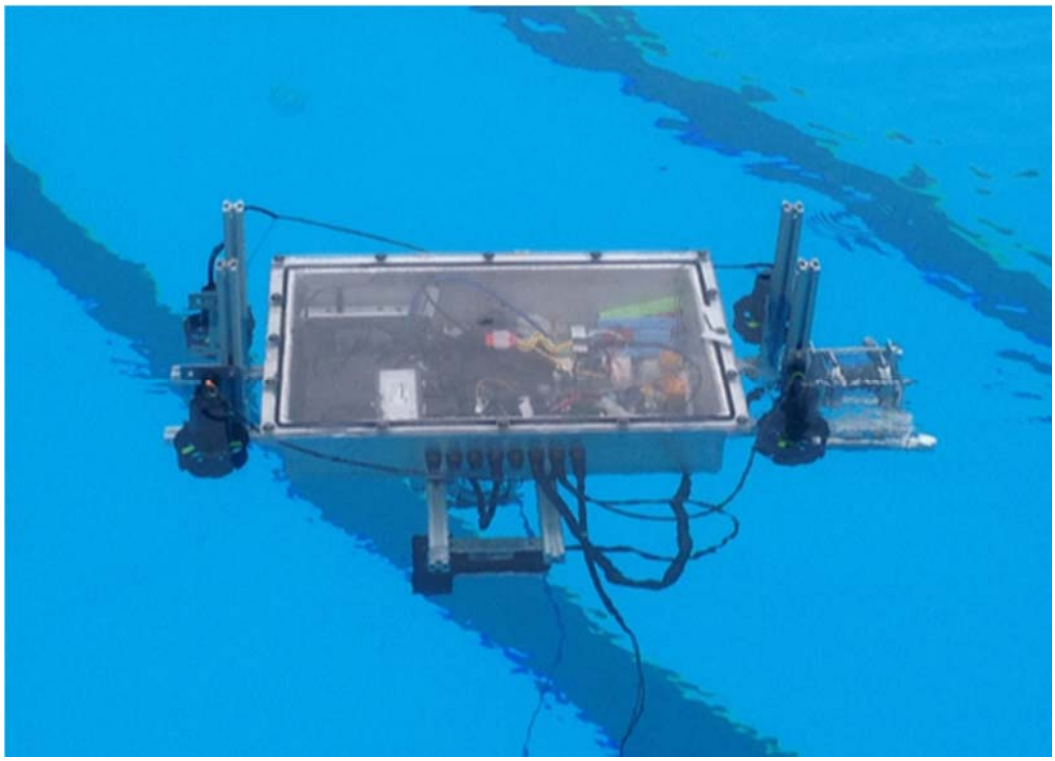
Team 4: ECE RoboSub



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Submitted To: Dr. Hooker

Authors: Brandon Anderson, LaNeicia Gomez, Travis Hett, Gabriel Mendoza,

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Abstract

This report contains the needs, proposed solutions, and other defining elements of the 2015-2016 RoboSub senior design project. The goal of the team is to create an autonomous submarine meeting the requirements to compete in the AUVSI 2015 RoboSub competition. All the information in this report specifies what is needed and the steps and solutions that will best accomplish that. The project is a continuation of earlier senior design projects, which were still in development and incapable of meeting the competitions requirements. The needs of the submarine are to install and utilize the proper devices for full functionality. The components of the sub have been explored, and groups have been created with specific tasks to move the project forward. A plan has been implemented and goals have been set to complete this project more efficiently.

1 Introduction

With a substantial increase in the use of autonomous systems, a growing need for developing this technology has led to the formation of many projects and competitions designed to spur research into this area. From research to military operations, autonomous systems can grant access to areas previously inaccessible to humans. Many competitions currently encourage people to develop autonomous systems of their own. One such competition is the AUSVI RoboSub competition. The objective of this project is to design an autonomous submarine capable of competing in the AUSVI RoboSub competition.

Currently, the RoboSub we have is not able to meet performance specifications set down by the rules of the competition. The sub must complete a number of tasks on a course as shown in Figure 1. This paper describes the problems of the current design, the goal of the future design, and steps needed to in order to accomplish the specified goals. Ultimately, the team hopes to make the current RoboSub able to compete in the competition next year.

2 Need Statement

The project is required because it provides an opportunity for students to implement the knowledge gained from the many courses taken during the student's undergraduate career. The College of Engineering will allow this project to be done by sponsoring this group. Not only will this project be an investment financially, it will also serve as a mental investment. The faculty is determined to ensure that the students are successful. By doing so, the College of Engineering have provided information and a RoboSub from previous years. The current situation for the project is that it needs improvement before taking it to competition. The RoboSub is unsatisfactory because there are cracks in the glass that protects the internal parts from water damage. The size and shape of the current RoboSub is also unsatisfactory. Because of the many components, there is a large power consumption. This will require a battery that will have a long enough battery life to sustain the sub for the course it will have to run. The Robo Sub is not properly balanced when maneuvering underwater due to it being extremely buoyant. Both the internal and external parts of the RoboSub need to be analyzed and reconsidered before taking it to competition.

Need Statement: The current RoboSub has too many complications that prevent if from being competition ready.

3 Goal Statement & Objectives

Continue developing an autonomous submarine that will meet the requirements of the AUVSI foundation's RoboSub Competition.

Objectives (based on 2015 competition requirements[1]):

- Identify gates floating near the top of the water and steer through them
- Identify guides on the bottom of the pool and reorient the sub to follow them
- Identify multiple colored buoys and touch them in a specified order
- Identify a floating "portal" and navigate through it
- Identify bins on the bottom of the pool, one with a lid to be removed, remove the lid and drop markers into it.
- Slide open a door revealing multiple holes and corresponding numbers, then fire torpedos through specific holes to signify a certain number
- Identify and move two objects from location to another in a specific order
- Surface the sub up into a certain area

4 Methodology

The team plans to operate as closely as possible to a prescribed schedule of events. Due to the nature of the project, and the fact that the official rules for the competition do not come out until later in the year, this schedule is subject to change as the team progresses and new constraints appear. The ECE RoboSub team will be collaborating with the ME RoboSub team and working on the same sub by breaking up the subsystems and working on individual parts of the sub to complete a whole working unit. As such, the members of each team will be working closely on different parts of the subsystems, and the schedules of both teams will overlap based on which part each of the sub the team members are working on at any given time. Tentatively, the team plans to familiarize itself with the operating systems of the sub, and have an operable sub that can properly maintain its swim path and move consistently underwater by the end of October. This

task will be assigned to the all ME and CE members. By the end of November, the team plans to have designs for a new hull and have a sub that is able to identify each of the different task zones and determine which operations to carry out. The hull will be designed by the ME members, while the coding for task recognition and operations will be designed by the CE members. By the end of December, the team plans to have a gripper, torpedo launchers, and beacon recognition components designed, built, and mounted on the sub. Gripper and torpedo launcher design will be carried out by the ME members, while beacon recognition and operating code will be designed by the CE members.

5 Constraints

- The RoboSub must comply with all of the AUVSI foundation's competition rules:
    - Sub must be less than or 125 lbs
        - Sub must be less than or 84 lbs for no penalty to be incurred.
    - Sub must be maneuverable through "gates"
    - The torpedoes size, weight, markings and potential "loss" are identical to the Markers.
        - The torpedoes must travel at a "safe" speed.
            - A "safe" speed is one that would not cause a bruise when it strikes a person
    - Each marker must fit within a box 2.0" square and 6" long.
        - Each must weigh no more than 2.0 lbs in air.
        - Each marker must bear the team name or an emblem.
        - Penalties are as follows:
            - Any marker that exceeds these limits by less then 10% will result in a 500-point penalty. Any marker that exceeds these limits by more than 10% will be disqualified.
- The total cost must not exceed the allotted budget
- An example of competition constraints is listed in Table 1.[1]

Table 1. Competition Scoring

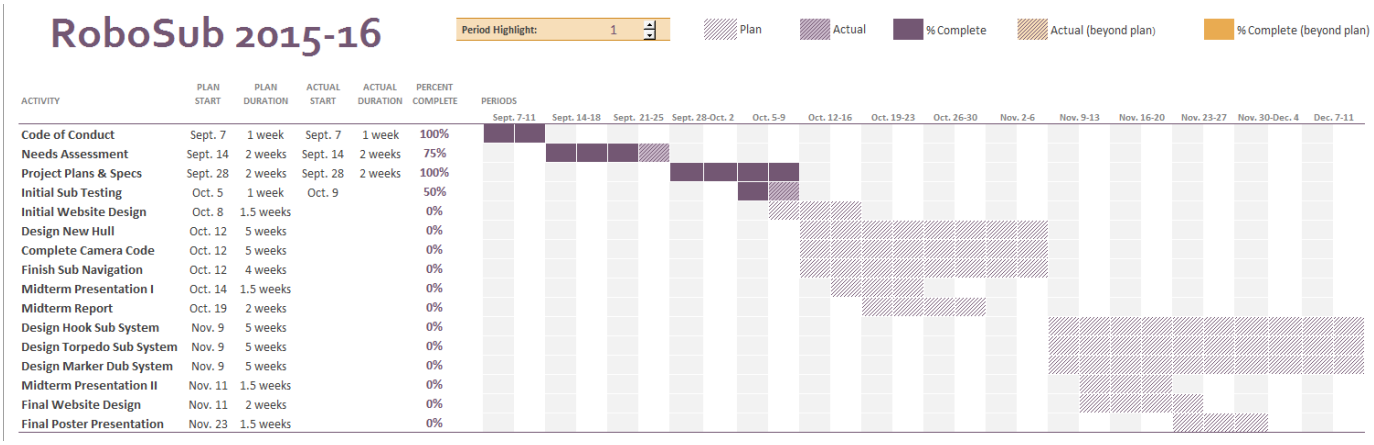
Subjective Measures	**Maximum points**
Utility of team website	50
Technical merit (from journal paper)	50
Written style (from journal paper)	50
Technical accomplishments (from static judging)	75
Craftsmanship (from static judging)	75
Team uniform (from static judging)	10
Team Video	50
Discretionary static points (awarded after static judging)	40
Total	400
Performance Measures	**Maximum points**
Weight	See Table 1
Marker/Torpedo exceeding weight or dimensional specifications by < 10%	-500 per marker
Pass through the validation gate	100
Maintain a fixed heading through gate	150
Follow the "Path"	100 /segment
Check Flux Cap (any solid, Red than Green)	400, 800
Time Portal (>½ above, <½ below & parallel) Straight through // with Style	400, 600 // 1000, 1400
Refuel: remove lid	700
Refuel: any, primary/secondary	500, 1200 / marker
Set Date: remove lid	700
Set Date: any, corr lg, corr sm	500,1000,1500 / torpedo
Surface within an Octagon	500
Surface within the correct Octagon	2000
Surface with the Object	600 / object
Drop the Object	200 / object
Object on Railroad	1000 / object
DeLorean in front of Train on Railroad Track	1000
Finish the mission with T minutes (whole + fractional)	T x 100

6 Work Breakdown Structure

6.1 Task List

With the collaboration of the two RoboSub teams, tasks will be broken down into those pertaining to Mechanical aspects and those pertaining to computer aspects. Designing a new hull, calculating heat dissipation, designing a gripper, torpedo launcher, and frame mounts will be designated to the ME members. Designing the movement codes, task recognition, gripper movement, torpedo firing, and visual capabilities will be designated to the CE members.

6.2 Gantt Chart



ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Code of Conduct	Sept. 7	1 week	Sept. 7	1 week	100%
Needs Assessment	Sept. 14	2 weeks	Sept. 14	2 weeks	75%
Project Plans & Specs	Sept. 28	2 weeks	Sept. 28	2 weeks	100%
Initial Sub Testing	Oct. 5	1 week	Oct. 9		50%
Initial Website Design	Oct. 8	1.5 weeks			0%
Design New Hull	Oct. 12	5 weeks			0%
Complete Camera Code	Oct. 12	5 weeks			0%
Finish Sub Navigation	Oct. 12	4 weeks			0%
Midterm Presentation I	Oct. 14	1.5 weeks			0%
Midterm Report	Oct. 19	2 weeks			0%
Design Hook Sub System	Nov. 9	5 weeks			0%
Design Torpedo Sub System	Nov. 9	5 weeks			0%
Design Marker Dub System	Nov. 9	5 weeks			0%
Midterm Presentation II	Nov. 11	1.5 weeks			0%
Final Website Design	Nov. 11	2 weeks			0%
Final Poster Presentation	Nov. 23	1.5 weeks			0%

PERIODS: Sept. 7-11 | Sept. 14-18 | Sept. 21-25 | Sept. 28-Oct. 2 | Oct. 5-9 | Oct. 12-16 | Oct. 19-23 | Oct. 26-30 | Nov. 2-6 | Nov. 9-13 | Nov. 16-20 | Nov. 23-27 | Nov. 30-Dec. 4 | Dec. 7-11

7 Assign Resources

The initial priority of the project is to run and perfect the initial sub left from previous years. Gabriel and Travis will be leading the camera code. They will make sure the code is in good working order, possibly looking into a new underwater camera. By completion, the code should be able to identify several different colors and their location/orientation and understand what is required by the combination of the two. LaNeicia will be working on the thruster/navigation code. This part of the project will guarantee that the thrusters are working properly. The depth sensor will also need to be in good working order. A new depth sensor might need to be utilized in this project. Brandon will be working on the hull team. Once done, a new hull with a much ligher,

more hydrodynamic design will be used for the RoboSub. Ideally this hull will be less than 100 lbs and able to hold the internal and external electrical components while keeping them cool and allowing for easy access to the internal parts.

8 Product Specifications

8.1 Design Specifications

The competition supplies rules and guidelines to follow as written in the constraints. The Sub must weigh less than 125 lbs, with extra points given to subs less than 84 lbs. Our sub currently weights 120 lbs. Our future design will ideally be under the 84 lbs marker. It must also be able to fit in a 6’ x 3’ x 3’ box. This sub requires many subsystems in order to be completely functional. As such, the needed power will be calculated as more and more systems are added and a more accurate estimation can be made.

8.2 Performance Specifications

As the submarine is constructed to meet the requirements of the AUVSI competition, its performance is limited by the competition. The sub is required to run autonomously. As such, its range will be limited to the size of the pool. Because the rules vary from year to year, the exact performance specifications will not be known until the 2016 competition rules are released. However, based on previous year’s requirements, many functions can be created and manipulated when the information is finally known. It must be able to identify and discern commands based on the orientation and color of different pipes and objects. With pipes it must either orient itself according to the pipe, or navigate in between them. The colored objects correspond to other required tasks as specified in the goals section[1]. A torpedo must also be deployable from the sub. A hook will be used to lift and move different items. In order to better debug the programming, data transmission from testing will be done during the test through waterproof Ethernet enabled screen sharing.

9 Conclusion

With a proper schedule and allocation of tasks, the team can properly move forward with the design aspects of the RoboSub project. Moving forward, parts and sensors can be purchased and added to the sub. The collaboration of the ME and ECE RoboSub teams will aid significantly in the work that can be accomplished for this project. Knowing what needs to be done in a timeline, can facilitate the production of a competition ready sub by the end of the Spring.

10 References

1) AUVSI Foundation 2015 RoboSub Competition Rules and Mission http://higherlogicdownload.s3.amazonaws.com/AUVSI/fb9a8da0-2ac8-42d1-a11e-d58c1e158347/UploadedFiles/RoboSub%20Competition%20Official%20Rules%20and%20Mission%20-%202015.pdf