RoboSub Team Killick 2017-2018

Continuation Document
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Legitimacy For Continuation

The RoboSub multidisciplinary project provides an invaluable experience for its members in both practicality for their professional careers. Continuation teaches students the importance of understanding and improving upon on a project by applying the latest technology and practices. The breadth of specialization this project provides replicates what many engineers see in the real world and is an impressive topic of conversation to employers. The RoboSub project is currently one dedicated year away from being competition ready. Testing performed at the end of the 2017-2018 year verified the system propulsion and mechanical system functionality, providing a platform to be improved upon in subsequent years. Developing the controls, vision, and mechanical teams would see this project at its full potential in one or two more iterations.

Future Work

With the completion of a reliably water tight and fully functional submarine chassis, future work can be focussed on completing the external and internal mechanical subsystems and finishing the logic that will drive the AUV at the competition. This includes: the mechanical arm, the ballast system, the torpedo launcher, vision detection and tracking code, PID based stability code, and further testing of all sub-systems. These systems have been under some amount of development, but need the attention of at least one student, preferably two, per system for a year. This would ensure that the systems are robust and then are packaged into the final design as streamlined as they were initially intended to be.

The ballast system has the most work completed in modelling and integration with the other systems left to complete. In the future it needs to be manufactured and prototyped multiple times with its electrical driving system so the control, water tight reliability, and size can be dialed in. The ballast system will function as the safety device of the submarine, and is an imperative device for the successful autonomous functionality.

The mechanical arm was initially modelled to be relatively simple, and to meet requirements that were tailored for the 2017 and 2018 competition tasks. These requirements should be reviewed and many of them deprecated. New requirements need to be written detailing the size constraints of the manipulator, but the best option and most easily implementable mechanical arm would be a 3 rotational joint arm with a 3 joint end effector. The arm should be streamlined and use fairings to maintain good flow while it is not in use. This allows for the modularity to complete varied tasks and this arm is a commonly studied and implemented configuration.

The torpedo launcher needs to be reformulated to be packaged in a streamline manner to the submarine, also making use of fairings. Since the controlling mechanism for the launcher is relatively simple, the majority of the effort spent on this extremenity should be focused on the torpedo design itself for accurate flight, and the actual packing of the launcher in or on the submarine.

After the last pool test, it was concluded that the propulsion systems performed successfully while logging temperature and current. The EMS can readily accept more values such as pressure, and IMU data. The battery ran for the maximum duration of 15 minutes, and the motors and ESCs performed at 50% and 100% capacity without overheating inside of the chassis. Moving forward, the EMS code will need some minor development as the Controls Subteam brings the AUV closer to autonomy. At which rate, that would be defining the absolute maximum chassis temperature and current and recognizing when the battery is too low. There are no recommendation to continue the project with a “Propulsion” team for future iterations. A few things that could be refined would be:

- Design a simple printed circuit board for the thermistor strings to reference a single resistor as opposed to having a ton of running wire through the sub going to the multiplexor
- Reduce the number of thermistors to just 6-8 for monitoring high risk hardware items
- Get a connector with ribbon cable attachments to replace hand soldered connector and wires
- Heat shrink and conformal coat everything for waterproofing
- Make sure there is no exposed wire to reduce possible shorts

There will always be a lot to do for sensors as there are advancements in sensors and computers. They are becoming more powerful, sensitive and smaller. Currently the AUV needs more vision coding so it is able to follow a line and recognize more objects. A lot of the base code is there, it just needs to be expanded. The dead dead reckoning from obtained solely from the IMU still need some work. Specifically in the area of filtering. As already mentioned the code that hands all of the data is already there, the focus should be getting python filters to remove drift from the acceleration and gyroscope. This should not be priority as there are other possible methods of obtaining a dead reckoning map that could be more accurate and easier to implement. One method would be to use a hydrophone array in combination with pressure transducers. The hydrophone array would be able to accurately determine the change in AUVs x and y coordinates and the and the pressure transducers can determine z component of position relative to the surface. With that being said, there have been many advancements this semester. Vision is able to draw a bounding box around a ball and track it. OpenCV has been installed onto several different computers that can be used in the AUV including a Raspberry pi. A PID has be created that takes in orientation information from an IMU, makes judgments and controls the motors. Several pressure transducers have been calibrated and install onto the AUV that will be able to determine dept of the AUV. As previously mentioned, there will always be more work for the sensors sub team and should be comprised of electrical engineers and computer scientists.

The 2017-2018 Controls sub-team spent a lot of time going to meetings that didn't really affect their subteam. The controls team should not have more than one meeting per week. Whether that is going to another sub-teams meeting, meeting as a Controls team, or going to a whole team meeting. An ideal situation for Controls would be to have the whole team work on a three week rotation. One week go to the whole team meeting, the next week Controls would meet as a team, and the last Controls might split up, having each member meet with the other subteams. Depending on the whole team's subteam composition, it is important that every Controls member has an idea of what all other sub-teams are working on, including the mechanical team.

On a technical level, future Controls teams need to work on stabilization. Then, move on to integrating the sensors and vision. Having a reliably stable chassis is important to have all other subsystems work properly. Once the AUV is stable then Controls can start working on navigation, choosing a method as to how the AUV will make decisions for movement.