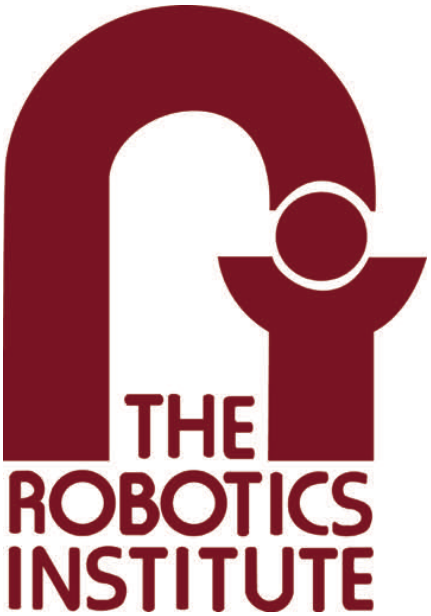

MRSD Project Course

Team I – AIce

Autonomous Zamboni Convoy

Individual Lab Report 6

Team

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1 Individual Progress

In the past few weeks, I worked on moving forward the process of collaboration with Isuzu Technical Center of America on drive-by-wire (DBW) conversion. In this semester, our goal is to integrate our software algorithm into a DBW ice resurfacer to achieve autonomous leader-follower convoy. The conversion of the electric Zamboni ice resurfacer to a DBW vehicle was critical, but also very challenging for us due to the lack of experience and technician's support, as well as time constraints. Isuzu ITCA proposed a collaboration to support us on DBW conversion. As shown in Figure 1, they will be responsible for the automotive-grade DBW ECU controller development and providing us support on actuator integration. After discussing with all parties, the final decision for DBW conversion is the option 2 in Figure 1. Isuzu will support the design of DBW system and provide full-time technician to do the conversion. An example of the steering system design is shown in Figure 2. Potential motors were selected based on the estimation of steering characteristics. An option of brake actuator is shown in Figure 3.

Our mitigation solution of not getting the DBW Zamboni vehicle on time is to use a DBW Yamaha ATV. I reviewed the basic autonomy stack of ATV and discussed with my team members about how to integrate our subsystems into the ATV autonomy stack. We plan to replace the navigation goal in the ATV autonomy stack with our leader-follower autonomy algorithm. Our current perception subsystem will be improved by fusing the camera and the LiDAR. I downloaded the GitHub repository of ATV and followed the commands to build the code. I installed several dependencies of the repository, including GTSAM, grid_map_ros, velodyne_msgs, Ceres, etc.

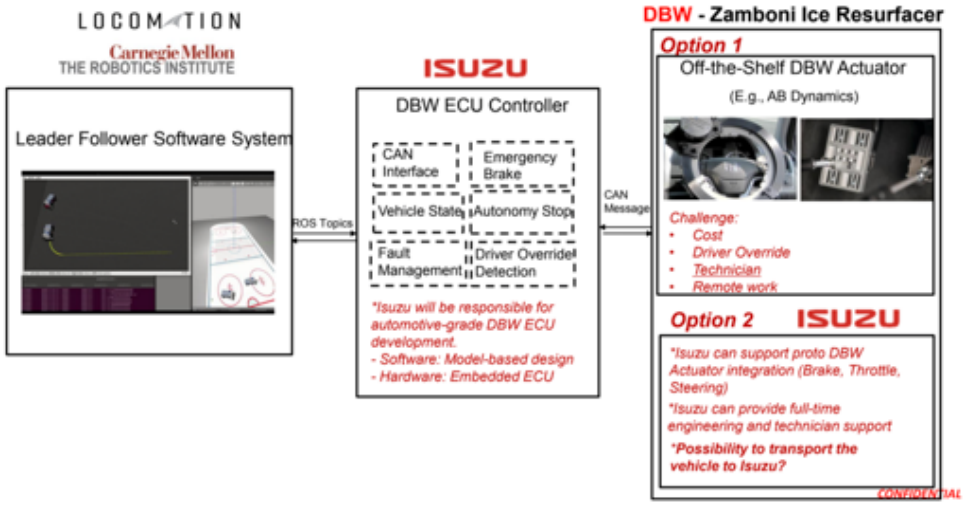

Figure 1: Collaboration with Isuzu ITCA

Figure 2: Steering System Example

Figure 3: Brake Actuator Option

2 Challenges

During the communication with different parties including Locomation, Zamboni and Isuzu regarding the collaboration with Isuzu, I was challenged by the fact that it often took a long time to get all parties to agree on something. The reason is that every email response takes time and our project involves many companies. Another challenge is that Isuzu requires more vehicle details and parameters, but the NDA between four parties including CMU, Isuzu, Locomation and Zamboni has not been signed. This has resulted in Isuzu now being unable to request more details and support from Zamboni to finalize the DBW design. The current solution is that while waiting for the NDA to be signed, Isuzu would order two potential motors for steering system. In this way, their engineers and technicians can

The challenge I met when I tried to build the ATV repository is that it requires a lot of dependencies. Some dependencies especially the GTSAM library took me a lot of time to install. I installed Ceres Solver, but when I built the code, it kept giving errors related to this library. I haven't solve this problem but will continue to find a solution.

3 Teamwork

Each team member's distributions are shown below:

Rathin Shah:

- Finalized Functional Requirements
- Studied Motor Controller for CAN bus communication for throttle control
- Studied electric throttle for voltage range
- Researched different DBW solutions for steering

Nick Carcione:

- Updated performance requirements
- Brainstormed potential DBW steering desig
- Reviewed ATV autonomy stack

Yilin Cai:

- Learned and reviewed the ATV autonomy stack
- Conceived the transferring and fusion of previous autonomy codebase to ATV

Jiayi Qiu:

- Worked on the collaboration with Isuzu
- Updated potential DBW steering and braking designs
- Reviewed ATV autonomy stack
- Installed dependencies to build the repository

Kelvin Shen:

- Refreshed memory of our codebase as well as ROS usage
- Reviewed ATV autonomy stack
- Modified our functional architecture accordingly

4 Plan

I plan to continue to follow the progress of the NDA and maintain communication with Isuzu on the DBW conversion updates. I also plan to solve the problems I met when building the ATV code. I will study the code and its ROS interface to integrate our previous algorithm into the ATV autonomy stack. Another important thing is to go to the test place of ATV so that we can learn how to operate the vehicle and I can also understand the driver nodes running on the desktops of the ATV. This will be useful for writing our ROS nodes and organizing rostopics.