Team Tarkshya

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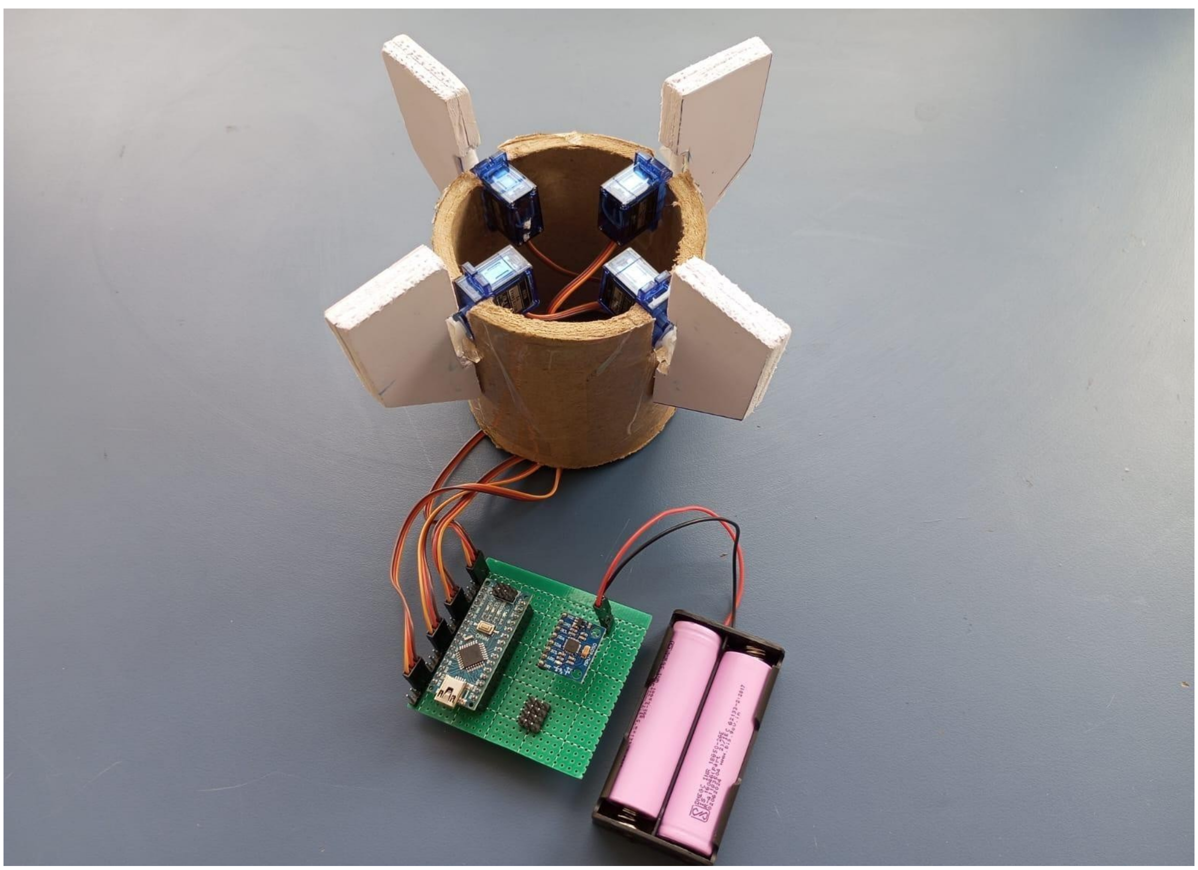
Result of the project:



MOVING FINS

Theory:

Moving Fins are a crucial component of amateur rocketry. Moving Fins helps in precision flight paths and maneuverability of rockets during flight time. Unlike fixed fins, which provide stability but limited control, moving fins can be adjusted during flight to alter direction of the rocket, maintain its stability and perform in-flight maneuvers.

Moving fins are controlled by a guidance system that receives data from sensors like gyroscopes (MPU6050) and accelerometers (ADXL320, ADXL321, ADXL322, ADXL330). This system calculates the necessary fin adjustments to maintain the desired flight path. The fins are then moved using actuators, often powered by hydraulic or electric systems.

Project Objective-

The primary objective of this project is to design and develop an advanced moving fin mechanism for the "VIKAS" rocket, enhancing its aerodynamic control and stability during flight. This mechanism aims to provide precise control over the rocket's trajectory, particularly in phases where traditional thrust vector control (TVC) may be less effective or require supplementary control. The project will contribute to improving the overall performance, efficiency, and reliability of the rocket during both ascent and descent phases.

Thematic Domain-

This project falls within the thematic domain of aerospace engineering, specifically focusing on aerodynamic control systems for rockets. It intersects the fields of mechanical design, control systems, fluid dynamics, and aerospace structures. The innovation in this project lies in the integration of moving fin technology with the existing TVC system, thereby offering a hybrid control mechanism that can adapt to various flight conditions.

Novelty of the Project-

The novelty of this project is the development of a synergistic control system that combines the benefits of thrust vector control with a sophisticated moving fin mechanism. While TVC is effective during the initial launch phase and in high-thrust conditions, moving fins provide superior control during lower-speed phases and in atmospheric flight, where aerodynamic forces become more significant. The integration of these two systems allows for more versatile and precise control throughout the rocket's entire flight profile. Additionally, the project explores the use of lightweight, high-strength materials and advanced actuation systems, which are designed to respond rapidly and with minimal power consumption.

Fin Nomenclature:-

A set of fins (3 or 4) is known as a **finset**. A set of fins manufactured as a single unit, mounted on a cylindrical sleeve that slides over the rocket body, is known as a **fincan.**
Fin Span: This is the length of a rocket fin, measured from the root (where it attaches to the rocket body) to the tip.
Semi-Span: Half the length of the fin span.

Root Chord: The width of the fin at its base, where it connects to the rocket body. Measured along the axis of the rocket.
Tip Chord: The width of the fin at its outermost point, the tip.

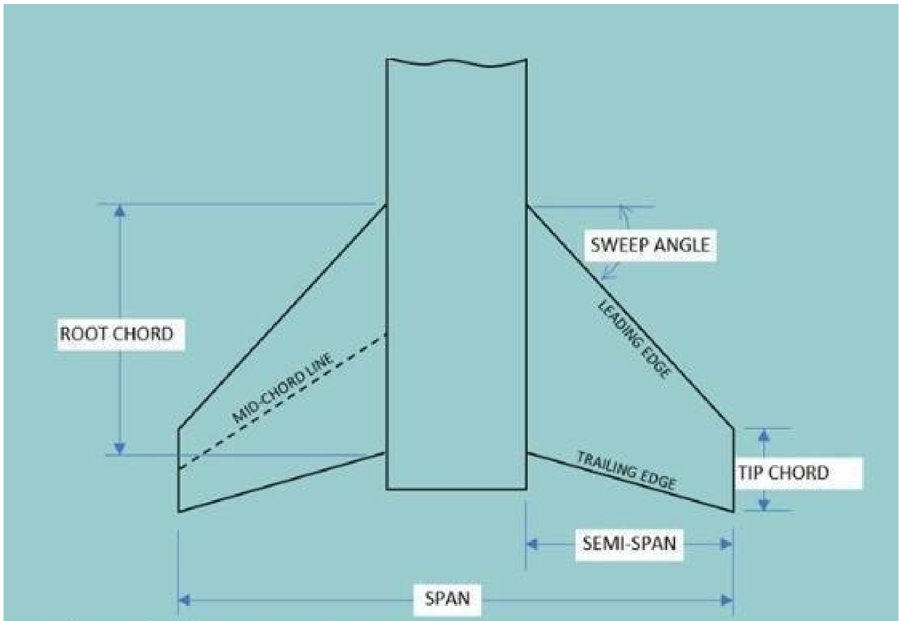
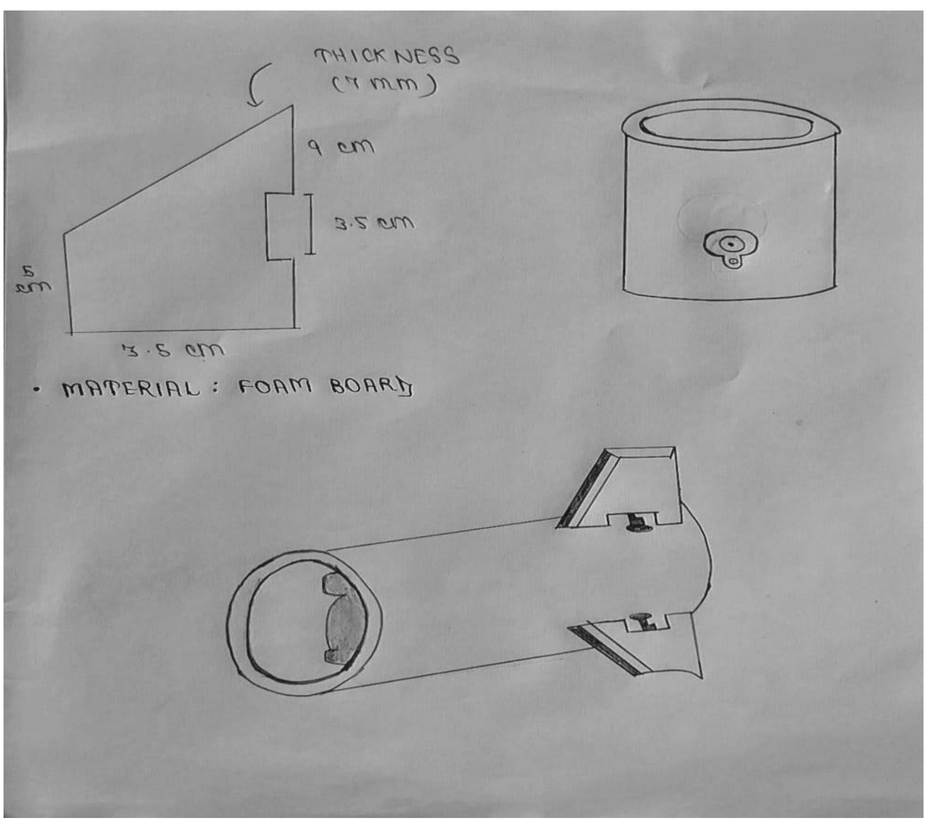


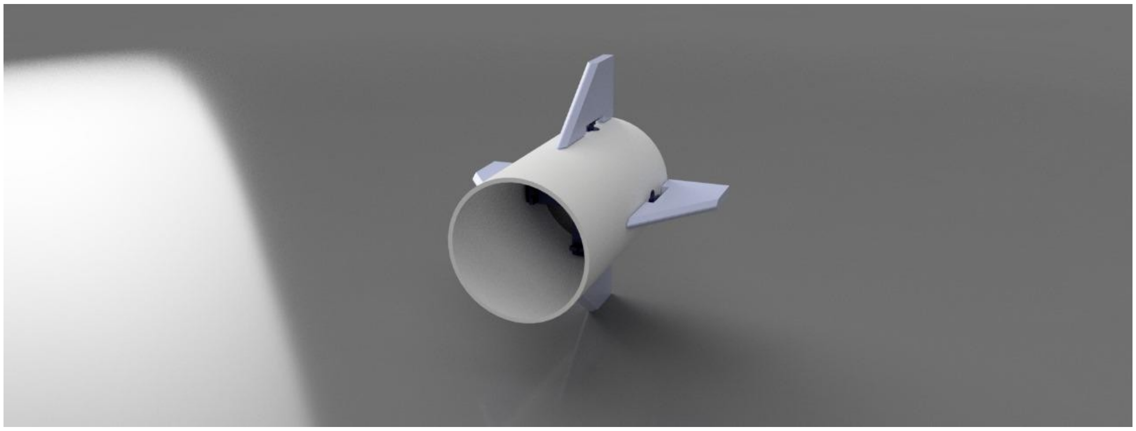
Figure 2: Fin nomenclature

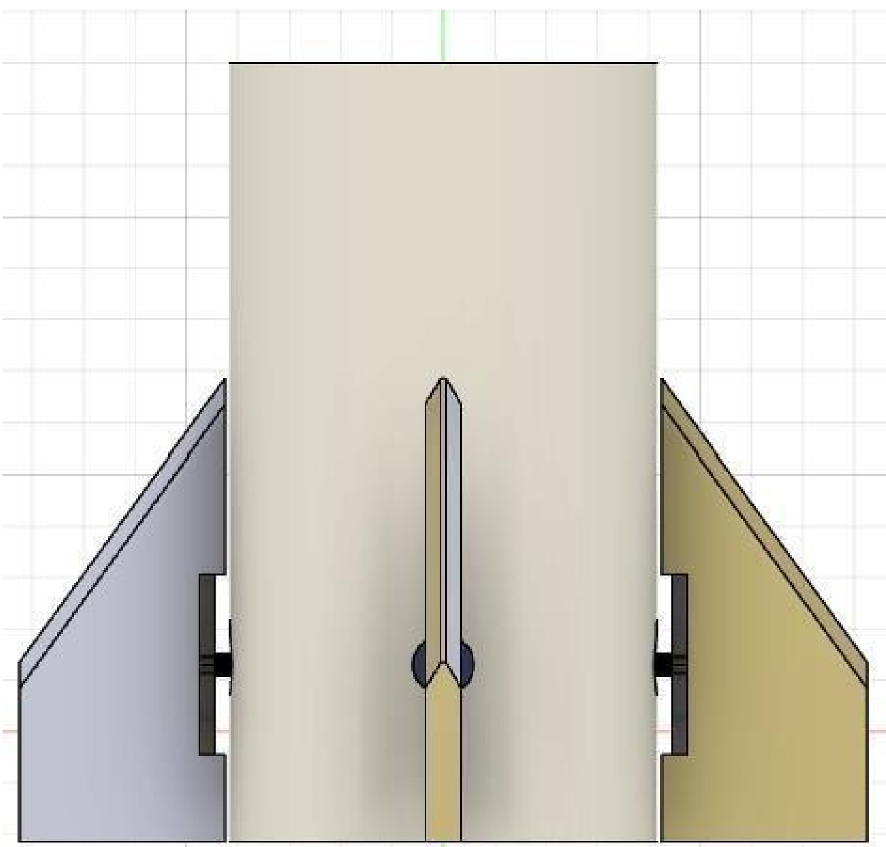
Sweep Angle: The angle between the root chord and tip chord. A positive sweep angle means the tip chord is angled backward relative to the root chord.
A negative sweep angle means the tip chord is angled forward relative to the root chord.

CAD Design/Series of Operations:

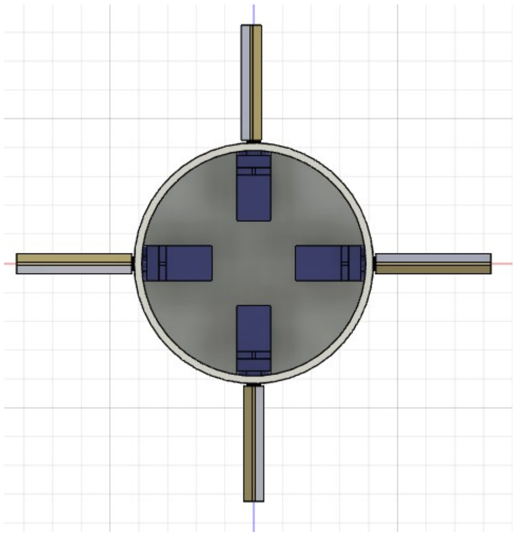


- **CAD Model Was Developed**

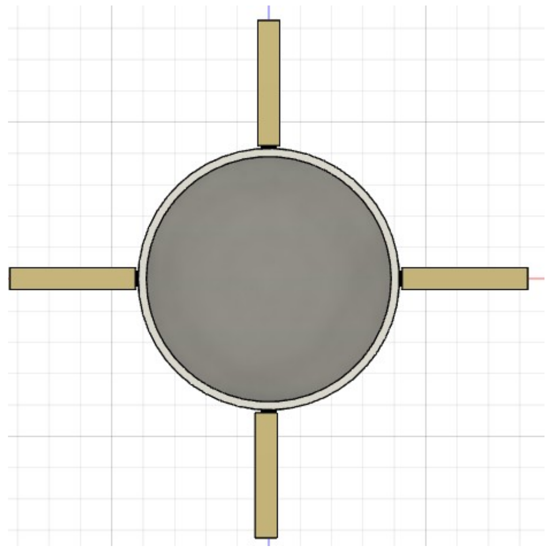




Front View



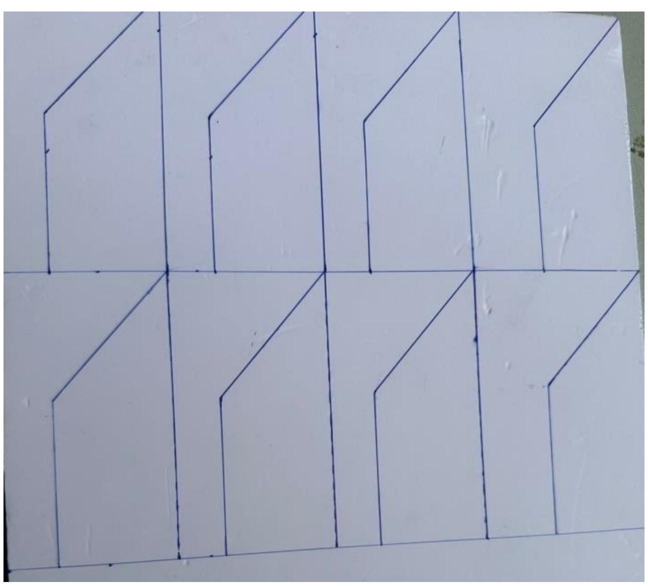
Top View



Bottom View

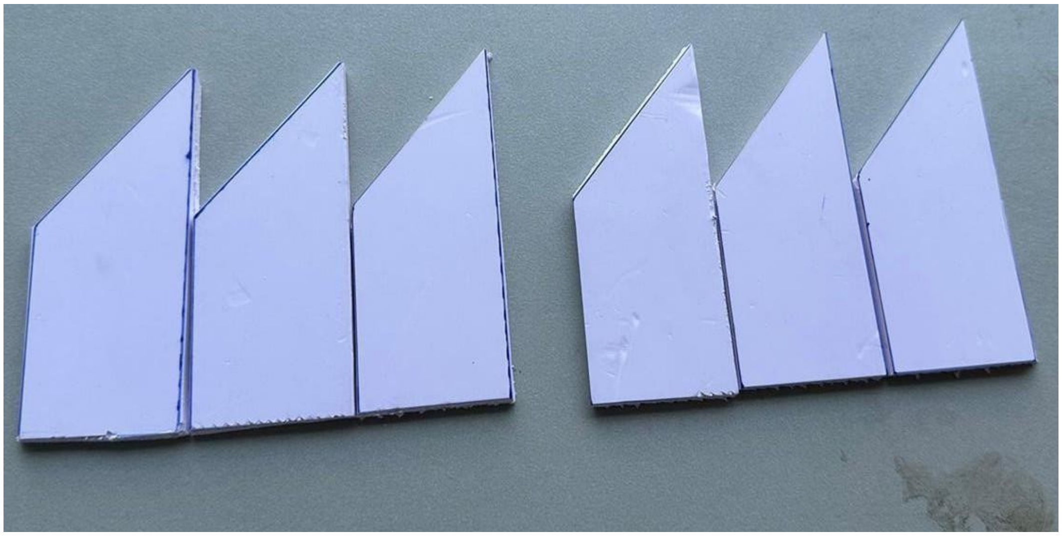
Making Of fins:

1.



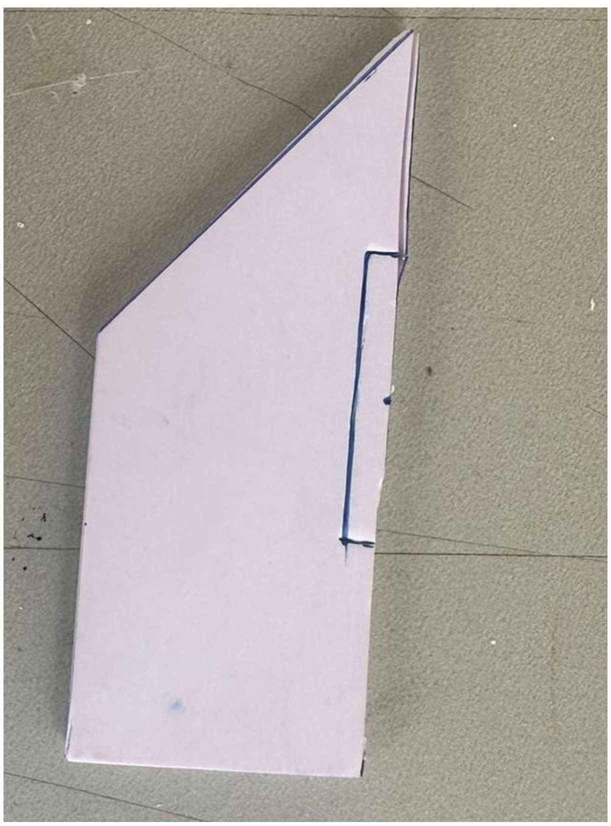
8 fins were sketched on foam board with the calculated dimensions.

2.



Fins were then cut from the foamboard using a cutter.

3.

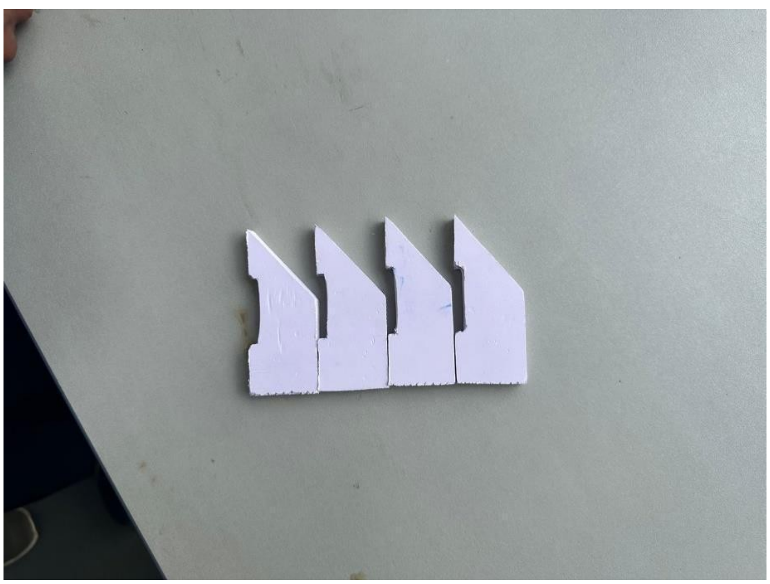


Creating a slot for servo horn

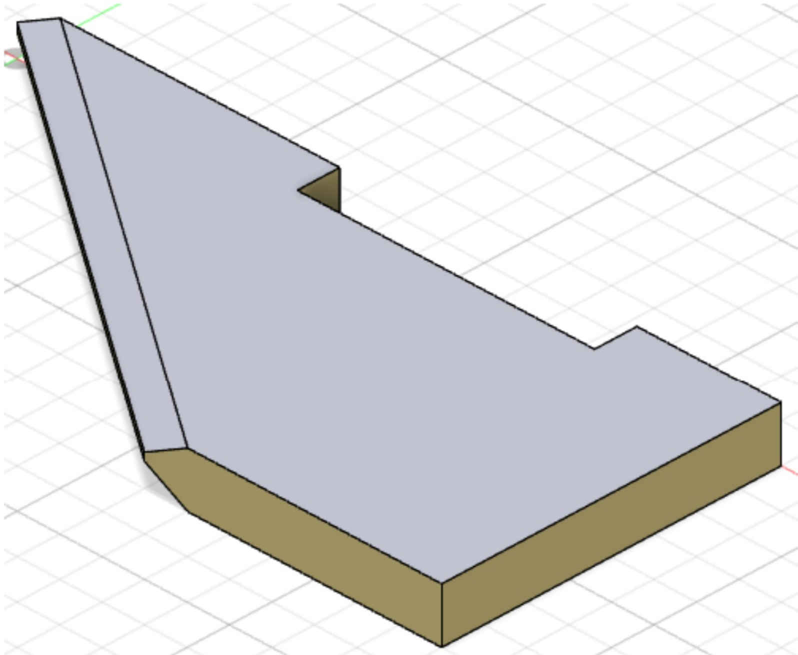
4.

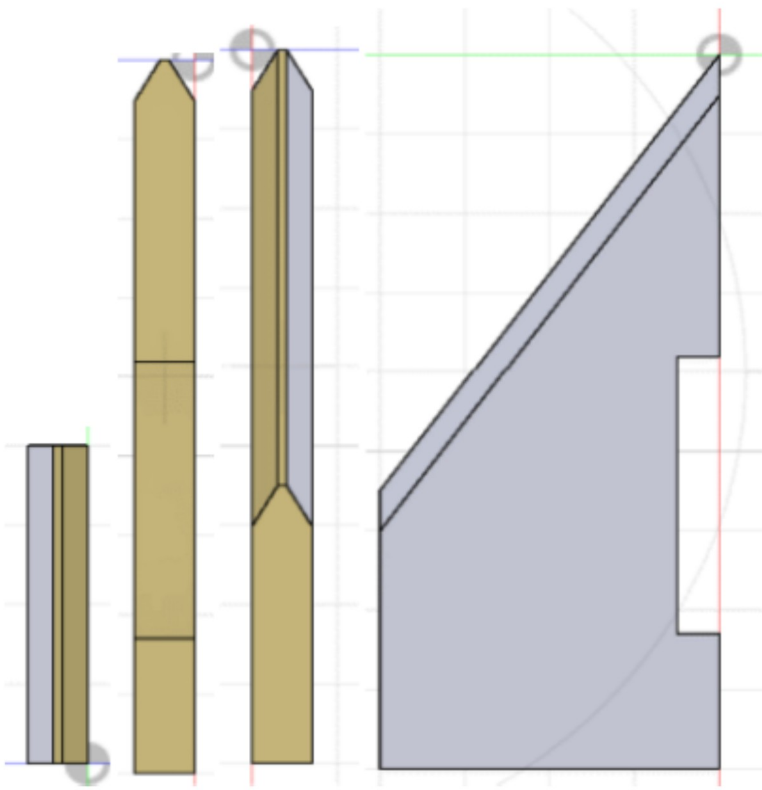
Cutting the slot and then joining 2 fins to create a major fin

5.



Sanding the extra surfaces from fins and making the final design.

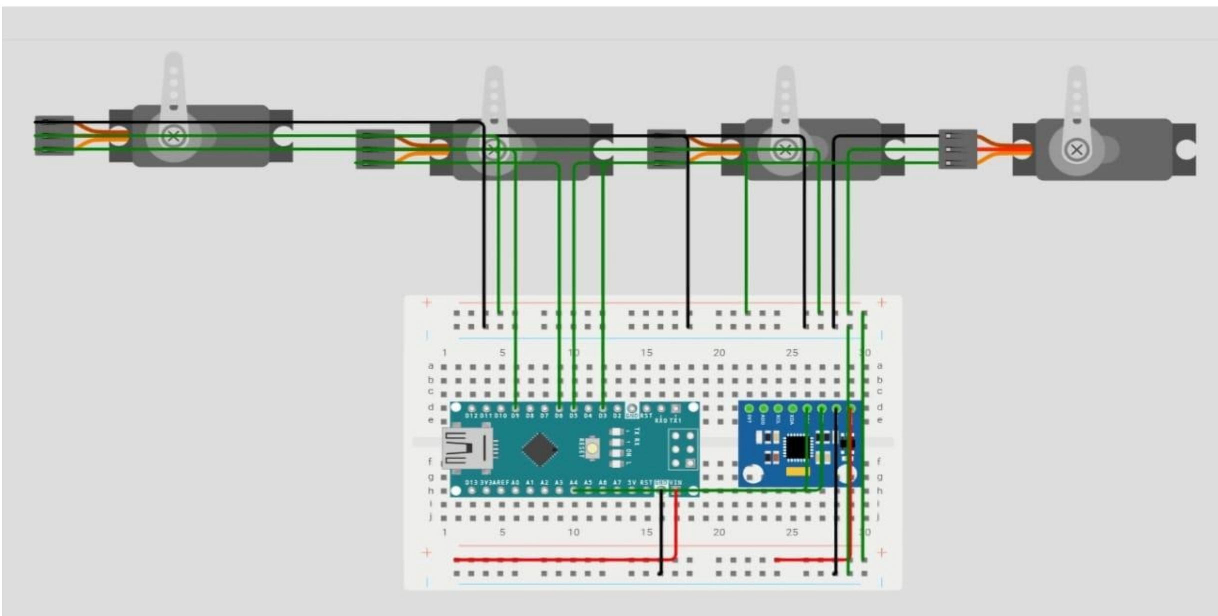




Avionics Components:

1. Arduino Nano
2. Jumper wires
3. Universal Board
4. 4 servos (SG9)
5. Standard Wires
6. Gyro Sensor (MPU6050)
7. Li-ion batteries (2 piece)

Circuit Design:



Code:

```
#include <Wire.h> #include <MPU6050.h> #include <Servo.h>

MPU6050 mpu;
Servo servoX1, servoX2, servoZ1, servoZ2;

int16_t ax, ay, az, gx, gy, gz; float angleX, angleZ;
float kp = 1.0, ki = 0.05, kd = 0.01;
float dt = 0.02; // Loop time in seconds
float alpha = 0.98; // Complementary filter constant

void setup() { Wire.begin(); Serial.begin(9600); mpu.initialize();

servoX1.attach(9); servoX2.attach(6); servoZ1.attach(3); servoZ2.attach(5);

if (!mpu.testConnection()) { Serial.println("MPU6050 connection failed"); while (1);
}
}

void loop() {
mpu.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);

// Convert gyro values to angles float gyroAngleX = gx / 131.0 * dt; float gyroAngleZ = gz / 131.0 * dt;

// Convert accelerometer values to angles float accelAngleX = atan2(ay, az) * 180 / PI; float accelAngleZ = atan2(ay, az) * 180 / PI;

// Complementary filter to combine gyro and accelerometer values angleX = alpha * (angleX + gyroAngleX) + (1 - alpha) * accelAngleX;S
// anglez = alpha * (angleZ + gyroAngleZ) + (1 - alpha) * accelAngleZ;

// Map angles to servo positions
int servoPosX = map(angleX, -90, 90, 0, 180);
int servoPosZ = map(angleZ, -90, 90, 0, 180);

// Control servos for X-axis
servoX1.write(servoPosX); servoX2.write(servoPosX);

```

```
// Control servos for Z-axis if (gz == 0) { servoZ1.write(90); servoZ2.write(90);
} else { servoZ1.write(servoPosZ); servoZ2.write(servoPosZ);
}

delay(0.000000000001);
}
```

Final Result and Conclusion: