ME 578 Assignment 1 Background Information

Data information:

The data provided comes from the rosbag files, which were collected on September 16. For ease of processing and to reduce the file size, we converted the files into a CSV format.

"*-odometry-navsat.csv" files contain the state information. This data is the result of LIO-SAM, the localization algorithm, and an Extended Kalman Filter (EKF). Thus the data is samples at around 100 Hz, give or take a bit due to the processing availability.
The important information from this file is the "pose.pose.position.x/y", which is the position of the ASV on the surface, ".pose.pose.orientation.w/x/y/z", which is the quaternion representation of the heading angle, ".twist.twist.linear.x/y" which is the linear velocity, and ".twist.twist.angular.z" which is the angular velocity about the z axis.

"*-command_force.csv" file contains the commanded force values to each of the thrusters. The thrust values can be converted to body-fixed forces and moments through the B matrix:

$$B = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ a/2 & -a/2 & b/2 & -b/2 \end{bmatrix}$$

where $a = 0.4$ and $b = 0.9$.
Moreover, this data is collected at 10 Hz, which is the control speed that we use for the QuarterScale Roboat.

Coordinate Frames:

As discussed in class, marine robotics tends to use a coordinate system where the $\hat{z}$ axis points into the ground. However, ROS uses a different coordinate frame where the $\hat{z}$ axis points away from the earth. Thus is necessary to convert the ROS coordinate frame into the marine coordinate frame through the rotation matrix:

$$R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

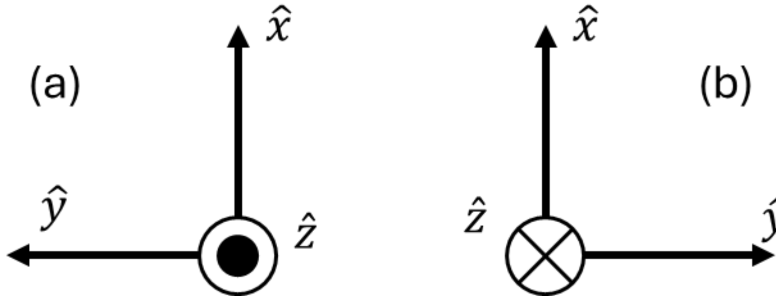

Figure 1: (a) ROS coordinate system. (b) Marine Robotics coordinate system.

Syncing the data:

As mentioned above, the collected data has different sample rates. Thus there are two methods to correct this issue: upsampling the lower frequency data or downsampling the higher frequency data. In both cases, one has to determine which indices in the high frequency data corresponds to low frequency data, as it is not a consistent 10x faster for all time steps due to ROS.
Upsampling the low frequency data can sometimes include interpolation methods, if the value is constantly changing (e.g. position and velocity). However, as the low frequency data is a commanded value, it is safe to assume that the value is constant for all values within the existing points.
Downsampling does the opposite; instead, one eliminates the extra points. Sometimes, filtering techniques can be used to remove some noise from the data (e.g. a moving average filter before and after the identified timestep to downsample to). Otherwise, one can just trim the excess data from the data array to achieve the desired frequency.

Data processing:

We provide a matlab function for extracting the key information from the CSV files and performing the data processing mentioned above. For more information, call “help GetRoboatRuntimeData” from matlab’s command line with the function in your path. Keep in mind that this function also sets the initial position as the origin for the data, overriding the origin from LIO-SAM. You can also modify or write your own data processing function in which ever language you prefer to complete the assignment in.