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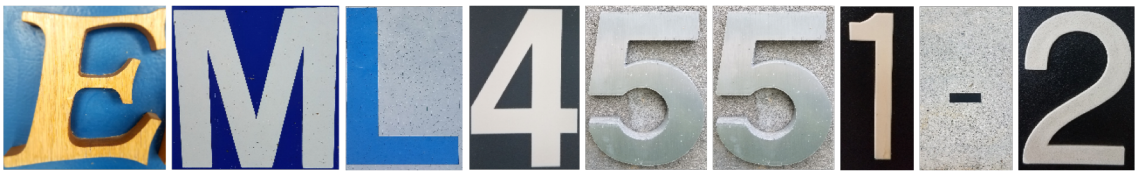

Team 14: AUSVI Robo-boat

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Abstract

The team is to build, and program, an autonomous boat that can navigate an obstacle course and complete challenges along the way. The boat be able to identify goal buoys, avoid obstacles, and launch and recover a drone. Points are rewarded for speed, so the boat must be able to quickly preform its calculations quickly and navigate the course quickly

Keywords: Boat, Autonomous Robot, Computer Vision.

Acknowledgement

FILL THIS IN

These remarks thanks those that helped you complete your senior design project. Especially those who have sponsored the project, provided mentorship advice, and materials. 4

- Paragraph 1 thank sponsor!
- Paragraph 2 thank advisors. – Mconomy and Clark, probably also Ordonez
- Paragraph 3 thank those that provided you materials and resources.
- Paragraph 4 thank anyone else who helped you.

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Chapter One: EML 4551C

1.1 Project Scope

Goal Statement:

Create an autonomous boat that will compete in the RoboNation RoboBoat competition and score at least some points in each of the competition.

Needs Statement

Design and build an autonomous boat which has the ability to traverse an above-water obstacle course. The boat must be able to take inputs from the environment and make decisions on how to react to situations.

Constraints

It is important to note that the following requirements are based off of the 2017 rules and regulations for the RoboBoat Competition. The rules will be updated accordingly when the 2018 rules are provided and finalized.

The AUVSI Foundation clearly laid out the constraints for the vehicle within the rules for the 6th Annual International RoboBoat Competition ("Roboboat Final Rules," 2017). There are restrictions for the maximum weight of the vessel (140lbs) and dimensions of the boat (3ft x 3ft x 6ft). Additionally, in the first portion of the competition the boat must be able to autonomously navigate through a single set of buoys. Failure to abide by these three rules leads to an automatic disqualification.

The rules of the Roboboat competition also lay out additional requirements ("Roboboat Final Rules," 2017). Failure to abide by any of these rules may also result in disqualification or loss of points. The requirements are as follows:

- **Autonomy:** The vehicle must be fully autonomous and all decisions must be made onboard the ASV.
- **Buoyancy:** The vehicle must be positively buoyant and must remain buoyant for at least 30 minutes.
- **Communication:** The vehicle cannot send or receive any control information while in autonomous mode. Communication is allowed between the vehicle and subsystems such as the AUV.
- **Deployable:** The vehicle must have its own 3- or 4-point harness for crane deployment.
- **Energy Source:** The vehicle must use a self-contained electrical energy source.
- **Kill Switch:** Vehicle must have at least one 1.5 in diameter button on the vehicle that, when actuated, must disconnect power from all motors and actuators.
- **Remote Kill Switch:** Vehicle must have at least one remote kill switch that provides the same functionality.
- **Payload:** Vehicle must have a place to mount a GoPro (or similar) camera.
- **Propulsion:** Any propulsion system is fine (thruster, paddle, etc.), but moving parts must have a shroud.
- **Remote – controllable:** Vehicle must be remote-controllable to be brought back to the dock.
- **Safety:** All sharp, pointy, moving or sensitive parts must be covered and marked.

- **Surface:** The vehicle must float or use ground effect of the water. Mostly submerged/flying vehicles are forbidden.
- **Towable:** Must have a tow harness installed at all times.
- **Waterproof:** Vehicle must be rain/splash resistant.
- **Weight:** Vehicle must be 140 lbs or less.
- **Interference:** Any vehicle that interferes with the competition's landscape or that leaves the assigned course is considered to be interfering. Interference can result in termination or disqualification at the judges' discretion.

1.2 Customer Needs

Requirements

The requirements for the boat are taken from the competition rules and task required ("Roboboat Final Rules," 2017).

- **Autonomy**: The vehicle must be fully autonomous with all decisions must be taken onboard the ASV.
- **Buoyancy**: The vehicle must be positively buoyant, remaining buoyant for at least 30 minutes.
- **Communication**: The vehicle cannot send or receive any control information while in autonomous mode. Communication is allowed between the vehicle and subsystems such as an AUV.
- **Controllable**: The vehicle must have at least one 1.5 in diameter red button located on the vehicle that, when actuated, must disconnect power from all motors and actuators. In addition

to the physical kill-switch, the vehicle must have at least one remote kill switch that provides the same functionality.

- **Deployable**: The vehicle must have its own 3- or 4-point harness for crane deployment.
- **Energy source**: The vehicle must use only self-contained electrical energy sources. Sailboats are permitted.

  Payload: The vehicle must have a place to mount a GoPro (or similar) camera. It must have an unobstructed view from the front of the vehicle.
- **Propulsion**: Any propulsion system is fine (thruster, paddle, etc.), but moving parts must have a shroud.
- **Remote-controllable**: The vehicle must be remote-controllable to be brought back to the dock.
- **Safety**: All sharp, pointy, moving or sensitive parts must be covered and marked.
- **Size**: The vehicle must fit within a six feet, by three feet, by three feet "box".
- **Surface**: The vehicle must float or use ground effect of the water. Mostly submerged/flying vehicles are forbidden.
- **Towable**: The vehicle must have a tow harness installed at all times.
- **Waterproof**: The vehicle must be rain/splash resistant.
- **Weight**: The entire maritime system (including UAV) must be 140 lbs. or less.

Engineering Characteristics and Documentation

Engineering characteristics and goals were derived from the requirements so that they can be evaluated.

- **Autonomy**: The boat must be able to function without any external communication. Functioning is defined as being able to identify the environment and react to it.
- **Buoyancy**: The boat should never sink under normal circumstances.
- **Communication**: The boat should be able to communicate with the drone it deploys, a waystation on the land, and the communication relay required for some tasks.
- **Controllable**: The boat should be controllable from a controller, and a computer. It should also have a physical and remote kill switch.
- **Deployable**: The boat should be easy to move and transport, and able to be mounted to the crane that will be used at the competition.
- **Energy source**: The boat should be self-sufficient with contain all its power supplies as a battery.
- **Payload**: The boat will have a docking station for a camera.
- **Propulsion**: The boat will be propelled forward, having at least a 2:1 thrust-to-weight ratio. As points associated with the thrust to weight ratio are uncapped.
- **Remote-controllable**: The boat should be wirelessly controllable from a controller, and a computer.
- **Safety**: All sharp, pointy, moving or sensitive parts will be covered and marked. All electronics will be secured and kept away from the water. The physical kill switch is easily accessible.
- **Size**: The vehicle must fit within a six feet, by three feet, by three feet area. A box will be built to transport the boat in, to ensure it stays within this area.

- **Surface**: The boat will function only as a boat, not as an UAV or a submarine. It will remain positively buoyant, and not submerge, without leaving the water.
- **Towable**: The towable harnesses must always be accessible and mounted.
- **Waterproof**: The boat will be water resistant; the electronics will be kept away from water as much as possible.
- **Weight**: The boat will be 70 pounds or less. The maximum weight to enter the competition is 140 pounds, but that comes with a rather large point cost. At 70 points point scores "0 points" for weighing 70 pounds, and points are rewarded for each pound under 70 pounds.

1.3 Functional Decomposition

Upon breaking down the goals of the project, it became apparent there are a list of functions that are mandatory for a successful run at the competition. These functions are associated with the project as a whole, rather than the individual boat and UAV. A list of these functions can be found below:

- Must be positively buoyant
- Must obtain information from its surroundings
- Must process the information it obtains and make decisions on how and where to navigate
    - Capable of discerning various colors, shapes, and letters/numbers
    - Calculate optimal paths for successful navigation
    - Avoid obstacles

- Use pinger, colored buoys, and various other markers as waypoints for navigation

- Must be capable of launching and retrieving a UAV

1.4 Target Summary

The targets for the Target Catalog, seen in Appendix C, were established by looking at the rules for the competition and the previous year's winners, alongside the existing boat inherited from last year's team.

The physical properties of length, width, height, weight, and buoyancy are mostly defined by the boat that is already built, and the rules for the competition. The other physical properties are obtained by looking at the previous winners and determining what properties would be required to be competitive.

The electronic properties were determined by looking at the rules for the competition and determining what the boat would need to compete and be a serious competitor. The battery life was determined by the looking at the length of the competition and allowing room for error, to ensure the boat doesn't die while competing. The GPS localization accuracy was determined by looking at what accuracy other devices, such as cell phones and other autonomous vehicles, can reliably maintain. The radio communication range was determined by the maximum distance the drone could be expected to fly.

The environmental detection properties were determined by the hardware available to the boat, and by the competitions that it will have to compete in. The color detection accuracy was a large issue for last year's team and will be a high priority as it is an integral part to many of the subsystems.

1.5 Concept Generation

Concept 1.

Concept 2.

Concept 3.

Concept 4.

Concept n+1.

1.6 Concept Selection

1.8 Spring Project Plan

Chapter Two: EML 4552C

2.1 Spring Plan

Project Plan.

Build Plan.

Appendices

Appendix A: Code of Conduct

Mission Statement

Team 14 is committed to ensuring a positive work environment that supports professionalism, integrity, respect, and trust. Every member of this team will contribute a full effort to the creation and maintenance of such an environment in order to bring out the best in all of us as well as this project.

Team Roles

Each team member is delegated a specific role based on their experience and skill sets and is responsible for all here-within:

Team Leader – Nick H

Manages the team as a whole, develops a plan and timeline for the project, delegates task among group members according to their skill sets; finalizes all documents and provides input on other positions where needed. The team leader is responsible for promoting synergy and increased teamwork. If a problem arises, the team leader will act in the best interest of the project.

The team leader keeps the communication flowing, both between team members and NSWC-PC. The team leader takes the lead in organizing, planning, and setting up of meetings. In addition, the team leader is responsible for keeping a record of all correspondence between the group and ‘minutes’ for the meetings, and communication with third party contact. Finally, the team leader gives or facilitates presentations by individual team members and is responsible for overall project plan and progress.

Lead Programmer – Nick G

Develops the software that will run the boat autonomously through the course, interfaces the computers on the boat and the hardware on the boat. The lead programmer is responsible for ensuring the boat can effectively use all of the hardware installed on it, and can navigate the competition regulation obstacles. In addition, the lead programmer is in charge of version control for the software, and devising tests that will effectively demonstrate the boat's strengths and flaws.

Financial Advisor – Mark C

Manages the budget and maintains a record of all credits and debits to a project account. Any product or expenditure request must be presented to the advisor, whom is then responsible for reviewing and the analysis of equivalent/alternate solutions. They then relay the information to the team and if the request is granted, order the select. A record of these analyses and budget adjustments must be kept.

Web Master – Alex N

Develops and maintains the website, ensures it meets all the requirements set forth both by the class requirements and the competition requirements. The Web Master is responsible for the version control of the website and ensuring all information is updated, accurate, and easily accessible.

All Team Members

- Work on the hardware of the boat, and the boat itself.
- Buys into the project goals and success
- Deliver on commitments

- Adopt team spirit
- Listen and contribute constructively
- Be effective in trying to get messages across
- Be open minded to other ideas
- Be willing to compromise when there are disagreements
- Respect other's roles and ideas
- Be ambassador to the outside world in their own task
- Represent FAMU and FSU in an appropriate manner in the competition.

Communication

The main form of communication will be over the group management app Slack as well as regular meeting of the whole team. Email will be a secondary form of communication for uses not being time-sensitive. For the passing of information, i.e files and presentations, Slack will be the main form of file transfer and proliferation.

Each group member must have a Slack account and working email for the purpose of communication and file transference. Members must check the Slack team chat at least twice a day to check for important information and updates from the group. Important information from the sponsor will be sent to all members via Slack, and important dates will be marked on the Slack calendar and set up to give the entire team several reminders.

If a meeting must be canceled, advanced notice will be sent to the team via Slack at least 24 hours in advance.

Attendance Policy

Any team member that cannot attend a meeting must give advance notice of 24 hours informing the group of his absence. Reason for absence will be appreciated but not required if personal. Repeated absences in violation of this agreement will not be tolerated.

Team Dynamics

The members of this team will work cooperatively as a team, while allowing one another to feel free to make any suggestions or constructive criticism without fear of being ridiculed or embarrassed. If any member on this team finds a task to be too difficult it is expected that the member should ask for help from the other teammates. If any member of the team feels they are not being respected or taken seriously, that member must bring it to the attention of the team in order for the issue to be resolved. We shall not let emotions dictate our actions. Everything done is for the benefit of the project and team as a whole, and together everyone achieves more.

Ethics

Team members are required to be familiar with the NSPE Engineering Code of ethics as they are responsible for their obligations to the public, the client, the employer, and the profession. There will be stringent following of the NSPE Engineering Code of Ethics.

Dress Code

Team meetings will be held in casual attire. Sponsor meetings and group presentations will be business casual to formal as decided by the team per the event. The final competition requires that each competing team has a uniform and members that attend the competition are expected to dress appropriately.

Weekly and biweekly Tasks

Team members will participate in all meetings with the sponsor, adviser and instructor. During said times ideas, project progress, budget, conflicts, timelines and due dates will be discussed. In addition, tasks will be delegated to team members during these meetings. Repeat absences will not be tolerated.

Decision Masking

It is conducted by consensus and majority of the team members. Should ethical/moral reasons be cited for dissenting reason, then the ethics/morals shall be evaluated as a group and the majority will decide on the plan of action. Individuals with conflicts of interest should not participate in decision-making processes but do not need to announce said conflict. It is up to each individual to act ethically and for the interests of the group and the goals of the project. Achieving the goal of the project will be the top priority for each group member. Below are the steps to be followed for each decision-making process:

- Problem Definition – Define the problem and understand it. Discuss among the group.
- Tentative Solutions – Brainstorms possible solutions. Discuss among group most plausible.
- Data/History Gathering and Analyses – Gather necessary data required for implementing Tentative Solution. Re-evaluate Tentative Solution for plausibility and effectiveness.
- Design – Design the Tentative Solution product and construct it. Re-evaluate for plausibility and effectiveness.

- Test and Simulation/Observation – Test design for Tentative Solution and gather data. Re-evaluate for plausibility and effectiveness.
- Final Evaluation – Evaluate the testing phase and determine its level of success. Decide if design can be improved and if time/budget allows for it.

Conflict Resolution

In the event of a discord amongst team members the following steps shall be respectfully employed:

- Communication of points of interest from both parties which may include demonstration of active listening by both parties through paraphrasing or other tool acknowledging clear understanding.
- Administration of a vote, if needed, favoring 3/4 greater majority rule.
- Team Leader intervention.
- Instructor will facilitate the resolution of conflicts.

Appendix B: Functional Decomposition

Upon breaking down the goals of the project, it became apparent there are a list of functions that are mandatory for a successful run at the competition. These functions are associated with the project as a whole, rather than the individual boat and UAV. A list of these functions can be found below:

- Must be positively buoyant
- Must obtain information from its surroundings
- Must process the information it obtains and make decisions on how and where to navigate
    - Capable of discerning various colors, shapes, and letters/numbers
    - Calculate optimal paths for successful navigation
    - Avoid obstacles
    - Use pinger, colored buoys, and various other markers as waypoints for navigation
- Must be capable of launching and retrieving a UAV

Appendix C: Target Catalog

Property	Target
Physical Properties[1]	
Length	5 feet
Width	35 inches
Height	28 inches
Top Speed	2 $\frac{m}{s}$
Acceleration	0.25 $\frac{m}{s^2}$
Turn Radius	0 meters [2]
Weight	70 pounds
Thrust to Weight Ratio	70%
Buoyancy	1 hour
Electronic Properties	
Battery Life	60 minutes
GPS Localization Accuracy	5 meters
Radio Communication Range	30 meters
Environmental Detection[3]	
Object Detection Range	7 meters
Accuracy of Color Detection	95%
Accuracy of Distance Reading	95%

1. Length, width, and height, and weight is measured in imperial units because the competition rules in imperial units. All other units are in metric units.
2. Turn radius while not moving in a lateral direction.
3. Environmental Detection in clear weather during daylight hours.

Appendix A: APA Headings (delete)

Heading 1 is Centered, Boldface, Uppercase and Lowercase Heading

Heading 2 is Flush Left, Boldface, Uppercase and Lowercase Heading

Heading 3 is indented, boldface lowercase paragraph heading ending with a period.

Heading 4 is indented, boldface, italicized, lowercase paragraph heading ending with a period.

Heading 5 is indented, italicized, lowercase paragraph heading ending with a period.

See publication manual of the American Psychological Association page 62

Appendix B Figures and Tables (delete)

The text above the cation always introduces the reference material such as a figure or table. You should never show reference material then present the discussion. You can split the discussion around the reference material, but you should always introduce the reference material in your text first then show the information. If you look at the Figure 1 below the caption has a period after the figure number and is left justified whereas the figure itself is centered.

Figure 1. Flush left, normal font settings, sentence case, and ends with a period.

In addition, table captions are placed above the table and have a return after the table number. The second line of the caption provided the description. Note, there is a difference between a return and enter. A return is accomplished with the shortcut key shift + enter. Last, unlike the caption for a figure, a table caption does not end with a period, nor is there a period after the table number.

Table 1

The Word Table and the Table Number are Normal Font and Flush Left. The Caption is Flush Left, Italicized, Uppercase and Lowercase

Level of heading	Format
1	**Centered, Boldface, Uppercase and Lowercase Heading**
2	**Flush Left, Boldface, Uppercase and Lowercase**
3	***Indented, boldface lowercase paragraph heading ending with a period***
4	***Indented, boldface, italicized, lowercase paragraph heading ending with a period.***
5	*Indented, italicized, lowercase paragraph heading ending with a period.*

References

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