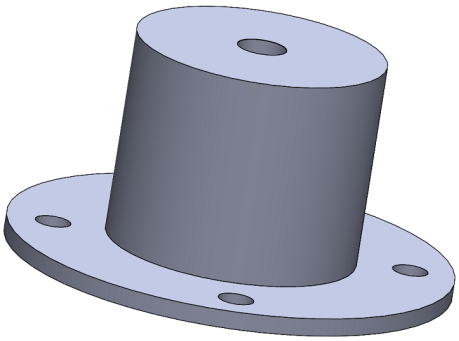
We made a supporting stand for testing how our tail is functioning (for both rudder and elevator)

Supporting stand

ball and socket joint



Upper cap to fix MAV on it. (removable)



Lower part to fix it on mount base

## Why we choose servo motor over other motor

- Servo motor offers low weight and fast response
- Very accurate rotation within limited angle
- It produces high torque
- It can be used to produce linear motion
- Efficiency is high
- Reliability is high

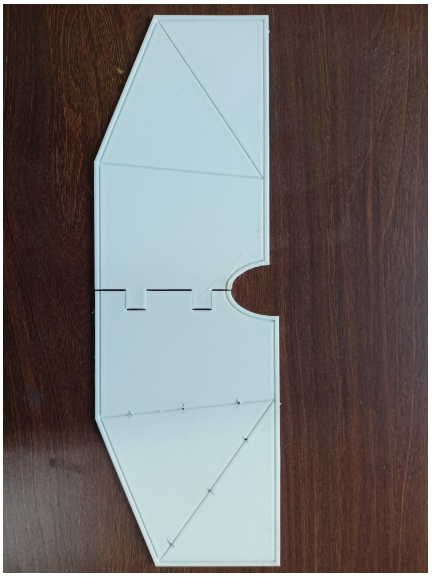
## Arduino

- We use Arduino UNO over Arduino Pro Mini  because Arduino UNO operates at the voltage of both 3.3 and 5V while Arduino Pro Mini operates at the voltage of 3.3V and our linear servo motor needs voltage between 3.7V-5V
- We made  the connections on breadboard and then operate the servos through joystick
- Joystick was controlled by an Arduino( we wrote a C++ code to operate it).

## The wings:

The current wings are made out of “Mylar” of thickness 4 micrometers. These wings were cut from the roll with a special technique. Initially a rough rectangular sheet was cut. After that It was kept on a 3-D printed mold which mounted on a box which was made air tight.

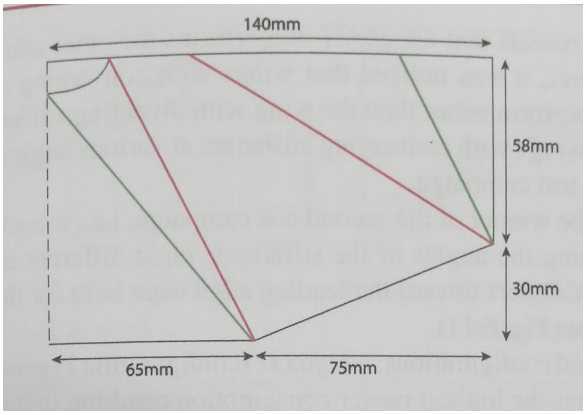
Further ahead, the box was vacuumed using a vacuum cleaner which in turn fixed the mylar sheet on the mold. This helped us to cut the sheet when the sheet was held tightly to have a perfect finishing to it.



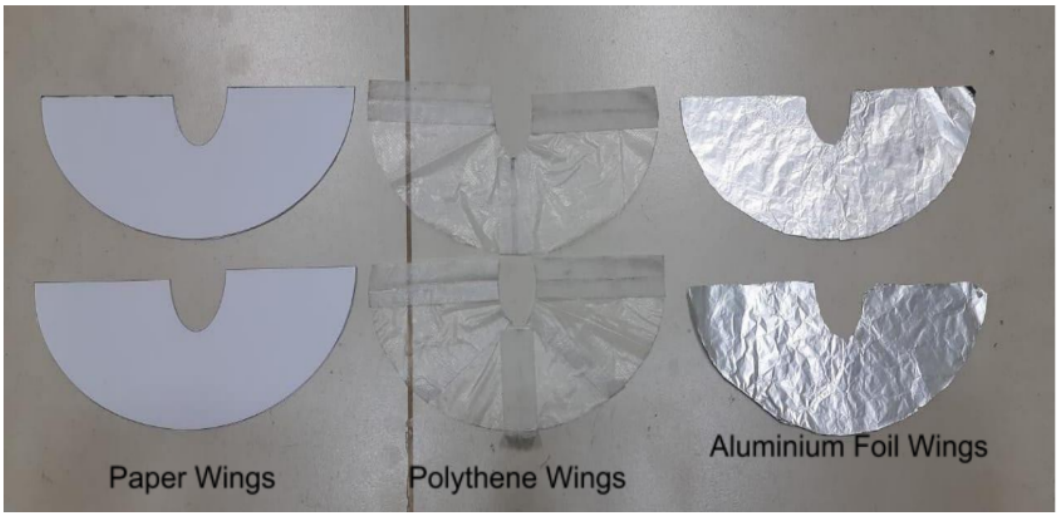
To provide firm strength, carbon rods were used which were circular and its size was 1 mm and 0.6 mm. The advantage of this is that it is light weighted.

The 1 mm rods are used to connect the wing to the mechanism which is responsible for the flapping movement.

The 0.6 mm rods are placed in a way that they provide maximum structural rigidity so that the wing generates maximum possible lift.




The previous design of the wings is given below which were not as effective as the current wings.

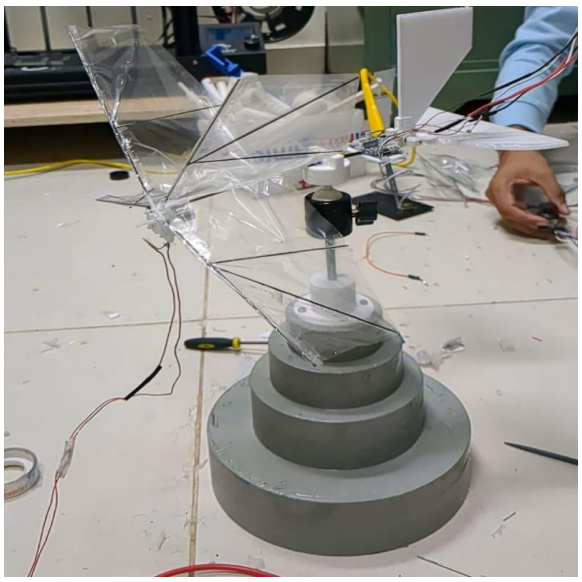


## Detailed specifications of the components we used were:

1. We use three AAA batteries
2. Motor: 6mm, 615 coreless DC motor.
3. PWM controller: 1.8V – 12V/2A DC Motor PWM Speed Regulator
4. Mylar wings of 4 microns
5. Carbon rods : 1mm and 2mm square carbon rods were used.
6. Push rods: 1mm
7. Linear servo motor: 1.5gram
8. Arduino Uno, Breadboard, Jumper wires,Dual-axis XY joystick
9. Depron Sheet: 3mm, 5mm

# CONCLUSION:

We were successful in making control of the flapping wing MAV. We conducted tests and validated it on a test stand and also tested it by hanging it by thread, the videos of the same will be shown at the presentation.



# REFERENCES:


- https://www.researchgate.net/publication/322308887_Studying_the_Effect_of_the_Tail_on_the_Dynamics_of_a_Flapping-Wing_MAV_using_Free-Flight_Data
- https://www.delfly.nl/
- https://en.wikipedia.org/wiki/DelFly
- https://link.springer.com/book/10.1007/978-94-017-9208-0
- https://www.researchgate.net/publication/322308887_Studying_the_Effect_of_the_Tail_on_the_Dynamics_of_a_Flapping-Wing_MAV_using_Free-Flight_Data
- https://www.youtube.com/watch?v=xEb9uBQzLP0
- https://www.youtube.com/watch?v=wxbiyjdrifo
- https://www.youtube.com/watch?v=E-HSgDQmuIg
- https://ornithopter.org/software.shtml


## Supervisor's Recommendation for the Evaluation

Please tick any one of the following:

1. The work done is satisfactory, and sufficient time has been spent by the student. The submission by the student should be evaluated in this term.
2. The work is not complete. Continuity Grade should be given to the student. The student would need to be evaluated in the next semester for the same Design Project with me.
3. The work is not satisfactory. There is no need for evaluation. The students should look for another Design Credit Project for the next semester.
4. [Other Comment, if 1-3 are not valid] _____

Signature of the Supervisor