INNOVATORS ROBOTICS

DREADNOUGHT

ABSTRACT

This Technical document describes Innovators Dreadnought (powerful WWII battleship) ROV-Remotely Operated Vehicle that has been constructed for the 2017 MATE-Marine Advanced Technology Education International ROV competition in Long Beach, CA on June 23-25, 2017. Dreadnought was designed and manufactured by Innovator's employees, a teen-lead company, which consist of 12

members and several mentors. Innovators are dedicated to all aspects of robotics &
STEM focusing on safety, innovation and team work creating amazing end products. This ROV was designed to address specific needs outlined by the potential client, the Port of Long Beach, CA & The Harbor Department. Innovators designed Dreadnought to be a product best suited to carry out precise mission tasks to assist in commerce, entertainment, health & safety in harsh aquatic environments.

The 4 needs:

- COMMERCE: Innovators Dreadnought (ROV) has features with overall advantages of speed, durability, strength, multi-functionality. It possesses 2 arms with 180 degrees' maneuverability. These features will benefit the hyper loop installation system because they can extend into small or compact areas allowing for precision on tasks which will expedite delivery of goods streamlining commerce.
- ENTERTAINMENT: Dreadnought is designed to handle all tasks well, but especially entertainment because of its dual-function arms & spinner which can rotate the valve without disrupting the port's water & light show. This gives it the ability to perform multiple tasks at once, saving time.
- HEALTH: Due to Dreadnought's 2 arms, it can collect & analyze the data twice as fast; therefore, making clean-up quickly & efficiently restoring health to the people & environment as soon as possible.
- SAFETY: Dreadnought has multi-directional thrusters giving accelerated maneuverability helping accomplish the tasks that focus on safety in surrounding areas.

Dreadnought's chassis is comprised of marine HDPE-High Density Polyethylene and 2 clear acrylic water-resistant ECT- Electrical Control Tubes. The ROV integrates five T100 shrouded brushless thrusters for directional control. It also utilizes a high-definition camera for driver & operator precision. Dreadnought incorporates two (4-servo) arms & two multi-directional claws for multi-directional control. The ROV also has a third arm (spinner) for rotating objects using a high RPM motor. The control system for the vehicle is implemented using Raspberry Pi 3 and Pi programming language. A custom-built tether connects on-board electronics to the pool-side driver's station. Dreadnought will be controlled (on pool deck) by 1 driver & 1 operator-who maneuvers the arms utilizing 2 Logitech joysticks and a controller designed to give maximum efficiency to its operators. Through the development process, employees have learned essential technical skills & worked diligently, as a team, to deliver a quality product.

ACKNOWLEDGEMENTS

Innovators would like to extend our sincerest gratitude to the following sponsors:

- e3 Robotics
- The Forge
- Exact Cuts
- Blue Robotics
- Fusion (3D printer)
- Dr. Walter Liebkemann MD/Greensboro Radiology
- MATE locations:
  - Old Dominion University Student & Wellness Center welcoming us to practice at their competition (Mid-Atlantic Regional-Norfolk, VA)
  - Reidsville High School (Carolinas Regional-Reidsville, NC)

Also, a very special THANK YOU to our mentors: Michael Ramey, Maria Rosato, Matt Trahan, Joey Adams, Joe Rotondi and all mentors from The Forge for donating so much of their time & energy towards our team and this project.

SAFETY

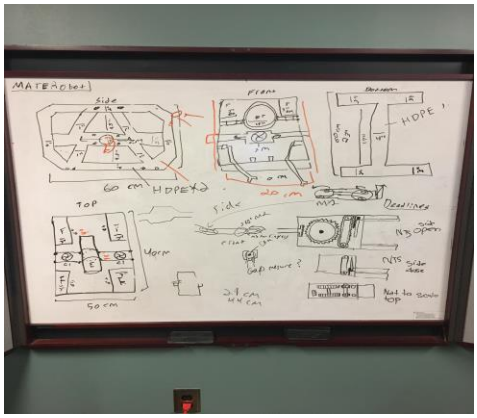
Innovators robotics considers safety the number one priority in all aspects of work. The employees always take a pro-active approach to ensure staff follow safety proto-calls. Innovators use a badge system that includes the employee's name, picture id, what they have been trained in and level that they have progressed. All staff are briefed on workshop safety procedures and location of first-aid equipment. The staff is also briefed on safety that is specific to the pool environment before ROV operations began. The ROV was built with safety in mind, and has several built-in safety features including:

- Over-current protection
- Kill-switch in the event of an emergency if a stop is required
- Warning labels to identify moving parts
- Removal of sharp edges
- Completely shrouded thrusters to prevent injury

In addition, Innovators have developed a safety checklist that uses proto-calls for the ROV. Operation for pre-flight, launch, recovery and post-flight. Pre-flight proto-calls include electronics and mechanical tests. Post-flight includes surface shut-down of all ROV systems. Launch & Recovery is done by a two-person team using handles on the ROV for safe entry removal from the pool. During all operations on or off site, the staff is required to wear closed-toe shoes and safety glasses.

DESIGN RATIONALE

A large need of the Port of Long Beach, CA is to have multi-functionality that can use one ROV for multiple missions. Dreadnought was designed to be able to do the task at hand, but there has also been space left open on the ROV for new and different attachments for future needs.



STRUCTURAL FRAME / CHASSIS

All components used in the construction of Dreadnought's chassis was designed and modeled using auto desk inventor 3D CAD software. The chassis was designed for strength and the use of 3 or more arms making it very versatile. The chassis is comprised of 3 main parts: the main side supports, the tube mount bracket and the reinforcement bracket. It is made up of 3/8" (0.9525 cm) marine HDPE-High Density Polyethylene plastic that has been water-jetted for precise cuts. It also uses a variety 3D printed parts custom-made to attach the 2 ECT-Electronics Control Tubes and other components. The chassis is 23" x 19" (58.42cm x 48.26cm). The approximate weight is 28.25lbs (12.81kg)

PROPULSION

Dreadnought is driven by five T100 Blue Robotics water-proof brushless thrusters. They offer very high power with over 5lbs(2.27kg) of thrust each. They are constructed using high-strength polycarbonate injection molded plastic. Everything that isn't plastic is either aluminum or stainless steel which doesn't corrode. The motors are mounted to give Leviathan all axis control. X-axis movement is accomplished by T100 motors, as well as, Y-axis. Propulsion can be reversed to give full 360-degree maneuverability and able to turn on a 0 degree radius. There is also a motor mounted sideways for Z-axis control of side to side movement. All motors have a housing to protect against injury.

TETHER

The tether is custom-built which uses CAT 5 for communication, video & a standard 10 AWG for power delivery to the ROV. The length of the tether is 50 feet (15.24m) for diverse use in all the challenges.

CONTROL SYSTEMS

The control software for Dreadnought was written by Innovator robotics using Raspberry Pi 3 framework & Pi oriented programming language. This allows seamless interaction with physical devices. It accepts input from the driver & the display provides feedback from Leviathan.

TOPSIDE CONTROL MODULE

The topside control module consists of a computer a Xbox controller and a custom control box. The driver uses a controller that utilizes a tank drive set-up for ease of use and practicality. It uses a standard definition monitors, for the driver and for the operator.

INPUT

The input controller consist of input interface classes & facilitates interaction between the user and control system. Each interface waits for a change in state & publishes an event that can be consumed by the controllers. The input controller supports input/output boards, Microsoft X-box compatible controllers, custom control box.

DISPLAY

The display is responsible for displaying the video feeds and telemetry data & allows the driver to control thruster power, arm power & claw power. It consists of two windows that can be configured to meet the needs of the driver & operator. The video window, along with showing a live feed, uses a display to relay important telemetry & mission data. Other windows include the input & settings configuration windows.

ELECTRONICS

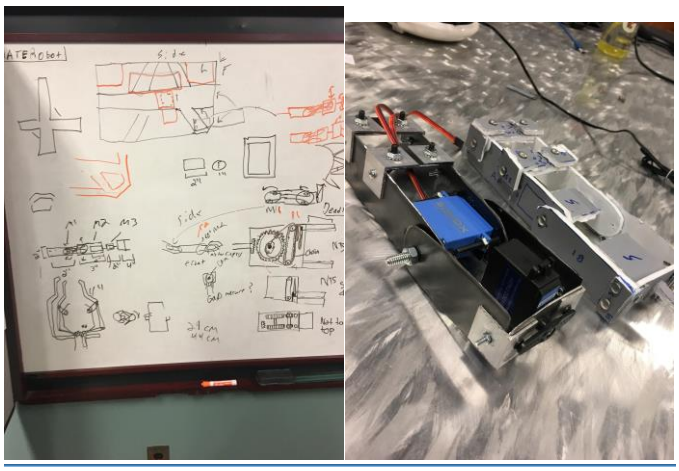
The 2 ECT- Electronics Control Tube houses the on-board electronics including components for voltage conversion, communication to the surface, video, thruster control arms, control & data acquisition. The ECT is a 12” x 5” (30.48cm x 12.7cm) clear-cast acrylic cylinder sealed at both ends with custom-machined Lexan end caps.

CAMERA

Dreadnought uses a high-definition camera mounted in the nose of the ECT to provide maximum view for its operators. It uses a USB cable to deliver feedback to the driver module.

ARMS

The two arms consist of aluminum L-brackets & using (2 servo) motors that connect to the claws to provide maximum 180 degree angle of control.

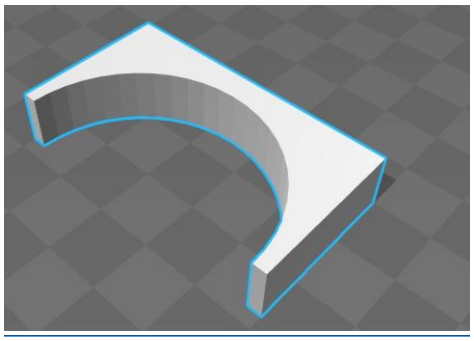


CLAWS

made of a variety of custom-designed 3D printed parts along with aluminum & rubber grips. It uses a water-proof high torque servo to control the custom shaped claw used to grip anything but especially PVC piping.

SPINNER

The spinner consists of 4.5” x 2” (11.43cm x 5.08cm) 3D printed U-bracket connected to water-proof high RPM brushless motor which is connected to the chassis via an aluminum L-bracket. Designed to allow driver to rotate can object, such as a valve, quickly & easily.



EXPENSES / REVENUE

Item	Value	Quantity	Total	Notes
Thrusters	$120	5	$600	
Foam	$80	3	$80	
ECT	$200	2	$400	
HDPE	$130	1	$130	
Water jet	$60	1	$65	
Servos	$12	5	$60	
Motors	$120	2	$120	
Other	$2,648		$2,648	
Est. TOTAL	$4,103	19	$4,103	

Donor	Value	Quantity	Total	Notes
Students	$300	12	$3,600	75 quarterly
Parts	$300		$300	Miscellaneous
Robot kit	$1,000	5	$1,000	Mate kits

NON-TECHNICAL

Innovators robotics is a relatively new company with advanced knowledge. We are founded by previous members with experience with FRC, VEX, FLL, FTC. A couple founding members that were on the previous roster had a non-structured team experience lacking in team building skills, communication, and over all team work, but not with Innovators. We pride ourselves with including all employees from the design on paper all the way to the finished product. We started in a garage with 3 members and a drill and have grown to 12 plus staff where our company does business at The Forge, 219 W Lewis St Greensboro, NC. We have access to meeting space, computer labs, textiles, tech labs, 3D printers, laser cutters, electronics, woodshop, metal shop & mentors. Unlike other robotics companies, we do not just do one competition such as FRC, we do many different types of robotics competitions. Innovators robotics gives its employees experience in all fields from engineering, electronics, programming, and CAD to giving power point presentations to other employees & businesses.

Innovators also work in partnership with e3 Robotics. Being able to partner up with e3 Robotics has created many opportunities in the team and out of the team, such as jobs and projects with companies. We part take in demos outside of the Forge. We go to schools, festivals, and other S.T.E.M. events to display the knowledge of an engineering field. One project included building a 20-foot-high trebuchet to help raise money for Breast Cancer Awareness

TROUBLE-SHOOTING

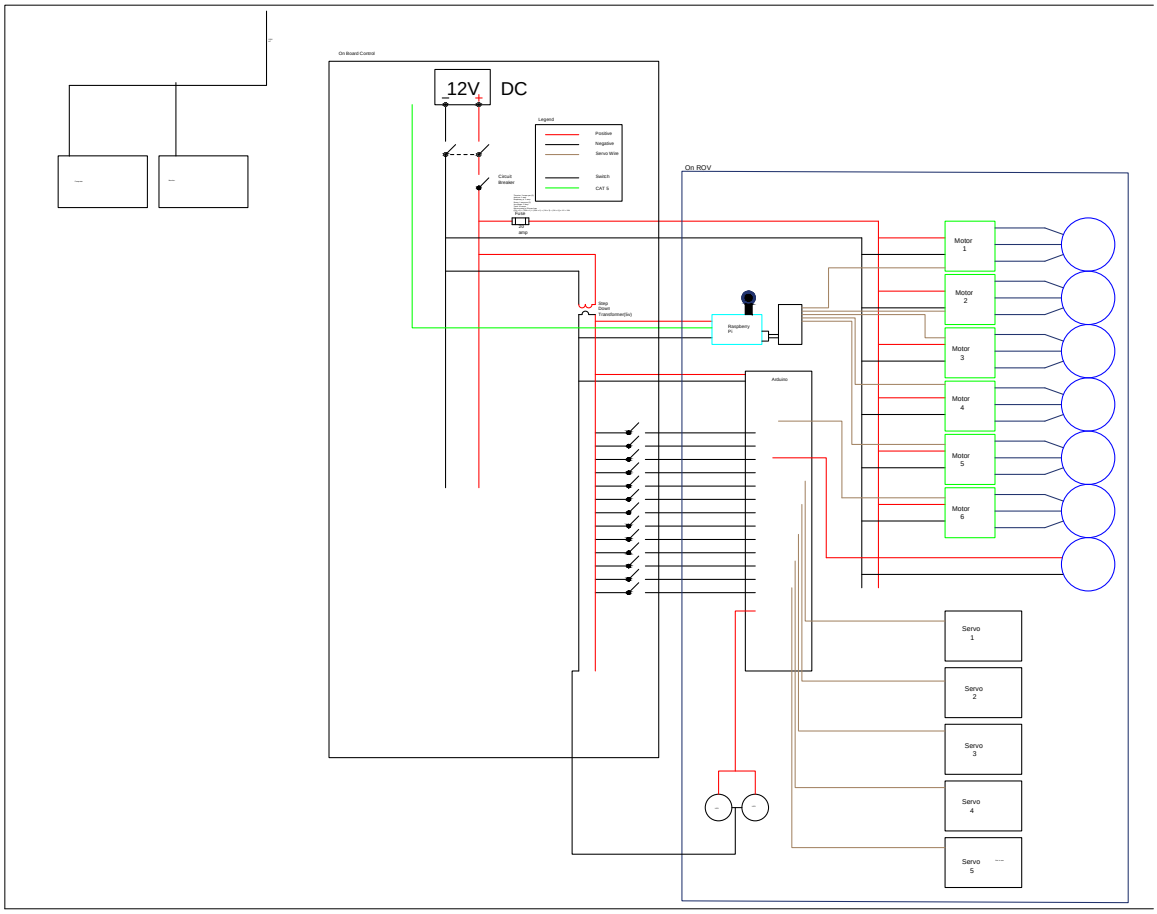
We access the problem, break issues into sub-categories. Then, discuss, as a team, how to best resolve each problem / situation in a cost-effective, efficient manner.

FUTURE IMPROVEMENTS

Innovators robotics, we are a company, that is willing to accept suggestions, learning advancements regarding STEM & robotics. We need to work on sponsorship & gain funding, continue to add new members giving additional skill sets & staff funding.


MATE


Innovators


On Board Control
12V
DC
Legend
Positive
Negative
Servo Wire
Switch
CAT 5
Circuit Breaker
amp
Step Down Transformer(6in)
On ROV
Raspberry Pi
Arduino
Motor 1
Motor 2
Motor 3
Motor 4
Motor 5
Motor 6
Servo 1
Servo 2
Servo 3
Servo 4
Servo 5