ME205

DESIGN LAB-1

PRESENTATION

TOPIC

Setup for measurement of Coriolis Force

GROUP-K

Team Structure

1 RACHAKONDA AKSHITH SAI

- 3D CAD modelling
- 3D printing
- Design Setup
- Presentation

2 JAY SURYA RAJ

- Research
- 3D printing
- Design Setup

3 PENTAKOTA LAKSHMANACHANDRA

- Arduino connections
- Coding

4 SANDEEP KUMAR

- Arduino connections
- Coding

5 KARRI HARSHA VARDHAN

- 3D printing

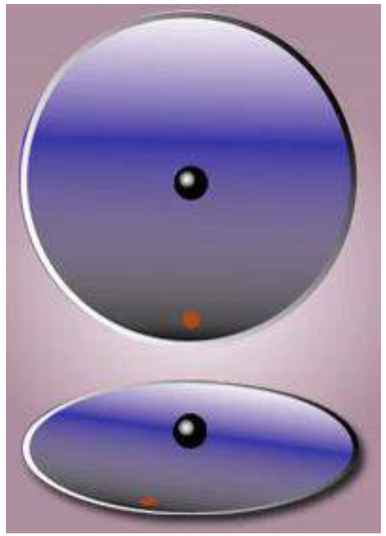
Introduction:

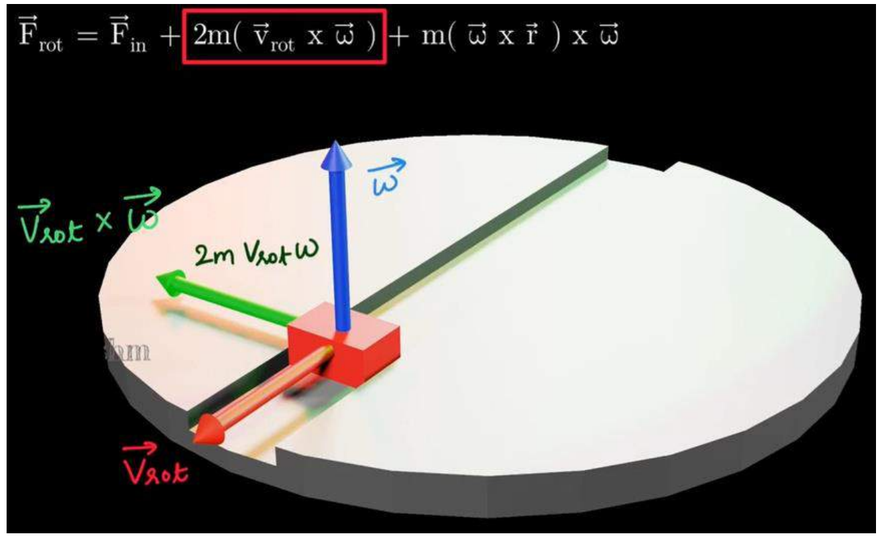
What is coriolis force?

The Coriolis force is an inertial or fictitious force that acts on objects in motion within a frame of reference that rotates with respect to an inertial frame. The Coriolis force acts in a direction perpendicular to two quantities: the angular velocity of the rotating frame relative to the inertial frame and the velocity of the body relative to the rotating frame, and its magnitude is proportional to the object's speed in the rotating frame.

Formula to calculate coriolis force: $F = 2m(v \times \omega)$

where,
F is coriolis force
m is mass
v is velocity due to rotatio
ω is angular velocity of rotating frame





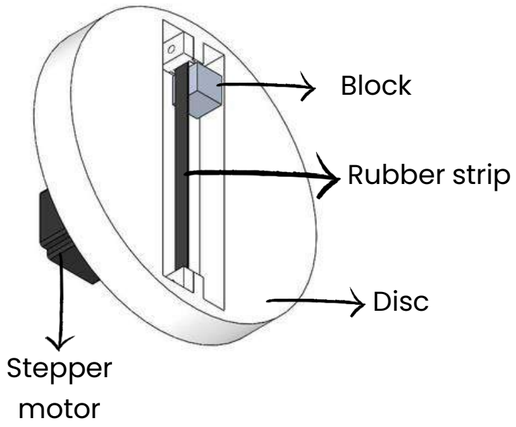
Project idea:

The Coriolis force is a fictitious force that comes into effect only in the rotating frame of reference that rotates with respect to inertial frame of reference.

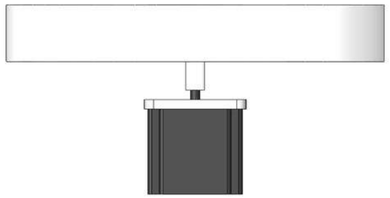
- So, we came up with the idea to design a circular disc with a rectangular slot in the center.
- A rubber strip is clamped at both ends of slot.
- A cubical block will be placed in the slot
- When the disc rotates in the anti-clock wise direction with a constant angular velocity powered by the stepper motor, the block will experience the Coriolis force.
- This causes deflection in the rubber strip.
- This deflection is shown in the output terminal and the maximum value (at the center) is taken for further calculations.
- From the value of deflection we can calculate back the force applied by block on the strip. Which in turn gives you the value of Coriolis force.

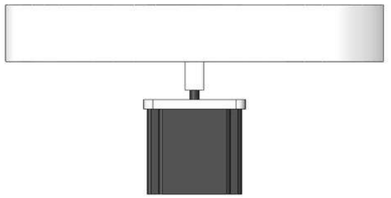
Reference

CAD model:

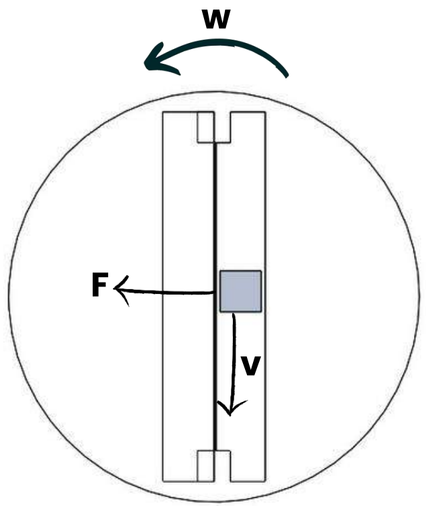


Front View

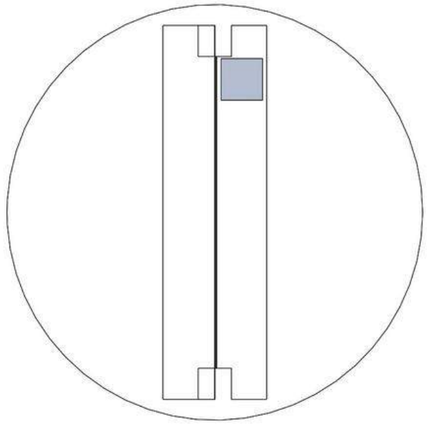


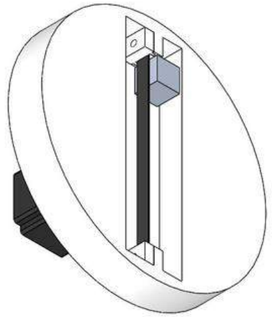


Side View



Top View



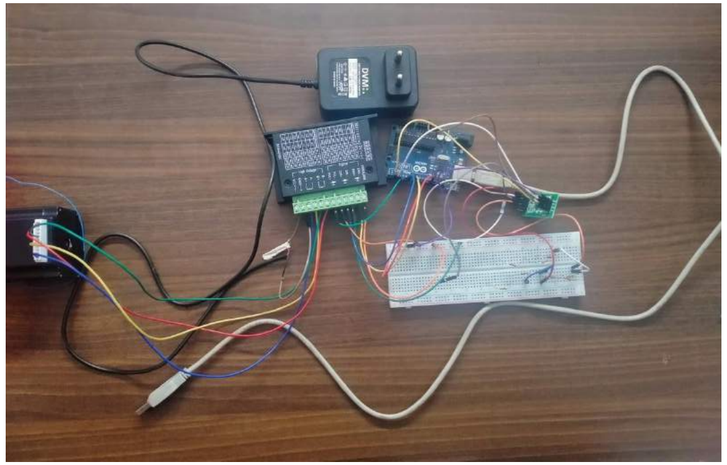


Isometric View

Components:

Electrical Components:

- Stepper motor
- Arduino board
- Bread board
- Micro step driver
- Strain Gauge - 120Ω
- HX-711
- Jumper wires - Male to Male, Female to Female, Male to Female
- Resistors - 120Ω (using 100Ω, 90Ω, 30Ω, 10Ω resistors in series)
- USB cable
- Power supply - 12V



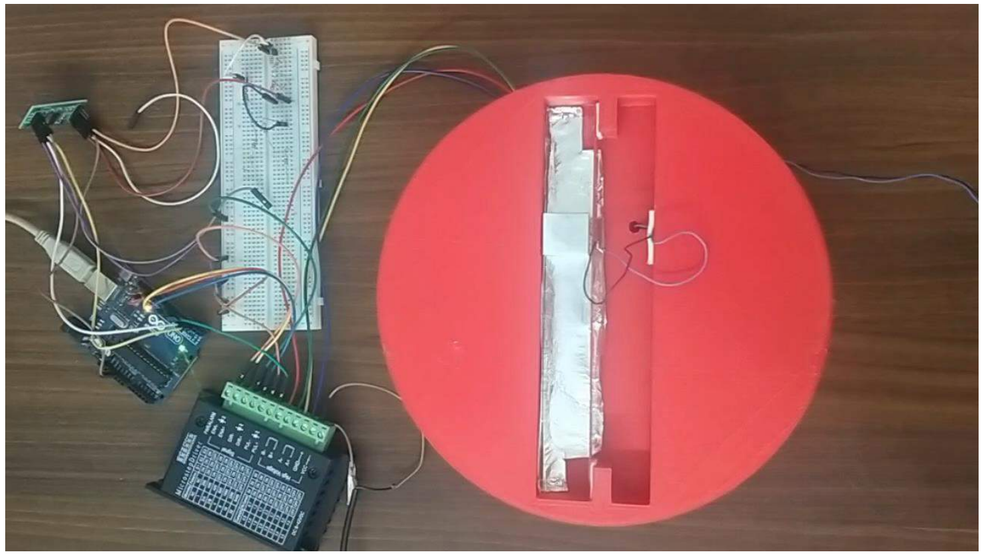
Miscellaneous Components:

- 3D printed disc
  Description:
  1. Circular disc of 20cm diameter
  2. Slot dimension - 18cm × 5cm

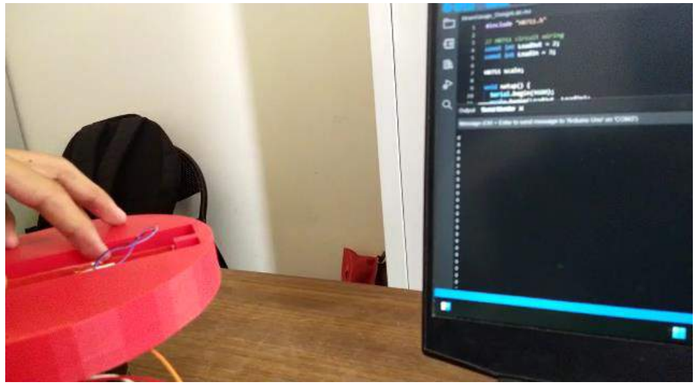
- Rubber strip
  Description: 18cm × 1cm × 1mm

- Aluminum block
  Description: 2cm × 2cm × 2cm

Working of the model:



Slow motion of block moving in the slot and applying force on the strip.



We were applying force on the strain gauge to get the deflection in the output terminal.
The values other than zero give you the values of deflection.

Arduino code:

To rotate stepper motor in anti-clockwise sense with constant ω:

```
// defines pins numbers
const int stepPin = 5;
const int dirPin = 2;
const int enPin = 8;
void setup()
{
 // Sets the two pins as Outputs
 pinMode(stepPin,OUTPUT);
 pinMode(dirPin,OUTPUT);
 pinMode(enPin,OUTPUT);
 digitalWrite(enPin,LOW);
}
void loop()
{
 digitalWrite(dirPin,HIGH); // Enables the motor to move in a particular direction
// Makes 200 pulses for making one full cycle rotation
 for(int x = 0; x < 1600; x++)
{
  digitalWrite(stepPin,HIGH);
  delayMicroseconds(800);
  digitalWrite(stepPin,LOW);
  delayMicroseconds(800);
 }
```

Deflection from Strain gauge:

```
#include "HX711.h"

// HX711 circuit wiring
const int LoadOut = 2;
const int LoadIn = 3;

HX711 scale;

void setup()
{
 Serial.begin(9600);
 scale.begin(LoadOut, LoadIn);
}

void loop()
{
if (scale.is_ready())
 {
  long reading = scale.read();
 Serial.println(reading);
 }
}
```

Force from deflection of strip:

```
# Python code to calculate force from maximum deflection

while(True):
  arr= []
  if input() == " ":
    break
  arr.append(int(input()))

L = 0.18          # Length of strip
b = 0.01          # Width of strip
h= 0.001          # Height of strip
Y = 10**4         # Young's Modulous of red silicone rubber
e = max(arr)      # maximum deflection from strain gauge
readings
I = b*(h**3)/12   # moment of inertia

print(48*Y*e*I/(L**3))
```

Flaws:

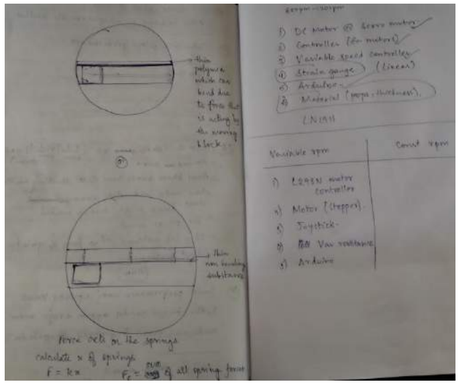
We were not able to solve these issues:

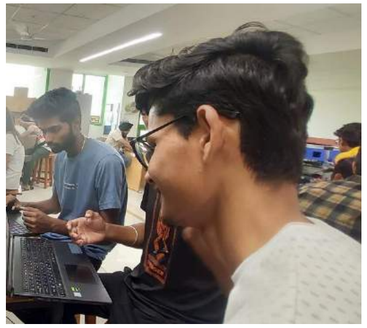
- Block is not able to move by itself in the slot when the disc is rotating, according to the theory of coriolis effect it should move by itself. This may be due to the rough surface as the disc is 3D printed. We used an aluminum foil to make the surface smooth. In this case block is taking very less time to reach the other end.

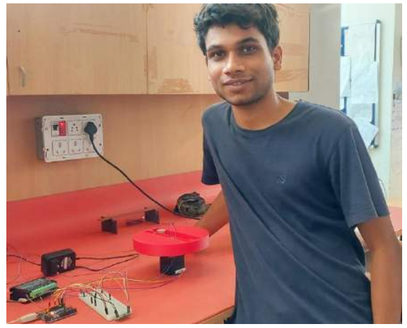
- We are not able to get the values of strain in the output terminal even if the force is acting on it. We checked our connections and code multiple times. Even though they are correct we are not able to get results. It just worked once and from the next time it is showing garbage values.

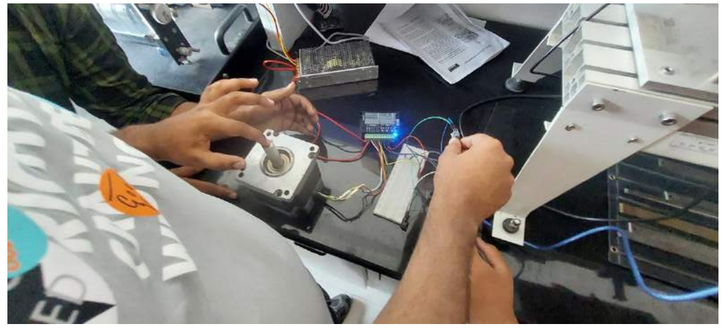
- The garbage values in the terminal may be due to unbalanced wheatstone bridge as we used series connections of variable resistors in series to get a total of 120Ω. The series connections did not give us the total resistance we needed.

Team discussions:









Thank You!

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