Needs Assessment

Design and Development of an Autonomous Underwater Vehicle

Team 23

AUVSI Robosub

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Abstract

The AUVSI Robosub competition is a yearly event held in San Diego California amongst teams from around the world. Our team intends to be the first team to represent the FAMU/FSU College of Engineering in the 2016 competition. This will be accomplished through the design, development, and extensive testing of a modular sub which meets all of the competition requirements provided by the AUVSI Robosub competition. Analysis has been completed on other teams design including past winners and previous teams from FAMU/FSU College of Engineering. These analyze the cost of the design as well as the overall components and methods used. Furthermore the sub from the 2015 ECE team was examined and an inventory of parts was created for possible use in our design. Our next steps will include testing last year's sub both at the component and system level. After this testing we will build upon last year's design to make a working platform to integrate our new ideas.

1 Introduction

FSU's autonomous underwater vehicle has been handed down for several years and the coming senior design team embarking on this challenging design project in hopes of making it to the International RoboSub Competition in San Diego, California. The main objective for the senior design team this year is to improve upon the progress made by last year's senior design team in hopes of taking the progress already made to the next level of development and design.

At this point what it is known are the constraints and objectives the Robosub competition required of last year's underwater vehicles including the ability to operate completely autonomously, maneuver through obstacles and recognize shapes and color for direction, firing torpedoes through designated target, recognizing a frequency and traveling to it. At this point it is assumed last year's requirements will be similar to this year's and move forward. What needs to be done is figuring out how far last year's team actually got, in terms of their submersibles ability, and how much of their hardware and software is useful of us to take with us as we take this design to the next level.

2 Project Definition

2.1 Background research

The AUVSI Robosub competition is held yearly amongst schools from around the world. The competition rules stay mostly the same from year to year[1]. In the past these rules have included picking up an object from the bottom of the pool, shooting a torpedo at a target, and following a designated path. Figure 1 below shows the layout of the pool and the different tasks to be completed. Teams typically represent either mechatronics clubs or senior designs teams from their respective universities. In addition to the variety in schools competing there is also a wide distribution in the complexity of designs. For example the winner of the 2015 competition was San Diego State University[2]. This team has a large multidisciplinary group of engineers that

build upon previous years design. At the other end of the spectrum is teams such as the Amador Valley High School robotics club which is comprised entirely of high school students[3].

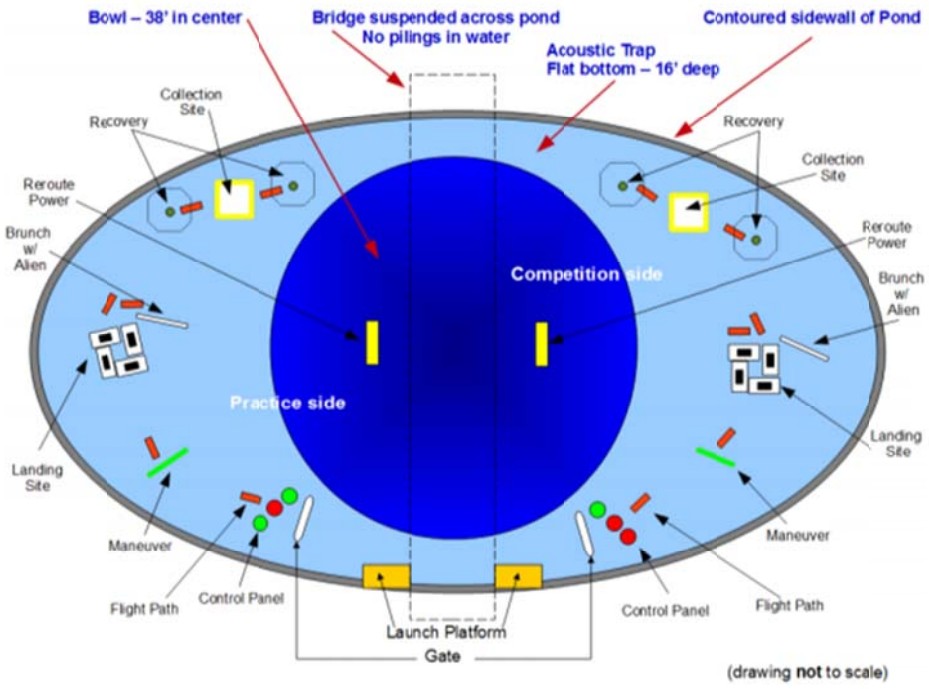

Figure 1: Competition Track

Our biggest competition will be teams that have previously competed in the competition because these teams have the opportunity to optimize their code and overall design based off performance in past years. Our situation is different because the FAMU/FSU college of engineering has never competed at the competition or fully completed a design. For this reason we must study our competitors by reading journal papers which are submitted by each team as a requirement for entry into the Robosub competition. In these papers the teams provide insight on how their sub was designed. In addition to these papers many teams have websites with additional resources that our team can review to give us insight in our own design.

2.2 Needs Statement

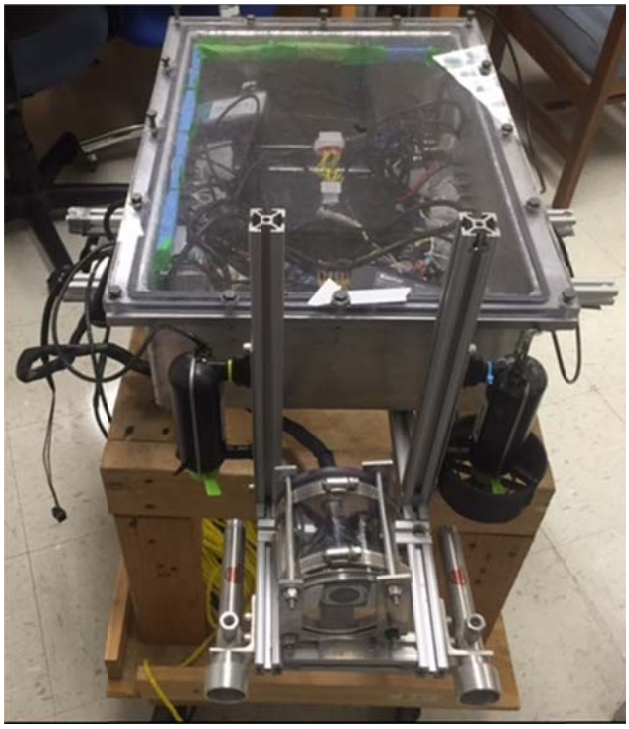

Figure 2: 2015 Sub Design

The development of a robotic submersible to bring to the AUVSI competition has been a university design project for many years. However, no design has been successful enough to compete. The most recent iteration of the submersible had its share of problems principally the design and integrity of the hull was less that satisfactory. Due to various leakage and weight issues the robot was delayed indefinitely and the team did not end up putting in the various additional subsystems needed. While many of the components are in the current model the implementation was lacking. A revised version is necessary in order to better bring these components together in a coherent manner. The previous year's autonomous underwater vehicle is incomplete and unable to be brought to the upcoming competition.

2.3 Goal Statement & Objectives

Goal Statement: "Redesign and improve upon last year's autonomous underwater vehicle making it capable of navigating an underwater course and accomplishing a variety of tasks set forth by the AUVSI competition."

Objectives:

- Fix leakage problem in hull
- Minimize weight
- Restructure frame in which the hull sits
- Develop various subsystems needed for competition

2.4 Constraints

Table 1: Weight Restrictions

Table 1: Size and weight constraints on AUVs entered into the competition.		
	Bonus	**Penalty**
AUV Weight > 125 lbs (AUV Weight > 56.7 kg)	N/A	**Disqualified!!!**
125 lbs ≥ AUV Weight > 84 (56.7 kg ≥ AUV Weight > 38 kg)	N/A	**Loss of** 250 + 5(lb – 125) 250 + 11(kg – 56.7)
84 lbs ≥ AUV Weight > 48.5 (38 kg ≥ AUV Weight > 22 kg)	**Bonus of** 2(84 – lb) 4.4(38-kg)	N/A
AUV Weight ≤ 48.5 lbs (AUV Weight ≤ 22 kg)	**Bonus of** 80 + (48.5 – lb) 80 + 2.2(22-kg)	N/A

This section describes the requirements and constraints for the design of the AUV as described within the rules for the 18th Annual International Robosub Competition[4]. These rules given are the requirements for the AUV to compete in the competition and thus are adequate constraints for the project.

Constraints

· The AUV weight must not exceed 125 pounds in air

· The AUV must be able to fit in a 6 foot by 3 foot by 3 foot box

· Torpedoes and Markers must be able to fit into a 2 inch by 6 inch space

· Torpedoes and Markers must have a dry weight of no more than 2 pounds

· Torpedoes must travel at a “safe” speed, or a speed that will not cause bruises when it strikes a person

· The vehicle must be battery powered and the battery must not have an open circuit voltage that exceeds 60V

· The vehicle must have a kill switch that can be easily accessible

· All propellers must have shrouds that surround them and have at least a 2 inch distance between the spinning disk and the edge of the prop.

· The AUV needs to be buoyant by at least 0.5% of the sub’s mass when it has been shut off through the kill switch.

2.5 Methodology

Our team intends to maintain a schedule such that there is a large amount of time in the spring semester to test and debug our sub in preparation for competition. With this in mind we believe that we should have an initial version of our sub in the water and tested well before the end of the semester in December. Many components may potentially be salvaged from last years sub giving us a jump start in the design process. Before additional work is done it will be necessary to test the components we intend to keep and integrate them as whole system. With a basic platform working we can then focus our efforts on debugging and installing hardware to complete competition tasks such as torpedo launches and lifting submerged items. Specific requirements have not yet been laid out for the 2016 competition so our goals for the near future must remain flexible and focused on creating a robust sub that can be built upon pending future requirements. Furthermore our team is still in the initial stages of our project therefore more detailed objectives

and schedule will become available as we proceed. To help with choosing what subsystems to focus on developing further the team decided to make a House of Quality(HOQ) matrix in order to find what engineering characteristics should be highlighted. The HOQ can be seen in table 2. From this table it can be seen that the dimensions of the body, the electronics housing, and the sensing equipment are the most important engineering characteristics.

Table 2: House of Quality

			Engineering Characteristics							
Units			ft^3	lbf	lbf	N/A	lbf	N/A	N/A	N/A
Customer Requirements		Importance Weight Factor	Dimensions	Buoyancy	Weight	Material	Thrust	Sensing	Frame	ElectronicsHousing
Cost		5	1			3	1	9	3	3
Accessablity		4	9		3				3	9
Size		3	9	3	3				3	3
Durability		4				9			3	3
Waterproof		5				3			1	9
Manuverability		5	3	3	1		9	9	1	1
Safety		5			3	1	3	1	1	3
	Raw Score		83	24	41	71	65	95	63	137
	Relative Weight %		14%	4%	7%	12%	11%	16%	11%	24%
	Rank Order		3					2		1

2.6 Schedule

A schedule of what was outlined in the methodology section can be seen in the Gantt chart located in figure 3. This Gantt chart is a work in progress simply giving an estimate of how long everything should take.

Task Name	Duration	Start	Finish
Needs Assessment	2 days	Thu 9/24/15	Fri 9/25/15
Old Sub Analysis	11 days	Mon 9/28/15	Mon 10/12/15
Troubleshoot	8 days	Tue 10/13/15	Thu 10/22/15
Submerge the Sub	2 days	Fri 10/23/15	Sun 10/25/15
Work on Sub-Systems	14 days	Mon 10/26/15	Thu 11/12/15
Re-Submerge	2 days	Sat 11/14/15	Sun 11/15/15
Debug	5 days	Mon 11/16/15	Fri 11/20/15
Polish	10 days	Mon 11/23/15	Fri 12/4/15
Final Submersion of the Semester	2 days	Sat 12/5/15	Mon 12/7/15

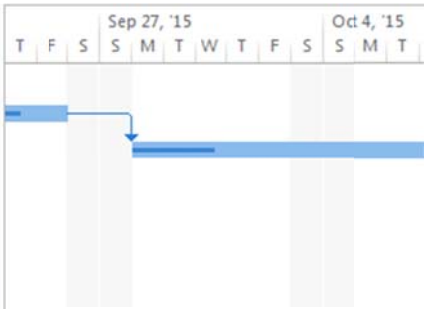

Figure 3: Gantt Chart

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3 Conclusion

The starting point for this project was to first do some preliminary research of older subs that have had success. The sub has to perform specific tasks so research was done on previous competitions so that there could be a starting point as the new rules for the upcoming competition have not been released yet. A bill of materials has been created and a schedule set up to ensure that the sub gets built as quickly and efficiently as possible. The next step in this project will be to reconstruct the previous FAMU-FSU robosub to see what systems are still operational and if any parts can be salvaged. The goal is to have a prototype sub under water by November.

4 References

1.) “RoboSub” AUVSI Foundation. Web. 25 Sept. 2015
<http://www.auvsifoundation.org/foundation/competitions/robosub>

2.) "SDSU Mechatronics Wins 1st Place at 2015 AUVSI International RoboSub Competition." *SDSU Mechatronics Club*. Web. 25 Sept. 2015. <http://www.sdsumechatronics.org/>.

3.) "AVBotz." *AVBotz*. Amador Valley High School Robotics Club. Web. 25 Sept. 2015. <http://www.avbotz.com/>.

4.) "RoboSub Competition Official Rules and Mission." *Auvsi Foundation*. Web. 26 May 2015.