Notions Development Academy, Alexandria, Egypt

MEMBERS

Shehab Ramy:CEO, Chief Electrical Engineer, Grade 10, 2nd year.
Mahmoud Alaa: CFO, Mechanical Engineer and Safety Officer, Grade 10, 3rd year.
Ahmed Nabil: Electrical Engineer, Grade 11, 1st year.
Nada Abdelmoniem: Mechanical Engineer, Grade 12, 1st year.
Noran Mohamed: System Engineer, Grade 12, 2nd year.
Hossam Amr: Chief Mechanical Engineer, Grade 12, 2nd year.
Ahmed Thabet: Electrical Engineer, Grade 11, 1st year.

MENTOR

Wael Eweda

Table of contents:

Abstract

Oceanus Company has been working in the underwater robotics field for almost three years. Continuing the company's original aim; designing and manufacturing efficient and high quality underwater Remotely Operated Vehicles (ROV) that satisfies customers, Triton, the latest ROV model yet, is specifically designed to work in extreme environments. From identifying underwater creatures to replacing corroded pipelines, Triton can function efficiently despite of the extreme conditions.

Passion and determination was the main fuel empowering the company to build Triton. Every aspect of the vehicle from the SolidWorks designing to the controller is carefully designed and thoroughly tested until they are working sufficiently.

Oceanus' ROV uses USB XBox Gamepad operating through an Arduino Leonardo microcontroller, to control 5 blue robotics thrusters (for navigation and maneuverability) and 2 manipulators (which carry out mission tasks accurately). Signals are sent through our 18 meter long tether to the on-board acrylic tube which encloses 7 circuit boards and also connect 4 isolated cameras which provide wide-angle clear view underwater with an LCD screens giving the pilot eyes underwater.

Figure 1: Oceanus' company staff.

Mission Theme

Figure 2: St.John's location.

Robots, in general, are used to accomplish tasks which humans are incapable of undertaking. In extreme environments as the Arctic, it is impossible for humans to explore underwater due to the extreme conditions such as the extreme cold, waves, wind, and currents. Thus, ROVs are used to explore these areas as they document sceneries using their high-definition cameras, to the
Screens at the piloting station. These ROVs can collect organisms' samples using its manipulators. They are also capable of inspecting and repairing subsea pipelines in these environments.

Figure 3: ROV exploring the Arctic.

St. John's city in Canada, Figure 2 shows its location, is not only where scientists begin their research in the Arctic but also it is the main supply base for the growing Canadian offshore industry and the home to many international oil companies. Production from the Newfoundland offshore began in 1997 and now accounts for approximately 35 per cent of Canada's total conventional light crude production. And indeed both scientists and oil companies need ROVs to make their jobs possible. They test their equipment in Memorial University of Newfoundland's Marine Institute (MI) and the National Research Council's Ocean, Coastal, and River Engineering (OCRE) as they have world-class facilities such as cold test laboratories (refrigerated material test laboratory),towing tank (200m x 12m),offshore engineering basin (75m x 32m) and Ice tank (90m x12m - the longest in the world), so they can simulate the extreme conditions that the ROV will encounter out in the sea.

1. Design Rationale and Vehicle Systems

1.1 Frame:

A significant improvement this year to the ROV compared to the company's previous models is the implementation of an enhanced streamlined frame that was carefully decided upon. Oceanus' design team settled on a rough draft that came out of the first few brainstorming sessions. The design was drawn on Solidworks before actually building Triton as it simulates the ROV so the required changes could be done without increasing the cost. Some changes were made to suit the tasks perfectly and the final design is shown in figure4 Oceanus chose this streamlined design shown to decrease the drag force on the ROV. Triton's frame is 45cm in length, 39cm in width and 40cm high.

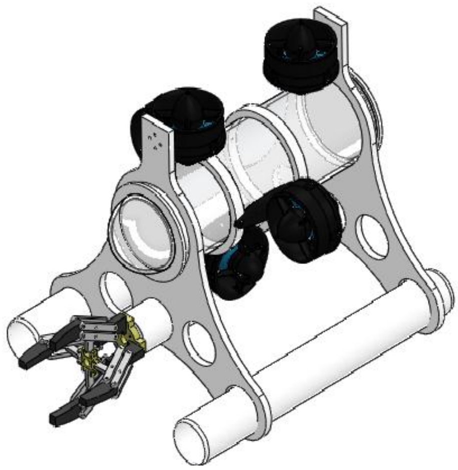


Figure 4: Triton's frame.

Most of Triton's body is made from High Density Acrylic to cope with high pressure, about 1 bar, in addition to its flexibility and shock resistance. As the acrylic is a good insulator and can be cut easily, it was used in the electric can and Triton's Video Ray dome.

Figure 5: T100 motor.

Durability, lightness, low moisture absorption and stability were the major factors considered by Oceanus during the designing process. Thus, the end caps were made using polyethylene.

1.2 Thrusters:

Triton's five efficient T100 electric brushless motors were chosen after several tests. The T100 motors proved to be better than other motors giving the vehicle efficient thrust for easy and stable maneuvering required in performing mission tasks, with less current consumption.

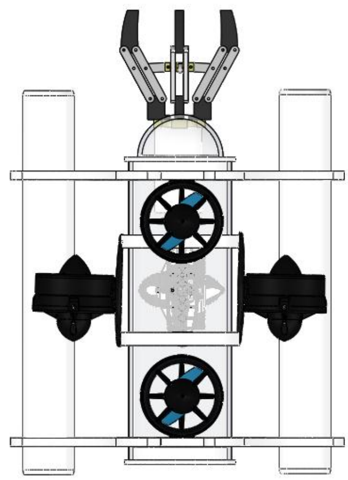


Figure 6: Motors' position.

1.2.1 Degrees of Freedom:

Triton moves around 5 degrees of freedom. The motors are positioned as shown in figure 6. Two motors on the side to allow it to surge and yaw, one allowing it sway and two others aligned on top of the ROV allowing it to pitch and heave.

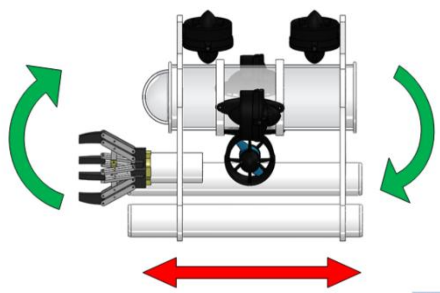


Figure 7: Triton's degrees of freedom.

Direction	Color
Pitch	●
Heave	●
Surge	●

1.3 Buoyancy:

Buoyancy was a crucial factor in the Triton's design process. ROVs require steadiness at varied depths and perform substantially better when their floatation is tuned correctly.

The mechanical team managed to make the center of buoyancy and the center of gravity above each other by adding weights and floating devices. The buoyancy was calculated as shown in figure 10.

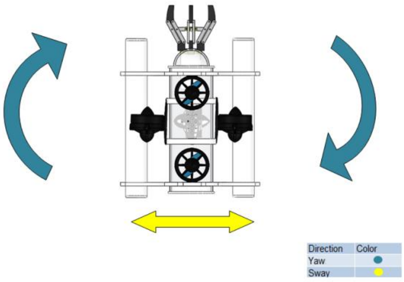


Figure 8: Triton's degrees of freedom.

The mass of the ROV outside water (m) = 4.7 kg.
ROV weight (w) = m*g = 47.0 ($g \approx 10$)
Up thrust force (f) = ρ*g*h=1000*10*5= 50000 N
Net force (ΣF) = 50000-47.0 = 49953

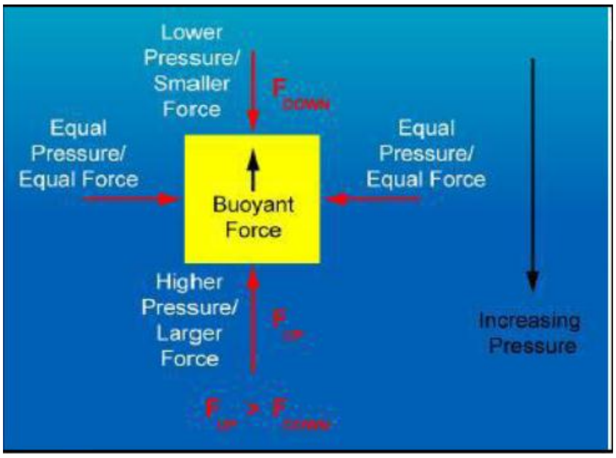


Figure 9: ROV Buoyancy.

Oceanus' mechanical team planned an experiment to calculate the amount of foam needed to carry the ROV. Thus, they cut a uniform cubic foam piece of volume $1 cm^3$ and added weights until it was balanced in the water, as calculated as follow:

$$1 cm^3 \rightarrow 1.1 \text{ kg}$$
$$V \rightarrow 4.7 \text{ kg}$$

Where V is the volume of floating material needed for critical floating of the whole ROV.
V= 4.7/1.1 cm^3

The staff calibrates the ballast of the ROV before each trial; as the water is different in each pool due to different densities as a result of a difference of percentage of chemicals such as salts and chlorine. Besides, the temperature affects the water.

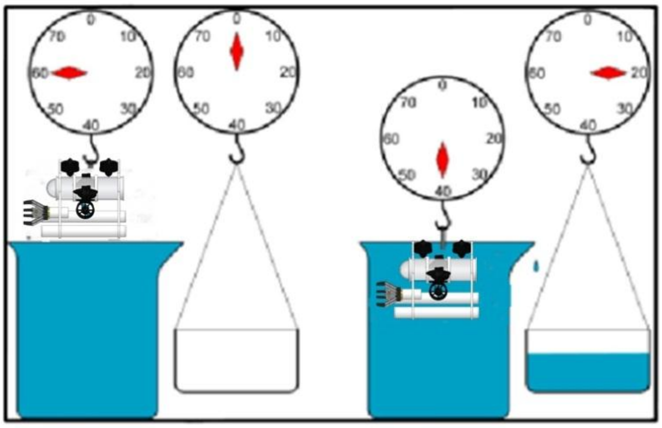


Figure 10: Measuring Buoyancy

1.4 Stability:

To ensure stability, the mechanical team designed a symmetric ROV so that forces would be distributed equally. The vertical motion motors are mounted at the ends of the ROV for stable ascends and pitch motion. Furthermore, the tether pull point is on the same line as the motors to sustain high stability.

1.5 Payloads:

For completing mission tasks efficiently Oceanus Company has equipped Triton with various payloads specially made by the mechanical team for every mission.

1.5.1 Lift line (figure 11):

The lift line is used to lift the corroded pipeline to the surface. It has a one way mechanism so when it is attached to the pipeline it will not be able to release it until it is pulled back to the surface. The lift line is made of LEGO pieces but is strong enough to lift the pipeline.

Figure 11: Lift Line.

1.5.2 Carabiner (figure 12):

The carabiner is used in removing U-bolts and the well head cap. It is also made of LEGO pieces and has a one way mechanism so the object attached to it cannot be released under water.

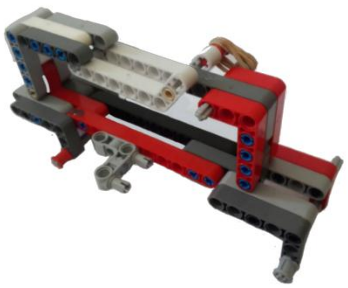


Figure 12: Carabiner.

1.5.3 Bilge pump (figure 13):

The Bilge pump is used in pumping water into the pipeline.

Figure 13: Bilge pump.

1.5.4 Manipulators:

Some mission tasks require multiple degrees of freedom such as collecting an urchin located on the seafloor in science under the ice mission. Triton is distinguished with two manipulators, the first is positioned in the front center of Triton (figure 14) and the other is positioned facing downwards to collect the urchin from seafloor (figure 15).

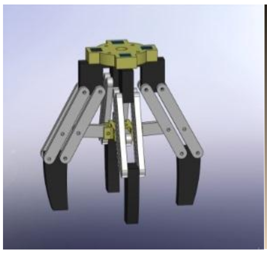


Figure 14: Triton's front manipulator.

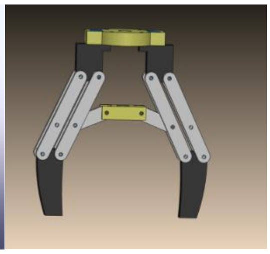


Figure 15: Triton's second manipulator.

1.6 Electronics:

Triton's Electric System Module was designed using Altium Designer. The first step in the design process was to choose the shape of the boards aiming to have the least volume with most surface area for electrical components to be mounted on and at the same time fit into the electric can.

Figure 16: Sensors' board.

Seven circular boards of diameter 10.5 cm were designed and connected in a cylindrical shape using twenty seven conducting copper spacers and a rectangular header board to transmit power and signals from one board to another, to eliminate the mess of wires when connecting the boards together

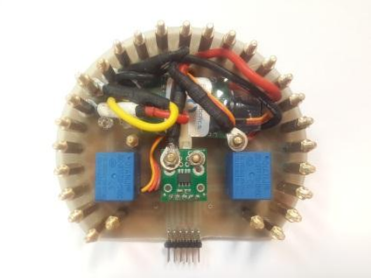


Figure 17: Motor Board.

The bottom board is the sensors' board (shown in figure 16) including the microcontroller "Arduino Leonardo", water sensor, Pololu Altimu sensor module and ULN 2803 Relay driver. Then comes five identical motor boards (figure 17) each containing one Electronic Speed Controller (ESC), two 12V relays and one Polulo Current Sensor. Finally, the upper board, "The Maestro", which contains a polulo mini maestro controller, controls all the thrusters and servos, reads data from current sensors.

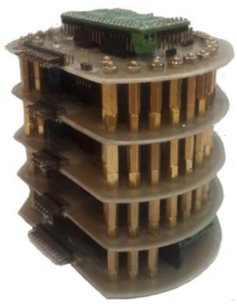


Figure 18: The Boards' stack.

1.7 Sensors:

1.7.1 Water Sensor (figure 19):

The sensor enables the system to detect water leakage in the Electrical Can so the ROV can automatically shut down in such a case for safety reasons and to avoid damage to the ROV's Electrical boards.

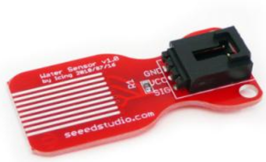


Figure 19: Water sensor.

1.7.2 The Pololu Altimu module (figure 20):

The Pololu module contains compass, gyroscope, altimeter and accelerometer. An Arduino Library accesses ten independent pressure, rotation, acceleration, and magnetic measurements that can be used to calculate the ROV's altitude and absolute orientation to facilitate the pilot's driving and to have precise movements for missions.

Figure 20: The Pololu module.

1.7.3 Current Sensor (figure 21):

Current sensors are used to monitor each motor current for safety reasons, which make the software able to protect the electrical components by decreasing the motor speed or stop it when the motor is over current.

Figure 21: Current sensor.

1.8 Controllers:

1.8.1 Arduino Leonardo (figure 22):

Receives sensor readings and controls the 8 relays for on and off controls through a ULN 2803 to control DC motors ,flash lights or any on and off control through serial communication from and to the station.

Figure 22:Arduino Leonardo.

1.8.2 Polulo Mini Maestro (figure 23):

Receives current sensors' reading and controls 8 servos and 5 T100 Thrusters. Receives and transmits data from and to the station serially.

Figure 23:Polulo Mini Maestro.

1.9 Driving Station:

Triton's driving station includes USB Xbox controller, a laptop running a C# application and to 2 screens to display the rest of the cameras (shown in figure 24).

Figure 24: Oceanus' driving Station.

1.9.1 Controller:

The Xbox controller is connected to the laptop as well as all different components of the tether. The laptop does not only take the input from the pilot through the Xbox controller to send to the ROV, it also receives important sensor data from the ROV and display it.

We decided to use the Xbox controller instead of traditional joystick because it is much easier for the pilot to control everything with it. It controls all thrusters on the ROV by connecting it to the laptop which serially sends signals to the Arduino in the ROV to operate the required thrusters.

Figure 25: Oceanus' Xbox controller.

1.10 Software:

Oceanus' software developing team has built two programs, one using C# on the laptop (on the surface) and one on the Leonardo Arduino (on the ROV). The program on the laptop shown in figure 26 displays the cameras using Emgu library. It also displays sensors' values which are received serially from the Arduino. Gamepad output is also received by the program then the program sends it to the maestro in a suitable form to control the motors. Measuring distances, which is required in the three missions, is made using the same program, as the co-pilot take a previously known measure as a reference and by the pixels' ratio, the co-pilot would be able to calculate the required distance.

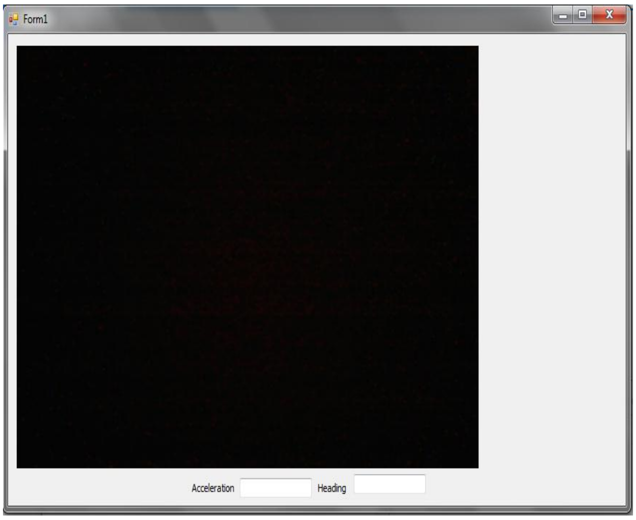


Figure 26: Oceanus camera interface.

The Arduino and the maestro receive the serial data and read the value of the required sensor and send it in a suitable form back to the laptop or operate the required motor.

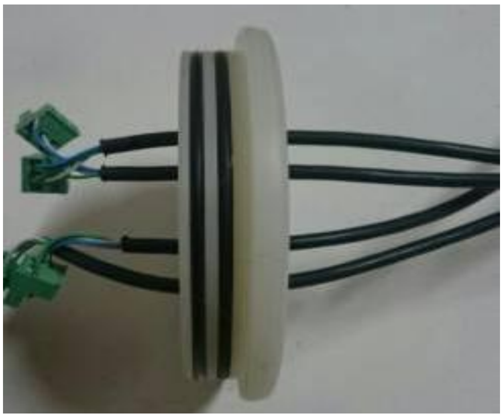


Figure 27: End cap.

1.11 Isolation System:

All circuit boards are put inside an acrylic can and are sealed with an end cap (figure 27) with 2 O-rings around, to prevent any water leakage to the boards.

1.12 Camera:


Figure 28: Wide angle camera.

Camera selection, positioning, and functionality are paramount for the pilot to be able to effectively accomplish the project missions. Triton is outfitted with one Full HD 1080P IP Cameras "Grand Stream" (figure 28). The front camera is not only used in navigating the ROV but also in identifying and counting sea stars. The camera has a 170 degree wide angle that eases the pilot's job as it allows him to quickly identify and maneuver the ROV. Triton also has three other 16ft USB Waterproof Endoscope Borescope inspection camera (Figure 29).


Figure 29: Endscope camera.

1.13 Tether:

The tether is ejected from the back of the ROV, as it is situated in the middle of the end caps of the electric can. The previous prevents the interference of the tether in the movement of Triton underwater. It is fully shielded to protect against any water interference in the wires as well as to avoid the entrance of water inside the electric can. The tether subtends twelve wires: 0V and 12V for the motors' power, 2Tx and 2Rx to receive and transmit data from and to the ROV serially, 0V and 12V for the cameras' power and finally 4 wires for the four cameras' signal. The company reused last year's tether as it was in a good condition and it was suitable for Oceanus requirements this year.

Figure 30: Tritons' tether.

1.14 Lighting:

Increasing the water depth leads to decrease in the light penetration in the open ocean. To provide adequate lighting, two radiators are mounted on the ROV.

In each radiator 3 high-power LEDs are placed as shown in Figure 31.

These emitters have the following data:

- Ampere: 300 mA.
- Volt: 12.0V.
- Watt: 10.08W.

Figure 31: Radiator.

Figure 32 shows the spotlight's housing made from copper; as it resists high temperature generated by the LEDs. At the front, the housing is sealed with a transparent acrylic disc. The disc has a thickness of 5mm and a diameter of 3cm which can easily withstand high pressure.

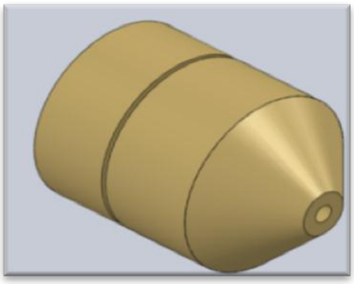


Figure 32: Spotlight's housing.

2.Safety

Safety is a crucial aspect in Oceanus Company; mentors have trained members to deal with tools and machinery safely. In the beginning, there were minimal bruises and soldering iron first degree burns which were treated immediately using our first aid kit which is always in reach in the workspace. Later on, members got used to using them and thank God none of the company members was seriously injured. Based upon the knowledge mentors have provided, members have built these set of rules and regulation while working.

Figure 33: Safety diagram.

2.1 Workshop

Providing a safe and well organized workspace helps ensure physical safety and also maximize productivity. Always making sure that there aren't any trailing cables that would cause anyone to trip and none of the tools or any object is placed on the ground; at all times our components and tools are placed orderly in the storage area. Also, if any tools were worn out or damaged -such as cutting blades or drilling bits or cutters- they are immediately replaced with newer and safer models. Needless to say food and drinks are not allowed inside the workshop.

2.2 Company staff

To eliminate all sources of accidents company members were committed to always have neither loose nor extremely short clothing on in addition to close toed shoes. Long hair was always tied and no jewelry or watches are allowed during handling Triton. While operating heavy machinery safety gloves and safety goggles must be worn, if the machine is loud ear protection is also a must. For instance, while using the cutting chop saw, these saws create dust, sparks, and debris, so eye protection is obliged in addition to wearing thick gloves and hearing protection as shown by Mahmoud in figure 34.

Figure 34: Mahmoud while working with safety goggles, gloves and ear protection.

2.3 Vehicle safety

Mechanical wise Triton's design already lacks sharp edges which helped a whole lot. Thrusters are securely attached to the frame and caution stickers are present on each propeller opening as a warning when the vehicle is on. The tether is always neatly coiled, only during the mission the tether is fully untangled to ease Triton's maneuverability.

Electrical wise a 25 Amp fuse is present on the positive power line on the tether connector end. Before enclosing the isolation tube we ensure that all wires are sealed and secured. A current sensor is connected to each thruster; to alarm the user if high current is consumed. A water detector sensor is installed inside the tube which automatically stops Triton if any leakage occurs. An emergency button is placed in the driving station to shut down the system in case of any emergencies.

3. Quality Assurance

3.1 Testing Methods

Previous years' experiences lead members to ameliorate testing skills to systematic testing during development of Triton; to minimize wasted time and to ensure high efficiency. Each system -frame, circuits, and isolation- was tested separately before assembly; this helped us to diagnose problems and failures effortlessly and dedicate all our effort to fixing the problem using our troubleshooting techniques.

Figure 35: Pressure chamber.

Concerning the isolation system it was tested using a pressure chamber, shown in figure 35 which we build to fit Triton. By implementing a simple design, it increases the pressure to ensure that the isolation system works orderly within a safe range. Because safety is what matters the most at Oceanus Company, the chamber simulates a depth of over 20m, which is approximately 4 times the specified in the MATE ROV competition rangers' class.

The electrical boards were short-circuit tested and the relays' boards were then tested each separately before connecting them all together using the copper spacers to make sure everything is working correctly. All the system was tested afterwards, before enclosing it in the tube. After assembly the vehicle was tested multiple times offshore and the pilot started training using the company's constructed props.

3.2 Troubleshooting techniques

To overcome any problem a strategy had to be made to diminish amount of time lost. To discover the source of a malfunction present in the system, first, we brainstorm the possible causes in order of likelihood, then a list of possible solutions is suggested after conducting an urgent meeting, each solution is carried out carefully. If the problem is fixed then the tasks will flow normally as planned, if not another solution is proposed and implemented until the problem is solved.

In addition to using the troubleshooting skills for every minor problem throughout our journey, their biggest test was in the regional competition. The technical committee accidentally supplied us with a 48 volts power source instead of 12 volts. Triton was not operating so by checking the power supply and finding out it was the wrong one. Since we had less than 12 hours for our next mission, we had to diagnose the problem and fix it quickly and efficiently. Discovering that both the camera and the up and down motor were not working, then by testing each electric board separately, we discovered that the motor was not working due to the malfunctioning of an ESC. Replacing the camera, ESC and the blown fuse, we retested every system ensuring that Triton was functioning once more. Our company having damage control skills we united our effort to fix an unintended problem in a short period of time working step by step along with our troubleshooting strategy.

4. Challenges

4.1 Technical

Normally with our team being students still seeking knowledge and learning from our mistakes, a couple challenges were experienced due to minor misunderstandings. An example of this was on the first attempt designing the electrical boards; the electrical team connected the boards using wires which resulted in an unorganized board and constant tanglement of the wires causing misconnections and failures which were hard to track. Subsequently we overcame this challenge by using conducting copper spacers instead of wires, leading to designing and printing a new board, in a couple of days the circuit was done once more; that lead to a slight increase in the budget but fortunately we stayed within the budget as we considered possible increases in it initially.

4.2 Non-technical

With each member having a busy schedule conducting meetings was a hard task, in spite of that; weekly meetings were held and we stayed in touch through our private Facebook group and by creating a Gantt chart tasks were carried out efficiently and on time. Another challenge was that the new members to the company were at first unfamiliar with the programs used and was their first time handling tools; so some time was spent for them to catch up with the older members. Being fast learners helped and it all paid off in the end. After the regional competition, our workspace was being renewed leaving us with no place to work, fortunately we found suitable cafes and workspaces to carry out meetings and carry on working.

5. Lessons Learned

5.1 Technical

Each member of the company has learned a plentiful of new things, for instance: designing circuit boards on Altium Designer, building electrical schematics while considering current calculations, designing on SolidWorks, handling all kind of tools such as: electric hand drill, soldering iron, and surely assembling skills. Each member had a chance to test pilot Triton which was a significant experience for all of us. Not to mention the technical writing skills while writing this report.

Also understanding C# programming language was possibly the most helpful and useful skill learned by our programmer this year. Software team learned many skills, including how to use basic if statements, serial commands, and the most important skill of all, knowing how to troubleshoot.

5.2 Interpersonal

This year our cooperation and teamwork skills were raised to a maximum, our responsibility to teach one another and excel together, hand in hand with no one left behind, helped us achieve this. In addition our time management skills were improved as we had to balance team meeting timings with our school lessons. Moreover our presenting skills are enhanced due to watching videos for Steve Jobs and other well skilled presenters, we tried our best to absorb the best ways to present our company.

6. Future Improvements

Without doubt Oceanus Company has excelled throughout the past years, nevertheless; still seek perfection. Primarily, the company wants to use a manipulator with more degrees of freedom which will enable the client to achieve a wider scope of missions underwater. Another improvement is to have a three-dimensional simulation of the ROV for the pilot to know the exact degree of tilting of the vehicle under the water which can be known using the Pololu module which is already used in Triton. Furthermore, improving our method of measuring distance is a crucial refinement to Triton which can be achieved by using stereo vision. We also want to develop the marketing of the company and the media design by introducing the company to magazines, newspapers and TV shows.

7. Reflections

"This year my skills improved vastly, which is very satisfying. I think that's the massive force that keeps pulling us into joining every year since we knew about the competition. Moreover this year lead me to discover my aptitude for leadership."

Shehab Ramy (CEO and Chief Electrical Engineer)

"Definitely this year has taught me a lot of new things, also the basics concepts of mechanics and electronics helped me in my school studies."

Mahmoud Alaa (CFO, Mechanical Engineer)

"As a high school student, participating in this competition has helped me embrace my passion in mechanics as schools don't provide practical work. Seeing Triton as a working vehicle after the hardship and sleepless nights is the most rewarding feeling."

Hossam Amr (Chief Mechanical Engineer)

"Joining this company added a lot to my personal and technical expertise. My C# language has improved noticeably and my teamwork has excelled a whole lot!"

Noran Mohamed (System Engineer)

"This being my first year, I have learned plenty of new skills such as: designing a circuit board on Altium Designer, printing and implementing circuit boards, and welding components. In addition to the enhancement of my problem solving skills while fixing the faulty circuit using our troubleshooting strategy."

Ahmed Nabil (Electrical Engineer)

"Participating in the ROV competition has introduced me to a world of innovation I have never heard of. Designing on SolidWorks was the most enjoyable task for me."

Nada Abdelmoniem (Mechanical Engineer)

"Time management was majorly improved as I learned to balance between studying and team meetings."

Ahmed Thabet (Electrical Engineer)

8. Teamwork

Since day one, the company is built upon the concept of teamwork which is that each team member has a responsibility to contribute equally and offer their unique perspective upon every aspect and when a problem arises teamwork helps us achieve the best possible outcome. As mentioned before former team members assigned themselves leadership roles; Shehab supervised the Electrical team, Hossam supervised the Mechanical team and Noran took charge of the embedded system control, with these roles being announced each new member worked in each system under the enlightenment of the team supervisors. After a couple of weeks, older members were done passing on their knowledge, making the whole company on the same ground level. Subsequently, the company was ready to elaborate and exceed the limits building Triton, with every member fulfilling their task according to the plan.

Being a company of young learning students we welcomed mentors' advice and critiques nevertheless both of us -mentors and members- were also keen that every system of the vehicle was made fully by company members from scratch without the need of their intrusion. Our mentor's constant reminder that mistakes are the portals of learning, helped us overcome challenges and constantly be motivated; eager to learn from our mistakes.

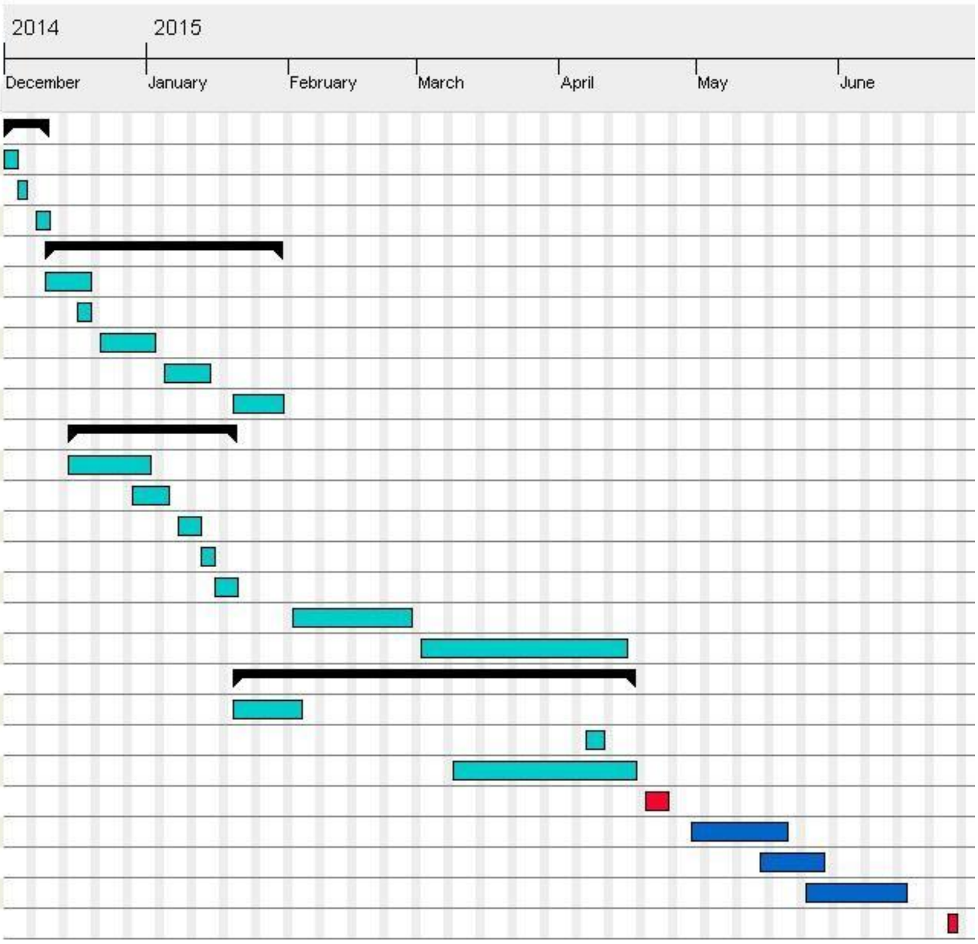
To organize we outlined a timeline for our progress then put it into a Gantt chart. A key feature of our schedule is that we have put into consideration an extra 2 weeks for sudden failures, emergencies and troubleshooting which helped us stay on schedule and for tasks to flow smoothly.

Moreover, we created an online Google Document to record each step of development to create this report easily and for every single member to contribute in technical writing making this report a team effort.

9. Project management

Oceanus Company managed to develop Triton by following the four main phases: initiation, planning, execution, and closure. The initiating stage included analyzing the mission tasks and carrying out company elections. After that came the most essential phase: planning and designing. Setting off with assigning roles, then deciding upon the budget and building up the timeline with specific tasks to fulfill accordingly taking into consideration shipping time of resources used. Ahead of time the company planned an extra 3 weeks for troubleshooting and for any unintended delays like repeating the electrical boards to replace wires with spacers and the exams' period when fewer meetings were held. Directly after agreeing upon tasks' details and members' responsibilities, execution started; making sure everything goes as planned. Throughout this phase mentors and parents were the ones who constantly kept us motivated and helped us push our limits. After the hard work and determination, the company finalized all tasks and tested Triton, arriving at the final phase: closure.

Name	Begin date	End date
Introduction	01/12/14	10/12/14
Competition Orientation	01/12/14	03/12/14
Company Elections	04/12/14	05/12/14
Task and role distribution	08/12/14	10/12/14
Mechanical	10/12/14	30/01/15
Brainstorming and Designing	10/12/14	19/12/14
Simulate on SolidWorks	17/12/14	19/12/14
Fabrication	22/12/14	02/01/15
Assembly	05/01/15	14/01/15
Testing	20/01/15	30/01/15
Electrical	15/12/14	20/01/15
Learning and Brainstorming	15/12/14	01/01/15
Designing on Altium Design	29/12/14	05/01/15
Printing and Implementing Circuits	08/01/15	12/01/15
Assemble	13/01/15	15/01/15
Testing	16/01/15	20/01/15
Testing and Troubleshooting	02/02/15	27/02/15
Pilot Training	02/03/15	15/04/15
Documentation	20/01/15	17/04/15
Technical Report	20/01/15	03/02/15
Poster Display	07/04/15	10/04/15
Presentation Preparation	09/03/15	17/04/15
Regional Competition	20/04/15	24/04/15
Design Modifications	30/04/15	20/05/15
Documentation Modfications	15/05/15	28/05/15
Pilot Training	25/05/15	15/06/15
International Competition	25/06/15	26/06/15



11. Project Costing

						Reporting period	
School Name:	Notions Development Academy					From:	24/12/2014
Instructor/Sponsor:	Oceanus Co.					To:	28/05/2015
Funds							
Date	**Type**	**Category**	**Expense**	**Description**	**Sources/Notes**	**Amount**	**Running Balance**
24/12/2014	Purchased	Hardware	Polyethylene		Used for vehicle frame	$175.00	$175.00
25/12/2014	Purchased	Hardware	Thrusters	5 T100 Thrusters	Including shipping customs	$860.00	$1,035.00
01/01/2015	Purchased	Hardware	Acrylic can	0.2 m long and 0.15 m diameter	Used for isolating electric boards	$15.00	$1,050.00
21/01/2015	Re-used	Hardware	Tether components		Re-used from previous year	$28.00	$1,078.00
06/02/2015	Re-used	Hardware	Manipulator	Materials from previous years	Used for making the manipulators	$29.00	$1,107.00
07/02/2015	Purchased	Hardware	Video Ray Dome	2 domes	Including shipping customs	$36.00	$1,143.00
09/02/2015	Re-used	Sensors	Main camera	Wide angle camera	Re-used from previous year	$172.00	$1,315.00
09/02/2015	Purchased	Sensors	Other cameras	3 USB endoscope inspection cameras		$50.00	$1,365.00
12/02/2015	Purchased	Sensors	Pololu Altimu-10 sensor		Including shipping customs	$72.00	$1,437.00
13/02/2015	Purchased	Electronics	Arduino	Arduino Leonardo		$50.00	$1,487.00
13/02/2015	Purchased	Electronics	Components and PCBs	Circuit components and printing circuit design		$81.00	$1,568.00
13/02/2015	Purchased	Electronics	Copper spacers	300 copper spacers	Used in connecting electric boards	$43.00	$1,611.00
22/02/2015	Re-used	Electronics	Gamepad	X-box gamepad	Used in control system	$11.00	$1,622.00
23/02/2015	Purchased	Sensors	Current sensor	5 current sensors	Measuring current on motors for safety reasons	$35.00	$1,657.00
23/02/2015	Purchased	Sensors	Water sensor		For safety reasons	$4.00	$1,661.00
15/04/2015	Donated	General	T-shirts	7 T-shirts for the competition day	Thanks to Excellent Threads company	$77.00	$1,661.00
27/05/2015	Purchased	General	Airfare	7 round-trip airfare to St. John's		$8,000.00	$9,661.00
						Total Raised	$77.00
						Total Spent	$9,661.00
						Final Balance	$9,738.00

12. Budget:

Item	**Description**	**Amount**	**Running Balance**
Electronic Components	Including Arduino and joystick	$500	$500
Sensors	Water sensor, current sensor and Pololu Altimu-10 sensor	$200	$700
Cameras	1 main camera and other 2 cameras	$250	$950
Polyethylene	For the frame	$150	$1100
Acrylic can	For electric boards	$20	$1120
Manipulator and payloads	For completing the missions	$50	$1170
Tether		$40	$1210
Thrusters		$900	$2110
T-shirts	For competition day	$50	$2160
Airfare	For 7 members	$7500	$9660
		Total:	**$9660**

12. References

- Oceaneering Americas Region HSE Employee Handbook
- Ratio between length-to-width, center of buoyancy, tether pull point, Kort nozzles, RS-232, tether, TMS, spotlights, Manipulator Title: ROV Manual, ISBN-10:0080982883, Author: Robert D. Christ.
- Advantages of polyethylene and acrylic Title: Underwater robotics, ISBN-10:0984173706, Author: Steven W. Moore.
- Left and right propellers URL:http://www.boatfix.com/how/props.html, Retrieved
- The ROV Manual By: Robert D. Christ and Robert L.Wernli, Sr. ISBN: 978-0-08-098288-5.
- http://www.safetyworksmaine.com

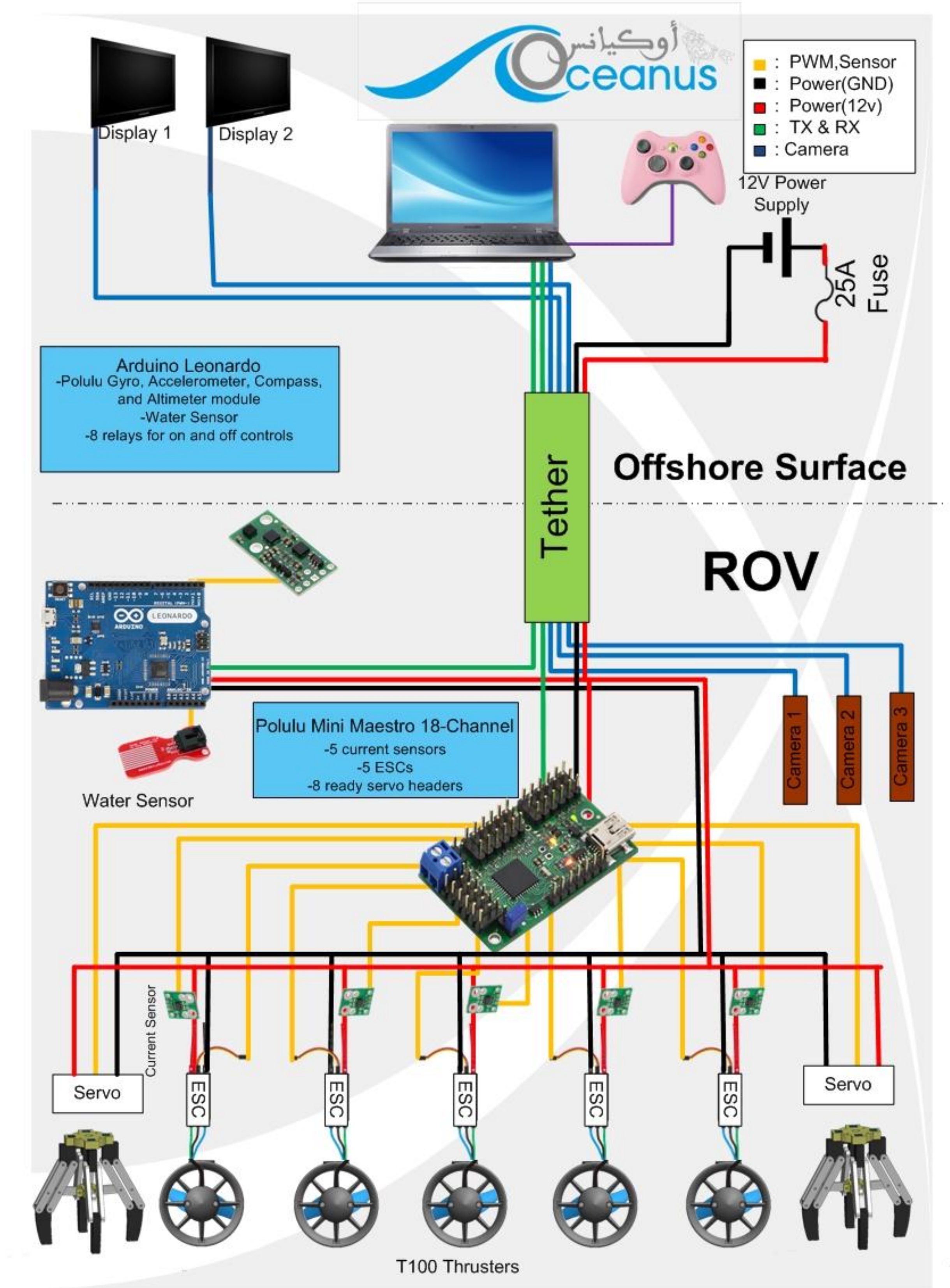
13. Acknowledgements

We would like to express our cordial thanks to

- MATE Centre for making this event possible.
- Engineer Wael Eweda for his endless support and advice.
- Engineer Karim Youssri and Engineer Mohamed Kholy for their patient guidance, enthusiastic encouragement and useful critiques throughout our company's journey.
- Notions DA for being our second home and providing for us.
- The staff of Hadath for organizing the regional competition.
- AASTMT Port Said for hosting the regional.
- Nouran Soliman and Yehya Elmasry for their support.
- Smouha Club for contributing with their pool.
- Excellent threads company for being generous enough to donate t-shirts for company members.
- Finally, we wish to thank our parents for their endless support and encouragement.

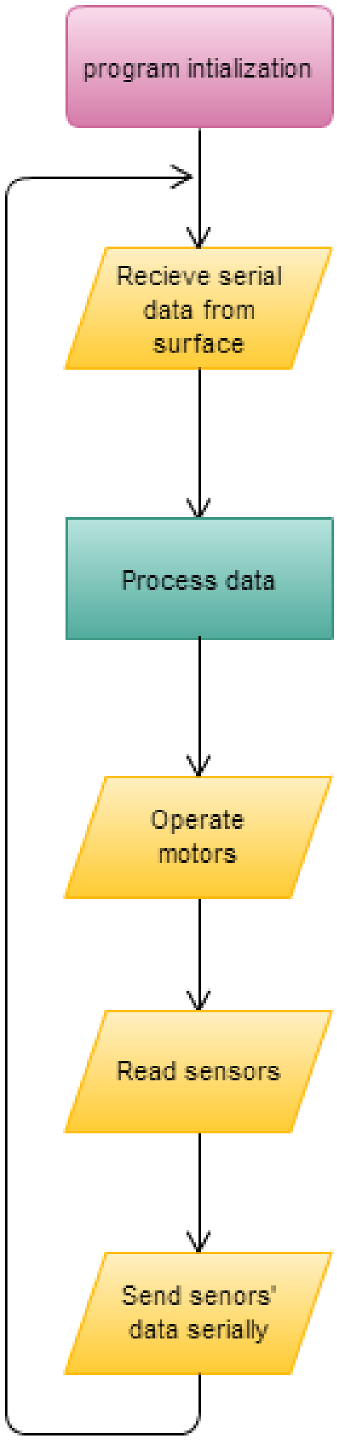
14. Appendices

14.1. System Overview:

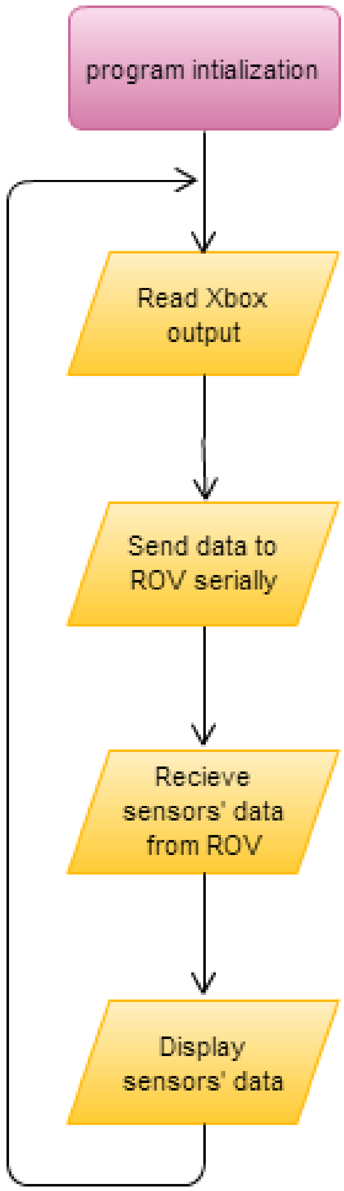


14.2 System Flow chart:

ROV:



Laptop:



14.3 Electrical schematics

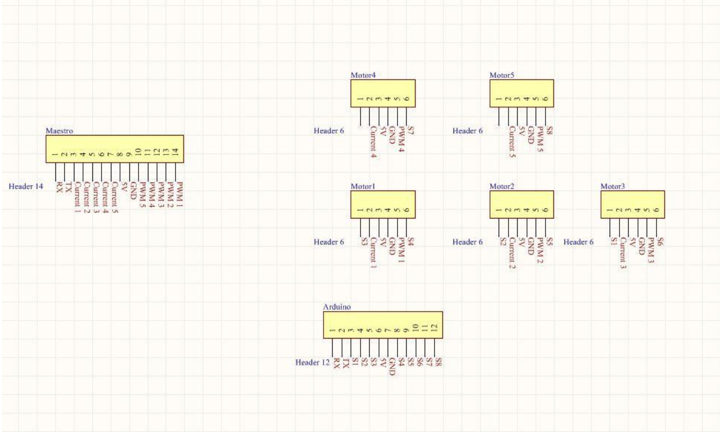


Figure 36: Header board.

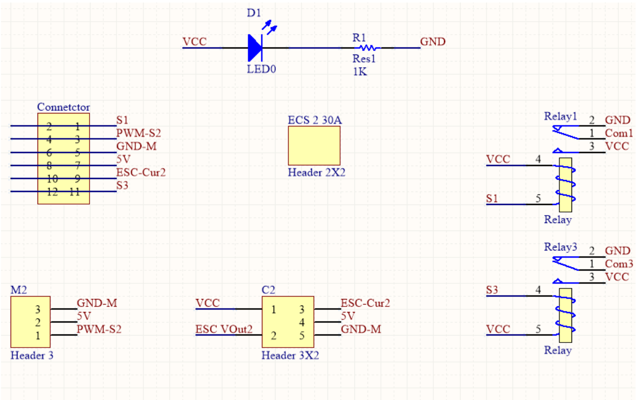


Figure 37: Motors and relays board.

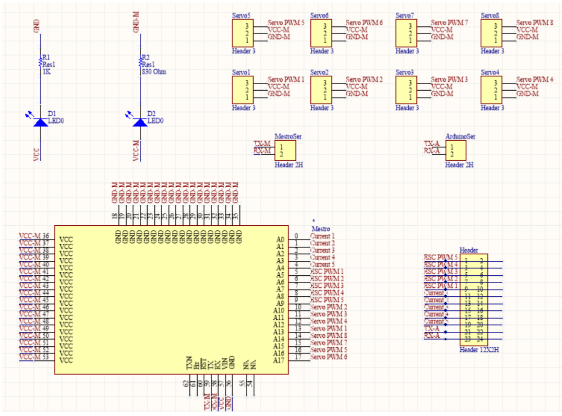


Figure 38: Maestro board.

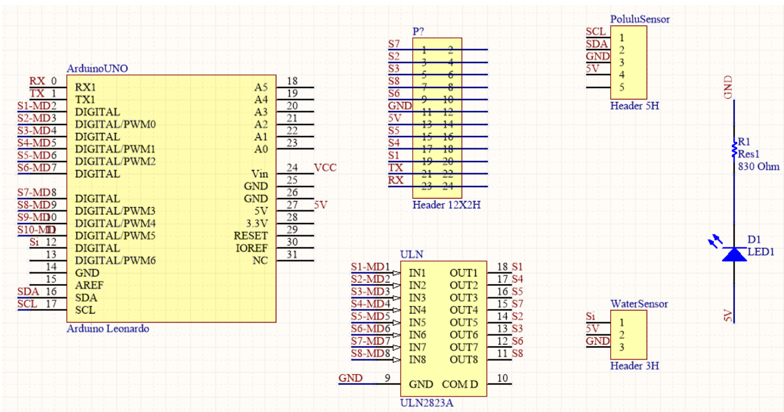


Figure 39: Arduino board.

14.4 Electrical Layouts

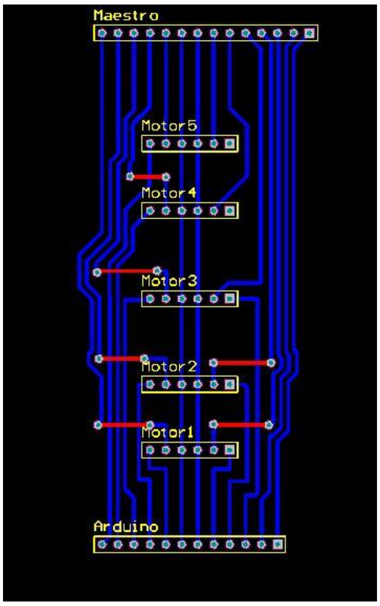


Figure 40: Header board.

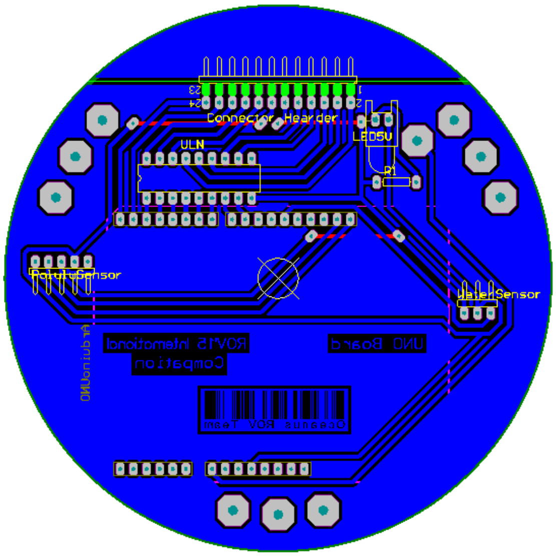


Figure 41: Arduino board.

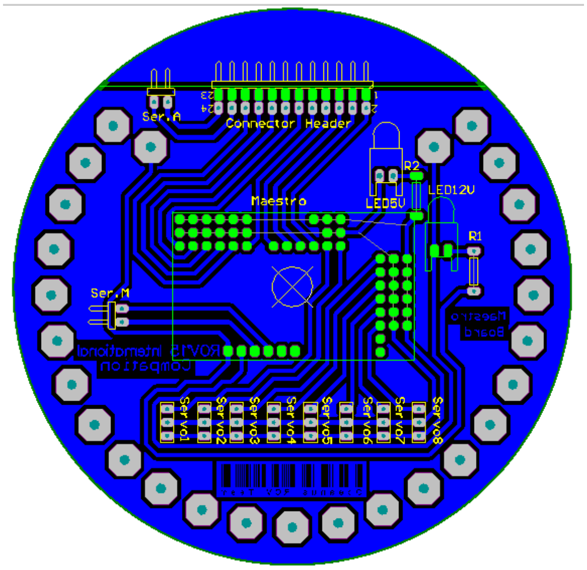


Figure 44: Maestro board.

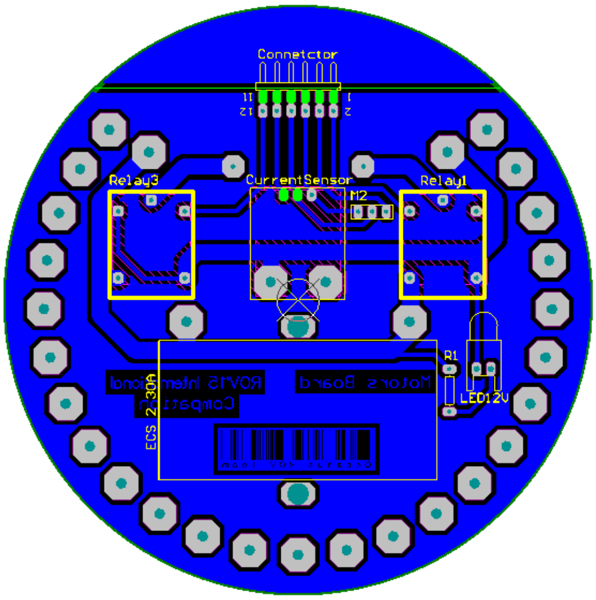


Figure 43: Motors & Relays board.

14.5. Safety checklists

OCEANUS SAFETY CHECKLIST

WORKSHOP

- ☐ Floor Space is clear of debris/objects
- ☐ Area tidy and well kept
- ☐ First aids available and stocked
- ☐ Corrosive liquids are safely stored

COMPANY STAFF

- ☐ No loose clothing
- ☐ Wearing closed toed shoes
- ☐ No jewelry/ watches
- ☐ Long hair tied
- ☐ Safety goggles when on deck
- ☐ Gloves and ear protection when operating heavy machinery

MECHANICAL

- ☐ Propellers are securely fasted
- ☐ Bolts and nuts tightened
- ☐ Caution stickers are placed on any possible hazard
- ☐ Wires and obstacles are away from motor path
- ☐ Tube is crack free
- ☐ Tether is properly secured at both ends

ELECTRICAL

- ☐ 25 Amp Fuse present in correct place
- ☐ Neither bare nor lose wires
- ☐ Isolation tube is properly closed and O-rings present
- ☐ ROV is disconnected from power supply
- ☐ Checking all connections before connecting power supply

14.6. Media Outreach

Our email: companyoceanus@gmail.com

Our Twitter account: https://twitter.com/Oceanus_Co

Our Facebook page: https://www.facebook.com/oceanuscompany?ref=hl