AUVSI Robosub

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Team 09

Project Plan Report
Document

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Introduction

It has been proposed that Northern Arizona University join the Robosub competition for the Association for Unmanned Vehicle Systems International (AUVSI) in 2016. Team nine for the Mechanical Engineering Design course has decided to take on this task. AUVSI has been holding this competition for 18 years and will host another competition in July, 2016. The competition is co-sponsored by the U.S. Office of Naval Research and is open to all students all over the country as well as internationally. Competitors in the past have included students from both high schools and universities worldwide. The competition requires that the robot being tested is fully autonomous and submersible [1].

Northern Arizona University does not yet have any kind of robotics team or a Robosub to compete in the competition, so the team plans to complete the project from start to finish. In order to do so, a proposal must be submitted to the AUVSI competition board to get accepted into the competition as well as complete the full design for the robot. The goal for the project completion is to create a competitive robot that meets all of the design requirements and completes all of the tasks autonomously.

Objectives

Although the official competition rules have not yet been released, all projects in the past have required that the same tasks be completed. Figure 2 in appendix A lists the tasks that have been required in the past, along with the units that define their completion. In order to make a design for the upcoming competition, NAU will plan to finish these requirements. In the past it has been required that the robosub must pass through gates, hit targets with a torpedo, and make contact with specific targets that are of a certain color. Some more tasks include dropping markers into specific bins after removing the lid. All of these tasks must be completed autonomously so there is a good deal of programming that must be completed so that the sub can identify different shapes and colors and navigate itself along the correct pathway.

Constraints

There are several constraints that must be met when considering designs for the RoboSub. Due to the nature of the competition, they are all more-or-less equally important; if the constraints are not met, our team runs the risk of being disqualified and being unable to compete. First and foremost, the RoboSub must be autonomous. It may not be controlled by or communicate with an outside source, and must do all of its problem-solving and decision-making independently. It must weigh less than 57kg, and fit into a box of a size not exceeding 1.83 by 0.91 by 0.91 meters. Another consideration for the competition is that the robosub must complete all tasks within a designated time of fifteen minutes. It must have a clearly marked manual kill switch accessible from the outside designed to terminate power to all propulsion components. This is assumed to prevent injury or damage to the equipment or other participants in case of malfunction or error. The sub must be electrically/battery powered, and the batteries must be sealed to reduce risk of damage or corrosion; the batteries cannot be charged inside of sealed vessels, and the open circuit voltage may not exceed 60 VDC. Except for torpedoes and markers, no part of the sub may detach during the runs. The sub must be able to be slung on a harness or sling for measuring, transportation, and safety purposes. Failure to meet one or more of these constraints, including additional ones not detailed here, can result in the team's disqualification from the competition.

Quality Function Deployment

The Quality Function Deployment (QFD) (figure 3 in appendix A) lists the customer needs and the engineering requirements for the Robosub competition. These requirements accommodate the customer needs and show the direction of improvement that needs to be taken to meet all criteria. The requirements for improvement were compared to the customer needs as well as the engineering requirements. The team learned that the most important requirement is linear travel. For instance, the highest score of any Engineering requirement is the frame shape, which has an effect on nearly all the customer needs. What's more, by scoring these requirements, the team can decide the most important criteria, such as the frame size, thruster power and the computer hardware size. Through the use of the House of Quality (Figure 4 in Appendix A) the positive and negative relationships can be seen between different engineering requirements. This can be used to analyze which design alterations will impact other requirements to determine a balance that satisfies the customer requirements most efficiently. With the information learned from the QFD, the team was able to begin generating concepts that fulfill both the customer needs and the engineering requirements.

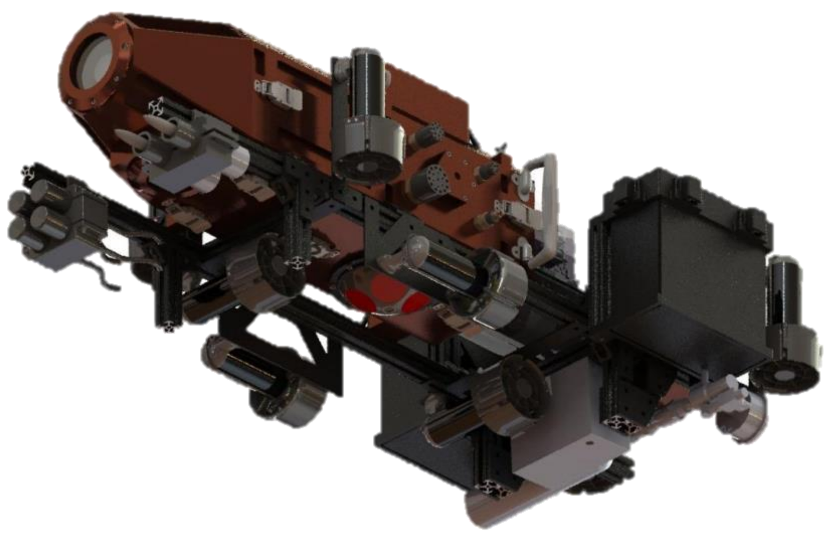
State of the Art Research

The term state of the art refers to the highest level of general development, as of a device, technique, or engineering field achieved at a particular time. This section is to shows the previous examples competition.

<u>San Diego State University Robosub</u>

Figure 1 : SDSU's 2015 Robosub design

Source: sdsumechatronics.org



The main design features of this robot is that it has eight thrusters providing propulsion in the forward, reverse, up, down, left, right, clockwise, counterclockwise, yaw, pitch, and roll. It is powered by two lithium-ion cell batteries placed in parallel and features a collection of inertial, visual, and pressure sensors that enable successful navigation through the obstacle course. It also includes an advanced vehicle software system-graphic user interface. This example allows the team to see better ideas for thruster position and software systems [2].

Project Plan

Figure 5 in appendix A shows a Gantt chart detailing the group's plan for moving forward with the initial phases of the project's progression. After this initial planning step, the group will work to create several concepts of what the final product should look like. Decision matrices and other tools will then be used to determine which concept will be implemented. After making this important decision, the group will create and test a prototype before compiling the final project proposal.

The team will meet (via Skype) with the Carl Hayden High School Falcon Robotics Team at least twice throughout the semester to discuss the project and exchange information. While they may not have much theoretical knowledge about engineering systems, they do have some experience with robotics in a variety of applications. Their input will be valuable to determine the most practical design solutions and to weed out any overly ambitious ideas that may not be realistic in application.

The bottom of the Gantt chart shows the weeks in which presentation and demonstrations will be conducted. These milestones will be important deadlines for the team and will help to keep the project on track.

Throughout the course of these phases, the group will maintain and update a website which will showcase the group's work and help to explain the concepts behind the competition. This website will be updated constantly as the group moves forward. Hopefully, it will give any outsiders ample information to understand, and maybe even get involved in the project.

Conclusions

Creating a Robosub to take to the AUVSI competition will prove a difficult task because NAU does not have any past experience in this specific field. It is the goal of the team to see an innovative project from start to finish. To guide future decisions for the design, previous robosub designs from past competing schools can be analyzed to determine which elements have been successful. In order to create a competitive project for the AUVSI competition, all of the constraints must be considered as several of these constraints will result in disqualification if not met. The Quality Function Deployment tables show which of these constraints, engineering requirements, and customer needs are the most important in the design process. It is important to consider the impact that each engineering requirement will have on the other requirements in order to create the best design option. The house of quality (Figure 4 in appendix A) will be used to make these determinations easier. Through the use of the Gantt chart, future action can be planned in order to stay on track and meet the deadline for the competition.

Appendix A

Figure 2: Objectives

Objective	Units
Pass through gates	ft wide
Torpedo target	ft^ area
Bump target	ft^2 area
Remove lid	ft from handle
Recognize Color	Red, blue , green , etc....
Drop marker	ft from bin
Complete all tasks quickly	S

Figure 3: QFD

	PHASE I QFD											
Customer Needs	Customer Weights (1-10)	Material Strength	Thruster Power	Power Source	Sensors Resolution	Camera Resolution	Ballast Volume	Frame Size	Connectors' Young's Mod	Computer Hardware Size	Programming	Casing Volume
Self-Functioning	10				*	*				*	*	
Finish tasks	10		*	*	*	*		*		*	*	
Kill Switch	10							*	*	*	*	
Weight	10	*	*	*	*	*	*	*		*		*
Size	10	*	*	*	*	*	*	*		*		*
Power	10		*	*		*		*	*	*		
Bouyancy	10	*	*	*			*	*		*		*
Recovery	9						*	*			*	
Water proof	10	*	*		*	*	*					*
Cost	8	*	*	*	*	*	*	*	*	*		*
Time to Finish Tasks	7	*	*					*			*	
	Raw Score	6	8	6	6	7	6	9	3	8	5	5
	Unts	Psi	W	W	Hz	MP	ft^3	ft^3	Psi	Bit	Bit	ft^3

Figure 4: House of Quality

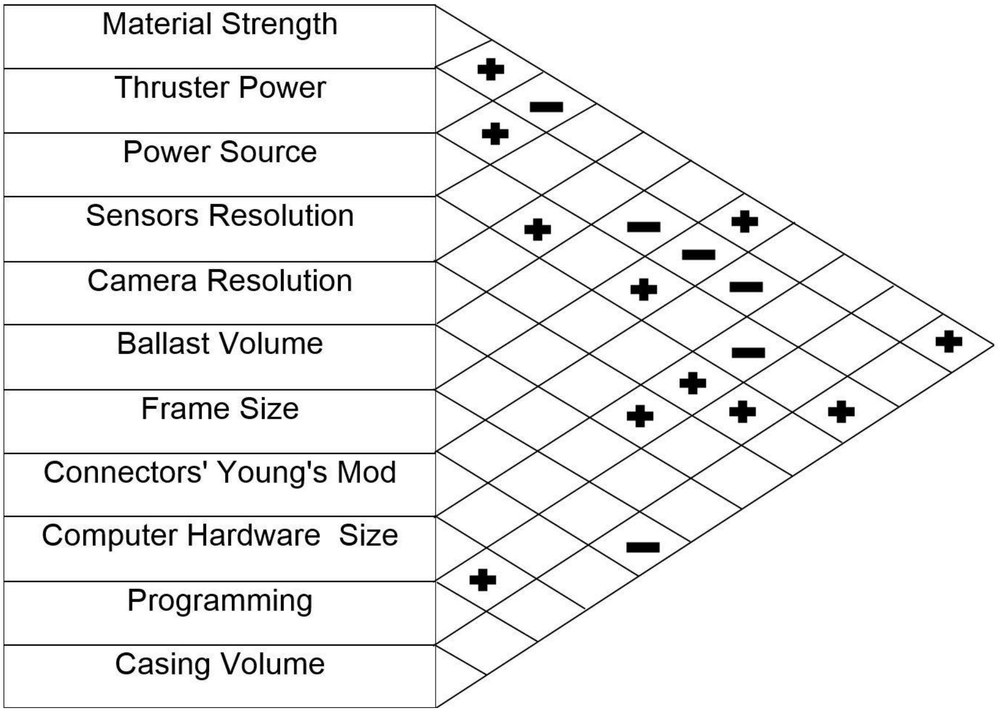
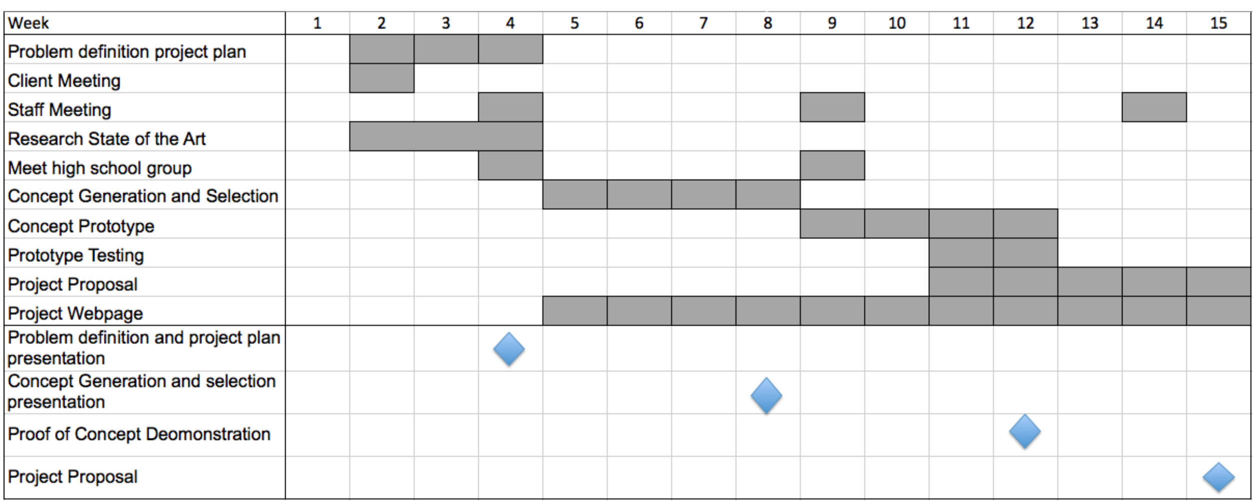


Figure 5



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