Propeller Rotor system for Data Acquisition

Preface

This project was made to be a part of the Machine Learning course. This sole purpose of the system is to generate data for training the machine learning model.

The project was commenced and completed during the summer vacation of the year 2019 under the guidance of (Prof.) Dr. N. R. Raykar.

Acknowledgements

I would firstly like to thank Dr. Raykar for giving me the opportunity to work on this project and for the support during the course of the project. I would also like to thank my parents for their support.

Lastly I would like to thank my brother, Pushkar for helping me in the simplest tasks during the project.

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1) Sensors-

The project revolves around collecting the data from the system. Without a doubt, the sensors are the heart of the system. Of the three parameters that are monitored by the system, the sensors for the force and rotational velocity were self-designed and manufactured.

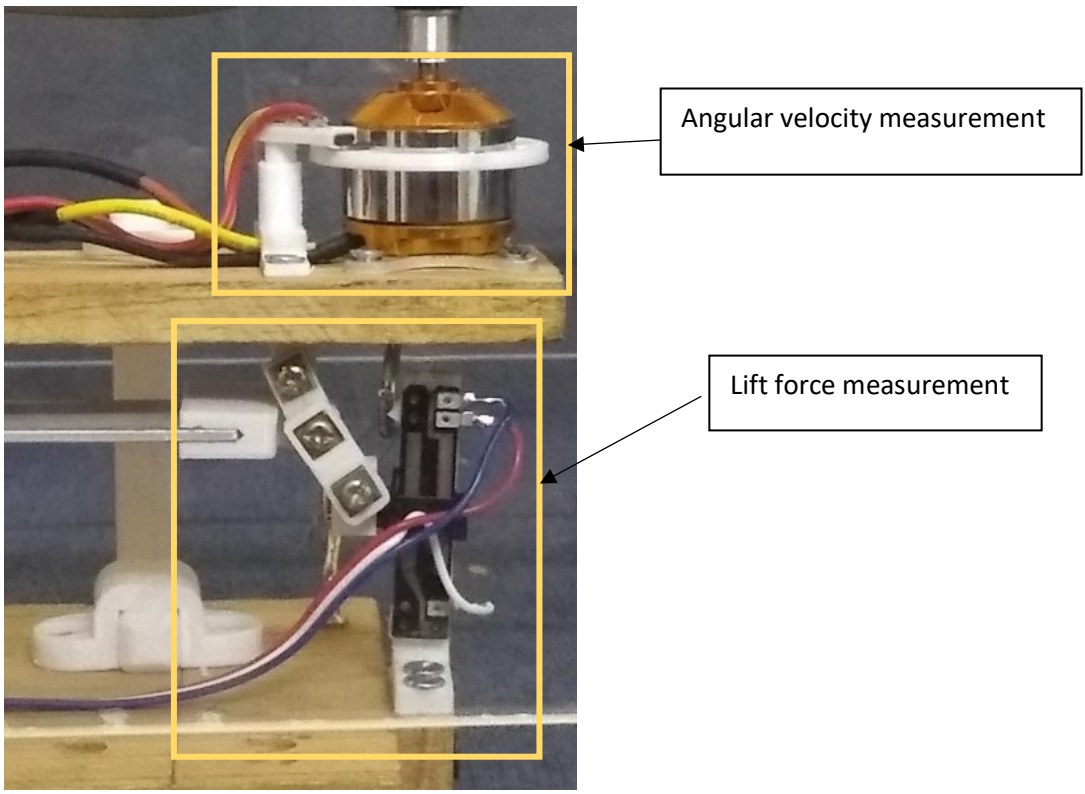

Figure 1 Sensor overview

a) Force Sensor-

The force sensor has two main components that is the spring and a displacement sensor. The role of spring here is fulfilled by a cantilever beam which is made of aluminum which is 2mm thick and approximately 25mm wide.

The main beam on which the motor is placed is hinged at one end and the other end is rested on the cantilever beam. Thus, the force developed by the propeller is taken up by the cantilever beam and it moves. The movement of the beam is directly proportional to the force which is developed by the propeller. Thus knowing the displacement will give the force developed by the fan.

For measuring the displacement, a linear potentiometer is used. The potentiometer will increase the voltage in proportion to the displacement. For measuring the output, the voltage from the potentiometer is fed into a differential op amp configuration to get rid of the offset voltage in the potentiometer and then is then amplified to make use of the complete range of the ADC of the Arduino.

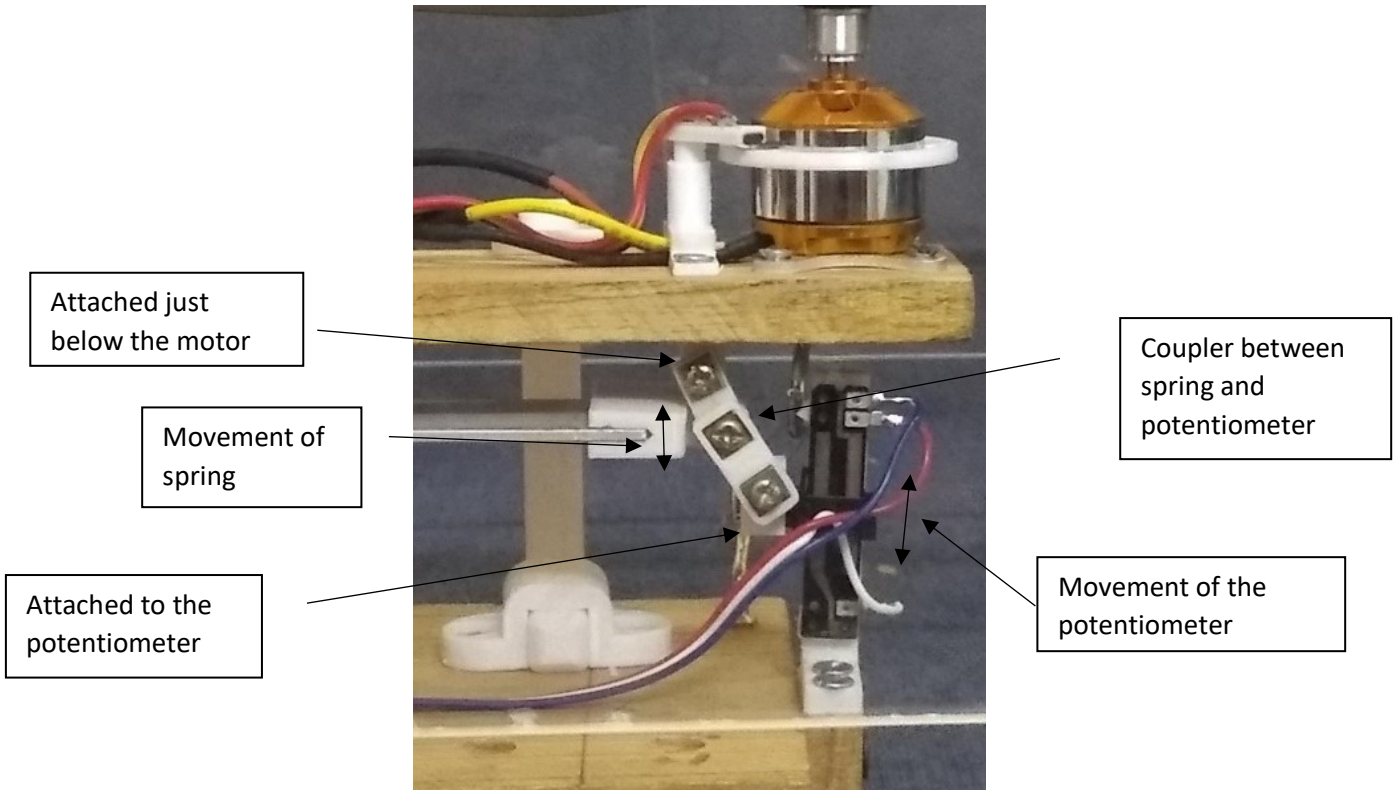

Figure 2 Force Sensorq

b) Angular Velocity measurement-

For measuring the speed of the motor, a combination of magnets and hall effect sensor is used. The hall effect sensor gives a high output when ever the a magnet is close it. Thus, magnets are attached on the motor and a hall effect sensor is placed very close to their plain of rotation such that the magnets can effect the hall effect sensor.

When the motor starts spinning, the magnet will cross the hall sensor repeatedly and this will result in small pulses from on the output of the hall effect senor. Measuring the time delay between two pulses, the frequency of the rotation can be found out.

The sensor used here is A3144 hall effect sensor. This sensor is given 5V supply with and the output is also given a 20k ohm pullup resistor.

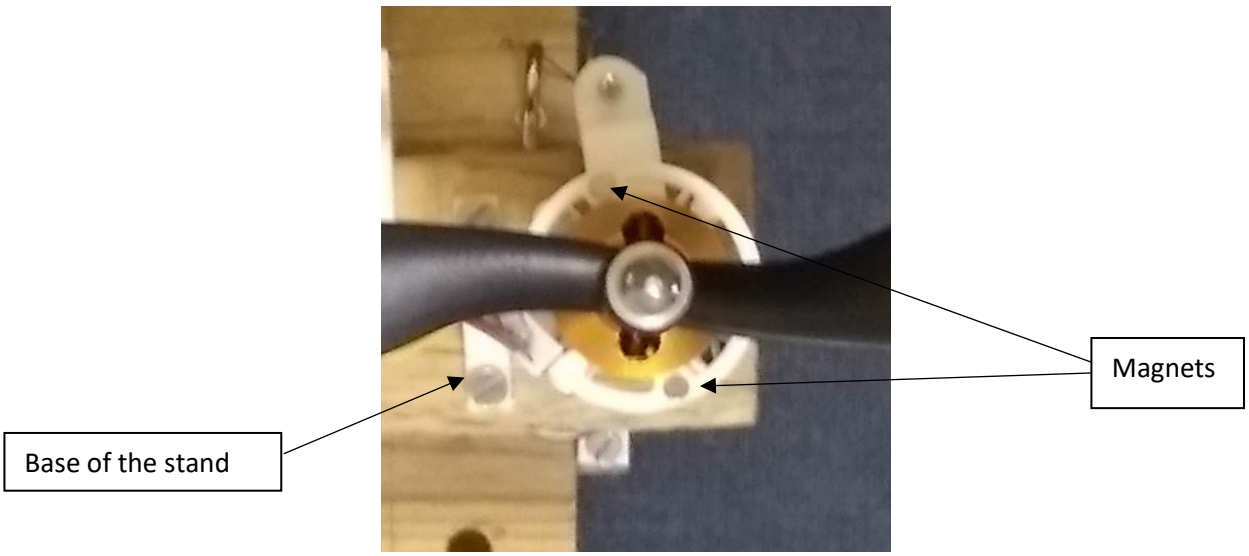

Figure 3 Angular Velocity Top View

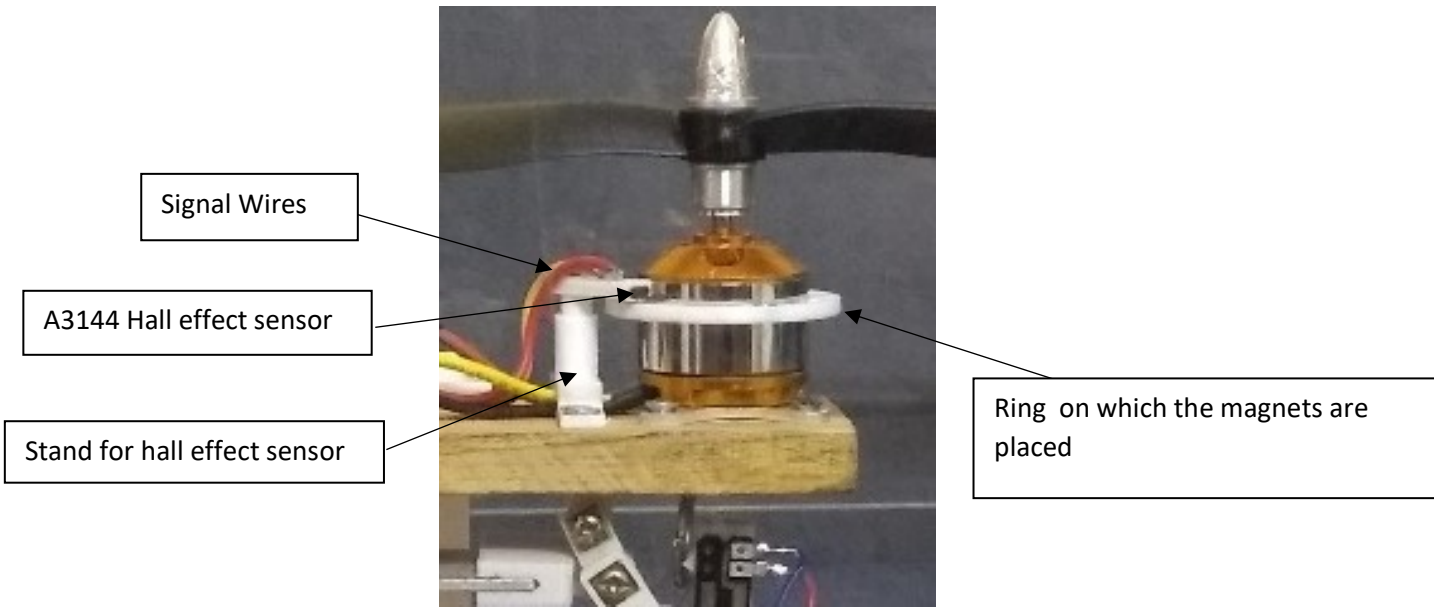

Figure 4 Front View

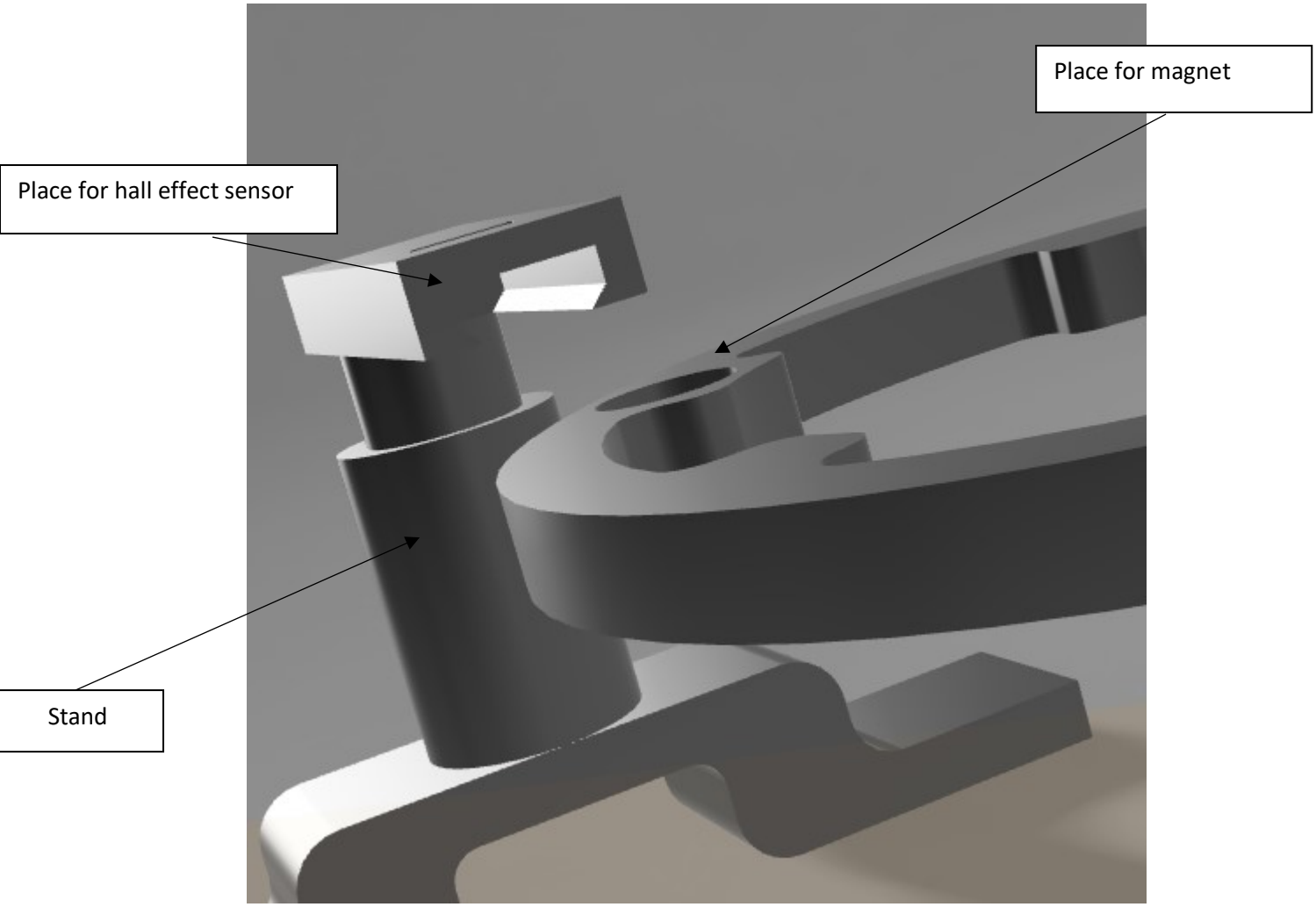

Figure 5 Complete overview of angular velocity sensor

c) Current Sensor-

The current draw of any system can be measured by adding a shut in the path of current. However, the electronic speed controller used in the project is not a simple resistive load and the current draw of the controller is in the form of extremely fussy waveform.

The voltage across the shunt will reflect all the noise in the current draw. This is generally not an issue for modern computers with extremely fast ADC (analog to digital converters) but for a small microcontroller like Arduino, this is still a bit too fast to it to process.

This solution for this is to use a low pass filter which can filter out all the high frequency noise and produces a clean output which can be processed by an Arduino.

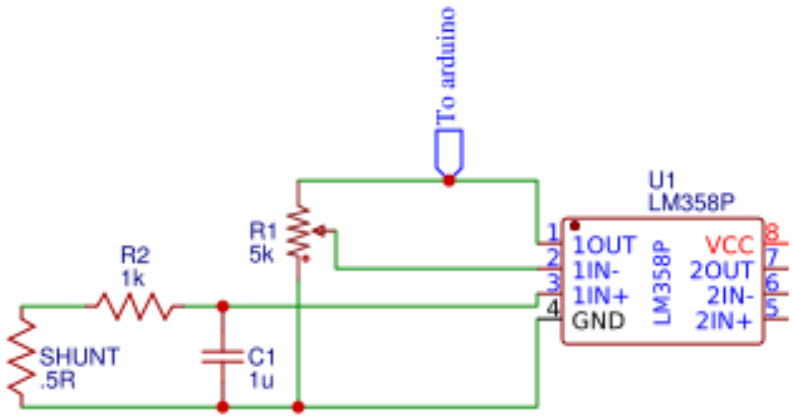

Figure 6 Ciruitry used for current measure

2) Protection

The machine has some components which run at very high speed which can harm if something breaks.

So, it has to have protective barriers to make it safe.

Following systems are in the project for operator's and project's safety.

a. Protective wall

b. Hook lock

c. Arrester

d. Weights

a. Protective walls-

The blades of the propeller are running at around 50-150 Hertz and can do serious damage if it brakes form the root and flies off. In order to make the environment safe, there is a clear acrylic sheets all around the fan.

The shape of the acrylic sheets is maintained by the four corner pieces which have slots in them to fit the sheets at right angles.

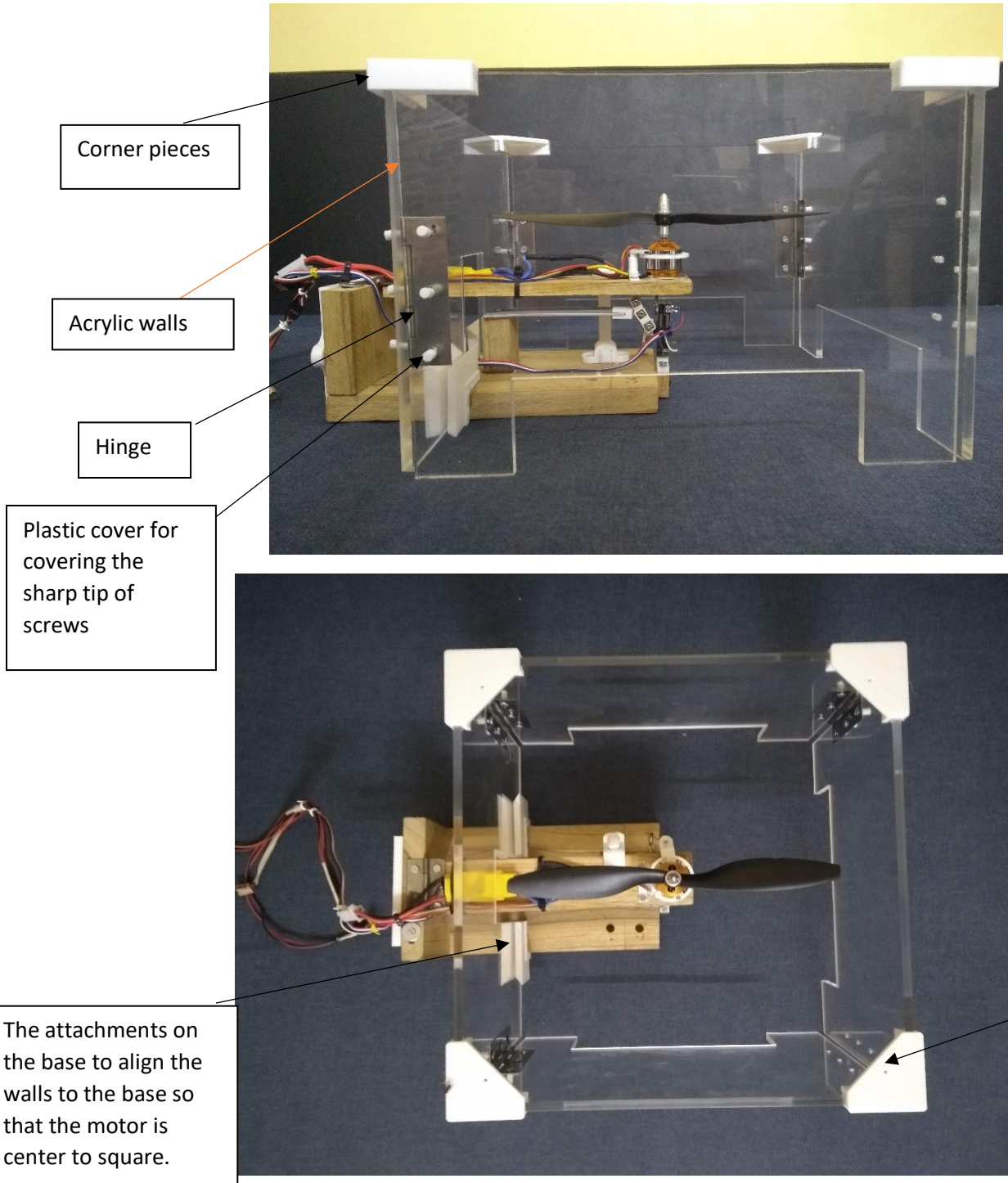

Figure 7 Top View of the Acrylic Wall

b. Hook Lock

The entire system is held horizontal with only one coupling that connects the beam to the spring. In case the coupler snaps, there would be nothing to hold the fan in place and that would just swing and the propeller may touch the wall and break.

In order to prevent that from happening, there is a backup mechanism which locks the fan to the base. This is executed by adding two hooks and the two hooks are coupled by a loop which is big enough to not to disturb the normal functioning but small enough to arrest the swing in case the coupler snaps.

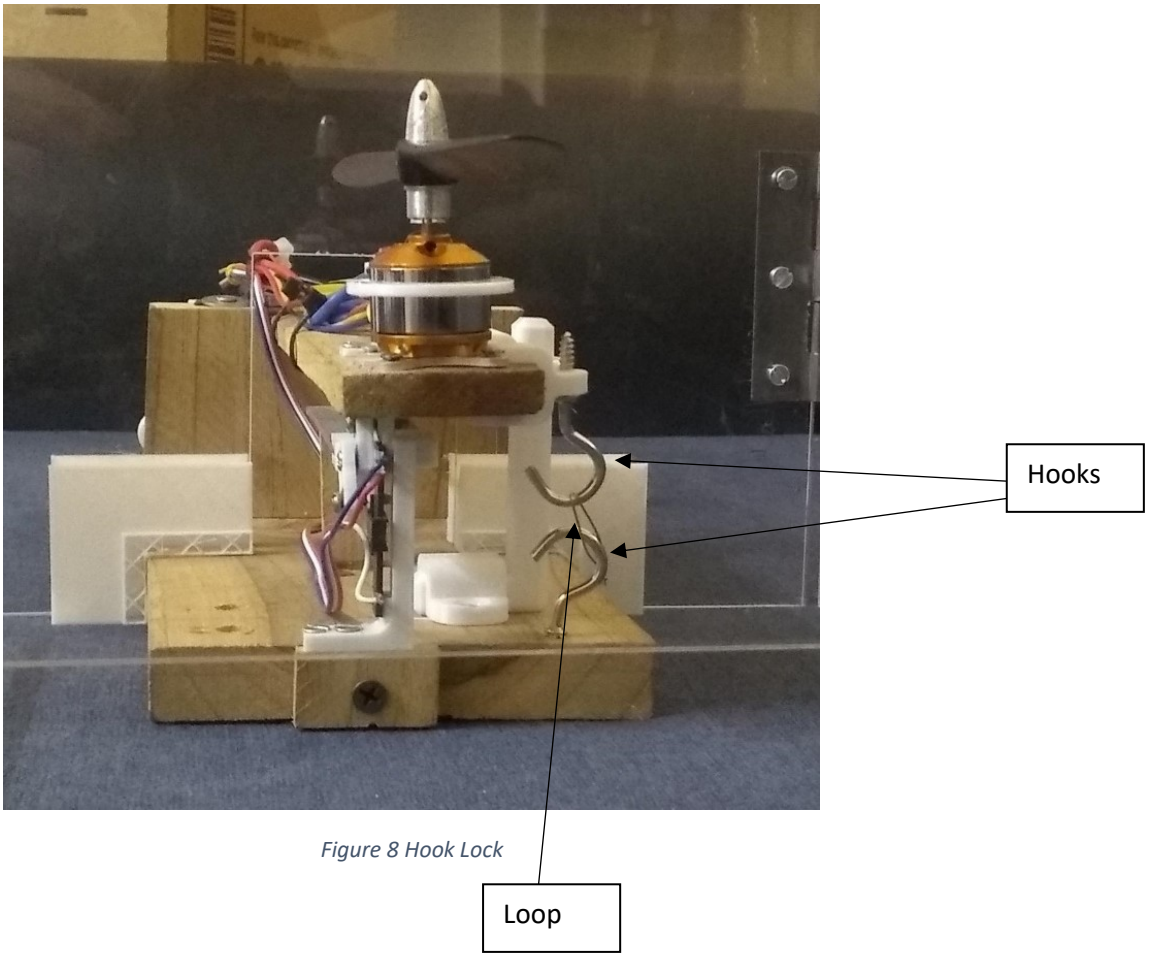

Figure 8 Hook Lock

c. Arrester

The force sensing system of the project is self-designed equipment and hence is not very will tested. The trial runs of the project showed no issues with its working but to be on the safer side, there is an arrester designed for the machines so that in stand by or under storage, the load on the sensor is taken up by the arrester. This prevents the unwanted shocks that the sensor may have to endure if the arrester was absent.

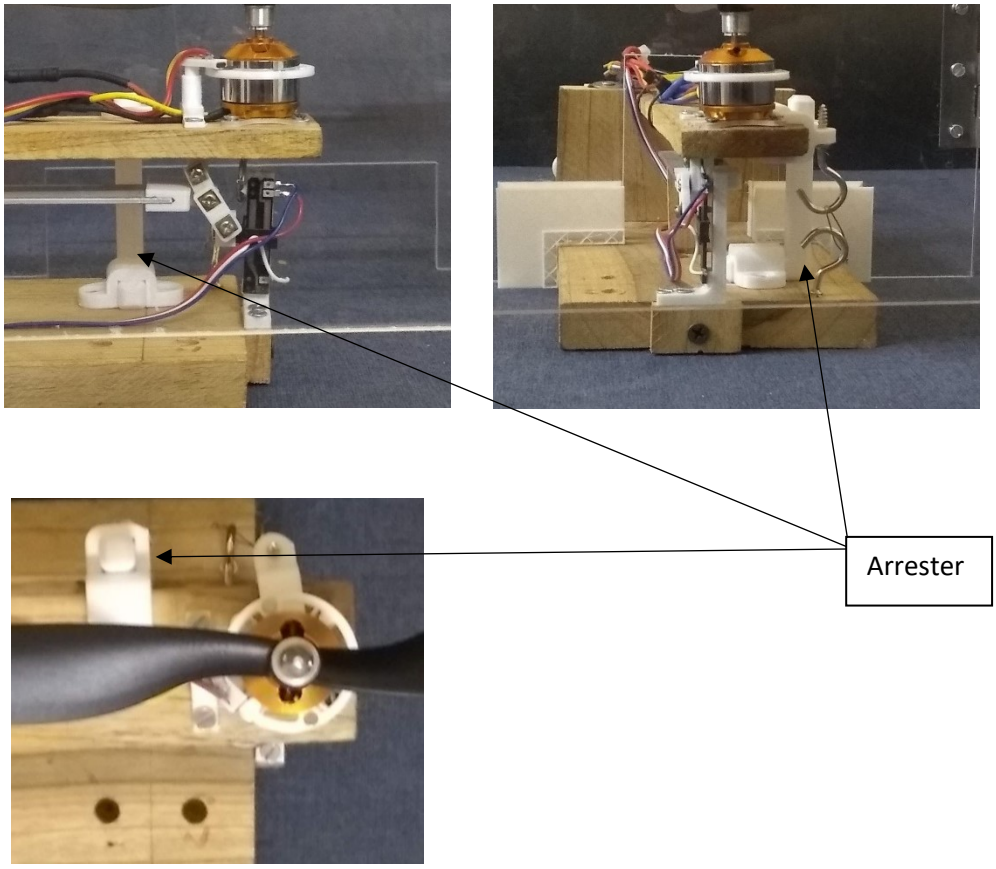

Figure 9 3D model of arrester

d. Weight-

The motor propeller system is so powerful that in absence of the protective glass, the motor can lift the entire machine from one side. In presence of the protective glass, the force is transmitted to the glass form the attachments used to align the glass to the base. This may brake the attachments. So in order to prevent that from happening, weights must be added so that the motor will not be able to lift the machine in the first place.

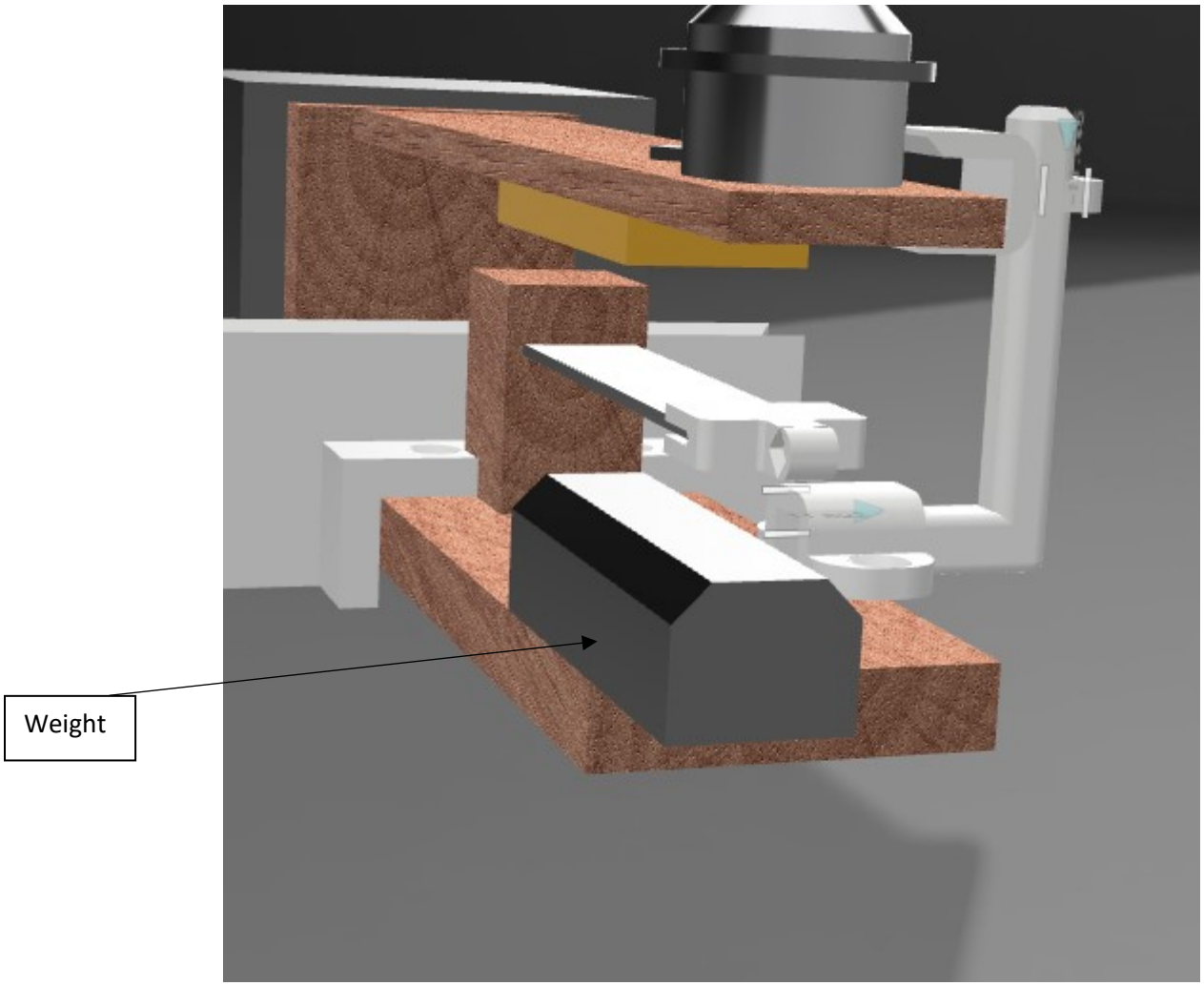

Figure 10 Weight in 3D model