RoboBot
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Abstract
As we progress further into the 21st century, an increasing amount of tasks and actions, which were previously controlled by humans, are now being done by sophisticated robots in conjunction with software and clever engineering. Our project explored the aspects and possibilities of an autonomous boat capable of traveling to destinations and avoid obstacles without any human input. The boat was designed around the guidelines for the AUVSI foundation and ONR’s 7th annual International RoboBoat competition held in Virginia Beach. These guidelines included tasks such as obstacle avoidance, speed testing, and autonomous travel. The competition guidelines also included strict rules on boat manufacturing, putting the design teams into constraints that truly test the team’s ingenuity.

The Competition
Design an autonomous and remote controlled boat that can compete in the AUVSI Foundation and ONR’s 7th Annual International RoboBoat Competition in Virginia Beach, VA in July, 2014.

Problem Statement
Design an autonomous and remote controlled boat that can compete in the AUVSI Foundation and ONR’s 7th Annual International RoboBoat Competition in Virginia Beach, VA in July, 2014.

The Hull Design
- Flat Bottom: •Good initial stability •Good for calm waters •Requires little horsepower •Rough ride in choppy waters •Slower speeds
- Round Bottom: •Moves smoothly through the water, even at low speeds •Susceptible to rolling
- Deep V-Hull: •Soft ride •Provides grip when turning •Fast speeds •Low speed stability is not great •Requires more horsepower to operate •Susceptible to rolling
- Multi-Hull: •Great stability due to its width •Has a large turning radius

Final Hull Design:...

Materials Used
- Extruded Polystyrene Insulation
- Fused Black Textured Seaboard
- Buoyant

Area of Boat Submerged
Assumptions: • Acceleration (a) = 0 • A_F = Frontal Area of Boat submerged • Velocity (V) = 0 m/s • F_B = Buoyancy Force

Variables: • p_water = 998 kg/m^3 • T_water = 1.127 m • m_buoy = 20 kg

Calculations: • F = F_B - F_D = m_a = 0 • p_A = p_water • A_f = m_buoy / p_water
• A_f = 0.018 m^2 of the frontal area is 35% of frontal area

Drag Force
Assumptions: • Velocity (V) = 1.4 m/s • F_D = Drag Force • C_D = Coefficient of Drag • A_f = Frontal Area Submerged

Variables: • p_air = 1.2 kg/m^3 • A_f = 0.018 m^2

Calculations: • F_D = 0.5 * C_D * A_f * V^2 • F_D = 36.97 N

Hull Analysis Conclusion
• The maximum weight our boat can contain without being fully submerged is 145 lbs.
• At a weight of 20 kg, our boat will need a thruster that can overcome the drag force of 36.97 N.

Preliminary (Mandatory) Tasks
- Speed and Control Demonstration: Demonstrate the trust of your ASV by hooking up your vehicle to a thrust measurement system. Your vehicle will then generate as much thrust as possible in 10 seconds.

Acknowledgements
Thank you to Professor Ahlgren for his guidance and support throughout the design process. Thank you to Andrew Musulin for his willingness to give us a hand whenever needed.

The Competition
General Requirements:

Autonomy
The boat must be fully autonomous and all decisions must be taken onboard the ASV.

Buoyancy
The vehicle must be positively buoyant and stay buoyant for at least 30 minutes in the water.

Communication
The vehicle must not contain any information or receive instruction while in autonomous mode.

Deployable
The vehicle must have its own 3 or 4 point harness for crane deployment.

Energy Source
The vehicle must be self-contained electrical energy source(s).

Propulsion
Any propulsion system can be used (thruster, paddle, etc.), but moving parts must have a shroud.

Remote – Control
The vehicle must be capable of remote control to be brought back to the dock.

Safety
All sharp, pointed, moving, sensitive, or dangerous parts must be covered and clearly identified.

Size
The vehicle must fit within a six-foot long, by three-foot wide, by three-foot high “box”.

Surface
The vehicle must float or use ground effect of the water. Mostly submerged or flying craft are forbidden.

Towable
The vehicle must have designated tow points and a tow harness installed at all times.

Weatherproof
The vehicle must be rain/splash resistant.

Weight
The vehicle and all sub-machines have a combined weight of 140 lbs. or less.

Alternatives
Seabotix BTD-150 Thruster
- Max Thrust = 28N
- Power: 110 Watt maximum
- Weight: 705 grams
- Max Continuous Amp: 4.25 A

Power Supply
- Two 12V Lead Acid Battery / 160 Watts

Remote Control
- (a) Dual Shake 3 Controller (b) USB shield (c) Bluetooth

Budget
- Extra Material Cost #
- Extruded Polystyrene Insulation $56 4
- Arduino Uno $36 1
- GPS Receiver $40 1
- Seabotix Thrusters* $1100 2
- Lead-Acid Battery $66 2
- Steel Beams $28 4
- Metal Rods (6) $10 1
- Seaboard $65 1
- Battery Charger $20 1
- Construction Adhesive $9 3
- Pololu 755 Motor Drivers $90 2
- GPS Shield GPS10710 $15 1
- Compass $20 1
- Bluetooth $40 1
- Switches $16 4
- Total $1596

* Generous donation by Professor Ahlgren

Electrical Schematic

Programming Method
Step by Step Process:
1. Input GPS Coordinates
2. Current GPS coordinates are signaled
3. Two GPS coordinates are compared
4. Boat will travel north/south first
5. Boat will travel east/west

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