NAKUJA PROJECT PROGRESS REPORT INTERNSHIP 2022 WEEK 7

FLIGHT CONTROL

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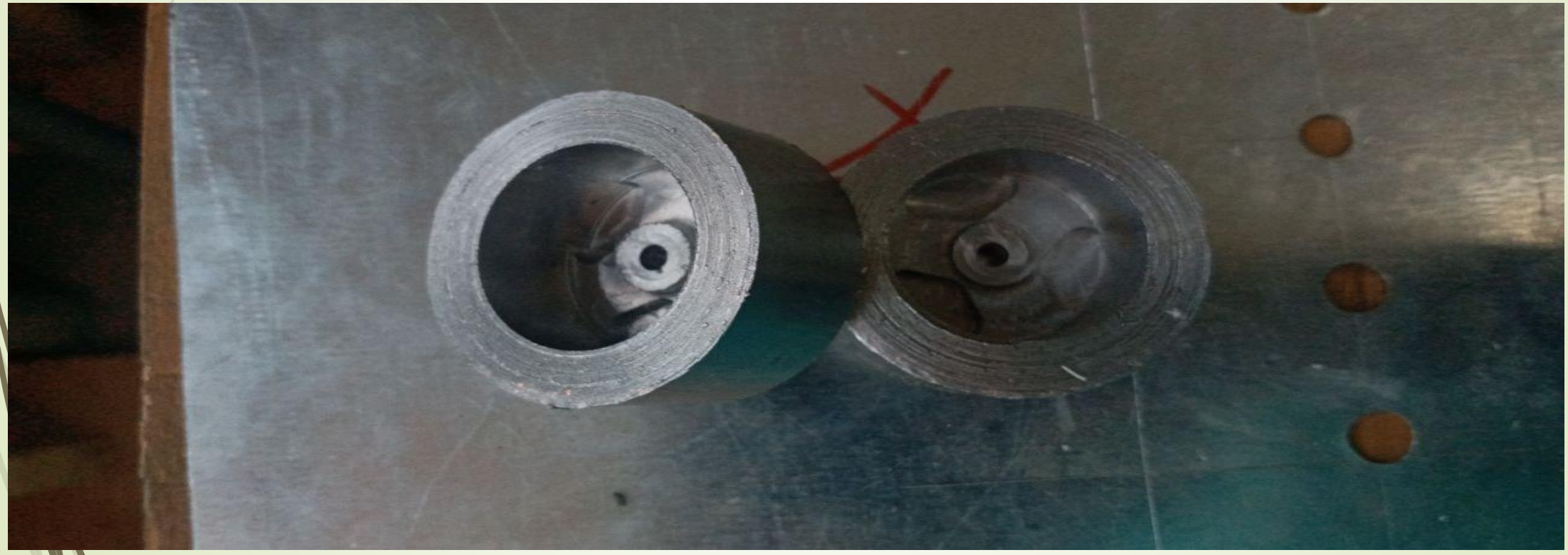
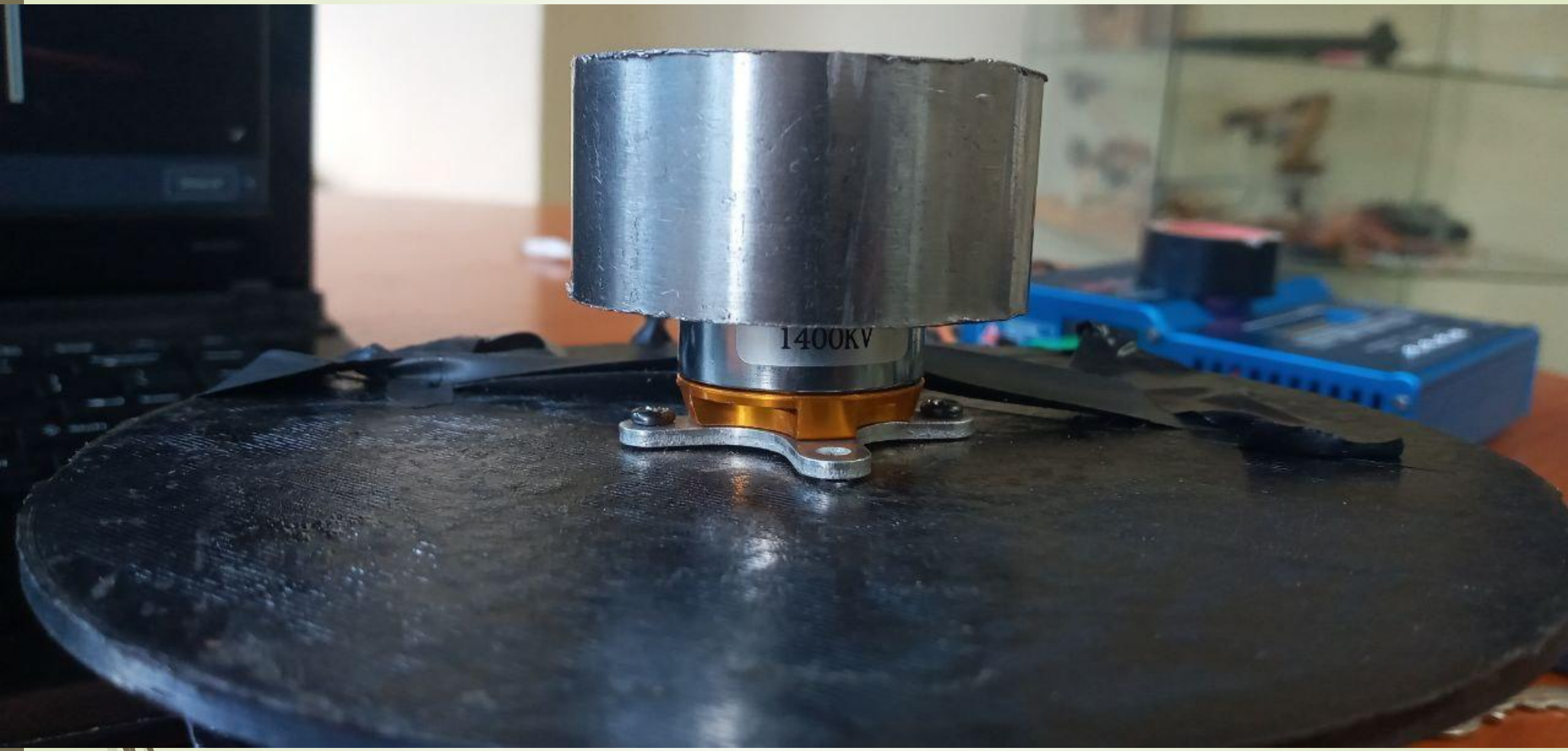
TASKS LAST WEEK

- Reaction wheel fabrication




1400KV

MPU6050 library reselection

- Getting data from the MPU6050:
- We have used and viewed source code for a number of libraries:

  Jarzebski/Arduino-MPU6050

  MPU6050_tockn

  Adafruit MPU6050 Sensor Library

Problems and inadequacies were encountered as these differ in:

- Method of gyroscope calibration and offset determination
- Accelerometer gravity compensation. The principle of equivalence.
- World frame versus body frame coordinates.
- Method of reading values from the accelerometer and gyroscopes
- Processing of raw data through smoothing and low pass filters
- Application of filters, Kalman filter or complementary like Madgwick/Mahony to fuse gyroscope readings
- Dealing with gimbal lock by application of quaternions rather than euler angles usage.

  Euler angles assume our rocket won't pitch 90 degrees.

  With quaternions a rocket could be programmed to do acrobatics(beware).
- Dealing with the cases where roll goes past +/-180

  Our Choice utilises the DMP and a FIFO buffer.
- https://github.com/jrowberg/i2cdevlib/tree/master/Arduino/I2Cdev
- i2cdevlib/Arduino/MPU6050 at master · jrowberg/i2cdevlib (github.com)

[#26] Kalman filter improvement (application to apogee detection)

- Future possible alternatives to the Kalman filter are:
- Unscented Kalman filter(uses Sigma points rather than linearization, computationally expensive)
- Extended Kalman Filter (uses Jacobi first order linearization. Computation of Jacobi's can be done before by hand or with Symbolic maths, numerical methods are computationaly intensive.
- Multiplicative Extended Kalman Filter.

The MEKF is an important modification of the Kalman Filter that makes it applicable to orientation estimation.

- Manifold Extended Kalman Filter

https://www.researchgate.net/publication/330128000_Kalman_Filtering_for_Attitude_Estimation_with_Quaternions_and_Concepts_from_Manifold_Theory

"Then, the MEKF with the RP chart and without applying the "chart update" is our best attitude estimator according to the adopted performance metric. This algorithm resembles the conventional "Multiplicative Extended Kalman Filter", but we have obtained the MEKF without having to redefine any aspect of the classic Kalman filter"

TASKS THIS WEEK

- Finish reaction wheel fabrication.

  Facing, tapping and filing.
- [#102] Fabrication of the safety cage.
- [#101] Fabrication of the reaction wheel mounting case.
- [#25] Test reaction Wheel on test bench with current firmware.
- [#29] Log operation data.
- Creating interfaces to hide implementation details, make for easier following, debugging and library changes.