

STATUS REPORT - Will Wu

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Status Update Period	Week of 02/19/23 - 02/25/23
Professor	Dr. Dorothy Wang

Accomplishments for the week of (02/13/23-02/19/23)

- *System Development in ROS2 is well underway*
 1. Based on our previous sensor data scripts, I developed an IMU wrapper "class" that packaged useful functions, sensor interfacing procedures, and data in a portable fashion.
 2. I finished and tested the first ROS2 node of the system, which interfaces with the sensor through the IMU wrapper class and publishes sensor data under the topic "IMU_raw".
 3. We gained a lot of working knowledge when programming this first node. Refer to our documentation on Github regarding ROS2 message types, the python build system, programming practices, etc.
 4. As part of the testing process, a "dummy" subscriber node was also implemented to monitor the published "IMU_raw" messages
 5. A quick demonstration was shown on Friday, Feb 26th during the group meeting.
- *Started Kalman Filter design*
 1. Through Wikipedia, relevant chapters of the K.J Astrom textbook, and other online tutorials, I gained a solid fundamental understanding of Kalman filters. Relevant mathematical backgrounds such as optimality proof, numerical iterations of the filter, etc were also hand checked and derived.
 2. Numerical methods involved such as alpha-beta filters and ALS (Auto-covariance Least Squares method) were also investigated and documented in the project journal.
 3. Basic process and output models of the three Kalman filters, which estimate the three key PiCar state variables, were also designed.
 4. I started the reference filter implementation via Matlab. Measurement noise of each sensor (IMU, encoder) are collected and calculated at equilibrium.
- *Payton completed the first iteration of the Picar shell*
 1. The first iteration turned out well. However, several sizing factors (position of the LiDar mounting holes, size of the mounting holes, etc) were incorrect.
 2. Based on the first print, we discussed and designed a second iteration, which includes new mounting poles and mounting holes for the Raspberry Pi. Payton will be modeling and printing the parts.

Plan for next week (02/20/23-02/26/23)

- Design and implement PID controllers
- Kalman filter design and verification via MATLAB
- Program ROS2 nodes for PID controllers
- If the PiCar shell print turns out satisfactory, mount LiDar and Pi to the car.

Topic Outline/ Progress toward deliverables

- I. Implement ROS2 sensor nodes for Encoder **Scheduled to complete by 03/01/23**
- II. PID Controller, linear estimator and angular estimator design. 10% done; ongoing: **2/24/23 - 3/9/23**
- III. ROS2 implementation. 10% done; ongoing: **to complete by 3/20/23**
- IV. Testing **Scheduled: 3/20/23 - 3/27/23**
- V. Pre-SLAM navigation **Scheduled 3/20/23 - 3/27/23**
- VI. SLAM study **Scheduled 3/20/23 - 4/27/23**

Issues

- The RPM sensor node implementation is trickier comparing to the IMU sensor node. Unlike the IMU, of which the value can be read at any given moment, the RPM sensor needs to be constantly monitored to register the magnet trigger. We will be investigating ROS2 “services” as a potential solution.