DEEP SEA DUNDEE

D.S.D

The Discovery

GROVE ACADEMY

Dundee, Scotland

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ROV Report

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Company Mission

Deep Sea Dundee is an organization that intends to give the best in marine ROVs. In spite of the fact that this is our first year entering the challenge, our talented group of specialists have assembled an extraordinary ROV that satisfies MATE guidelines. DDS's first creation, The Discovery, has been made with the utmost attention and undeniable professionalism. We have complete faith in The Discovery and that it is the greatest vehicle capable to the tasks at hand.

Abstract

Deep Sea Dundee's latest product 'The Discovery' is a ROV designed to complete a series of tasks as effectively and efficiently as possible to maintain healthy waterways, preserve history and ensure public safety. To meet these requirements we were split into 4 teams (Administrative, Electrical, Software and Mechanical) in order to increase organisation and work load. The ROVs' design contains a pressurised tube located in the centre to house software and electrical components and to assist with our ballast system and decrease the size of our tether to allow for smooth and lightweight travel. We took consideration into the size and weight of the ROV to effectively tackle tasks. Software was created and implemented using Arduino to allow for us to quickly make changes. The safety of the environment and people was also of great importance to us when designing the ROV so we ensured that the ROV had no sharp edges and safe wiring to prevent faults.

Company Effort

Team Contribution

The making of our ROV was a result of effective organisation and team work from each member of the team. When constructing and building the Discovery opinions were voiced on the direction we wanted the vehicle to go in and tasks were assigned to members of the team based on their skillset. Some included frame construction, thruster programming, tool production and producing the tether. In addition to the production of the ROV, practise was needed in the pool to allow us to learn our vehicle. This resulted in us needing to have a strict timeline to ensure we had sufficient time to complete all tasks.

Project Management

Due to limited time to construct our ROV a time plan was needed to ensure our success. When delegating tasks we set a time limit so that the appropriate amount of time was spent on tasks. By doing this we allowed ourselves time to test our ROV in the pool and make changes when needed. To delegate tasks we focussed on each team member’s experiences and strengths so that the task could be successfully completed. Once the team member was assigned a task we looked at the materials required to achieve our aim and these resources were then either acquired from the available resources we had or purchased online.

Design Rationale

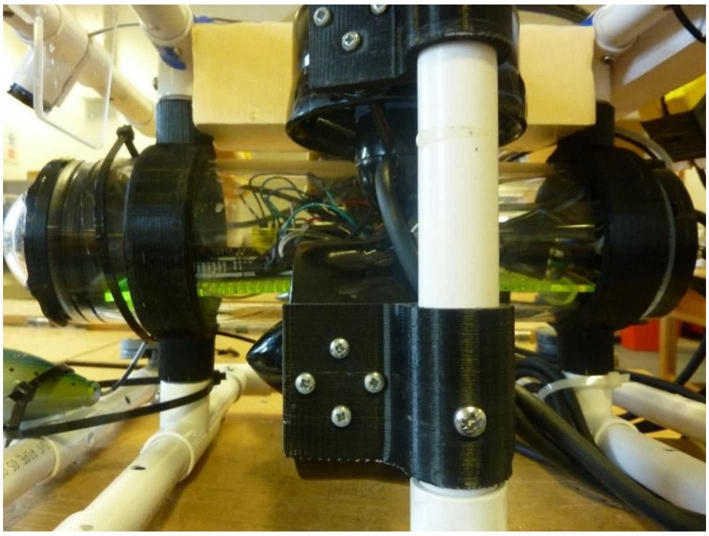
As a new company we had no previous experience or knowledge to base this year's ROV on. The finalised design for the ROV was decided due to the pressurised cylinder we were provided with, we decided to create our ROV with the cylinder being our centre point. Our intention from the start was to create a compact, agile and mobile vehicle which could be controlled electronically through a controller.
Features of the Discovery:

Frame – The frame of our ROV was made of PVC piping as it is lightweight and easy to work with and manipulate into the shape we desired. The shape was based on housing the central pressurised tube and to allow for tooling to be attached. After constructing and reviewing the design it was discovered that preventing water leaking into the pipes would prove difficult so we created holes across the whole framework to allow for water to flood it and to allow for predictable buoyancy. The PVC frame allowed for our piece of tooling to be easily attached to the ROV in our chosen positon. The cylindrical shape of the pipes were desirable as it allowed us to attach 3D printed brackets to secure our pressurised tube and thrusters in position.

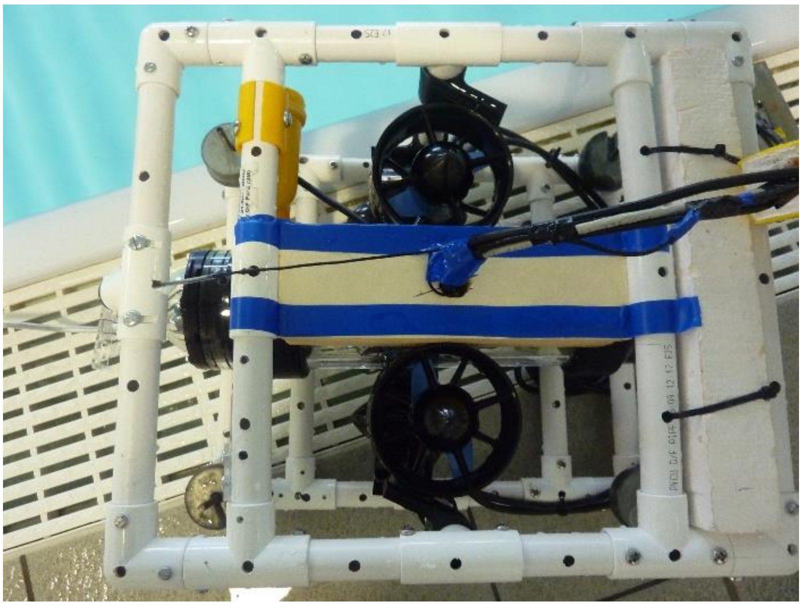
Thrusters – We opted to use 4 Blue Robotics T100 thrusters as they are one of the most powerful yet easily controlled motors available. Two are placed to control horizontal motion and the other two for vertical. They came with Electronic Speed Controllers which allowed us to easily adjust their speed using Arduino software.
Due to the lightweight frame of our ROV the speed to the thrusters had to be decreased to reduce power and allow for greater precision and accuracy when controlling the ROV.

3D Printed Brackets – We used the 3D printer to produce the brackets we needed to attach our pressurised cylinder and thrusters onto our ROV, it was simple to design on a manufacturing program called AutoCAD, we managed to get the sizes down to exact measurement which was a huge benefit. These brackets were easily screwed into our PVC pipe frame which proved to be another benefit of our material choice.

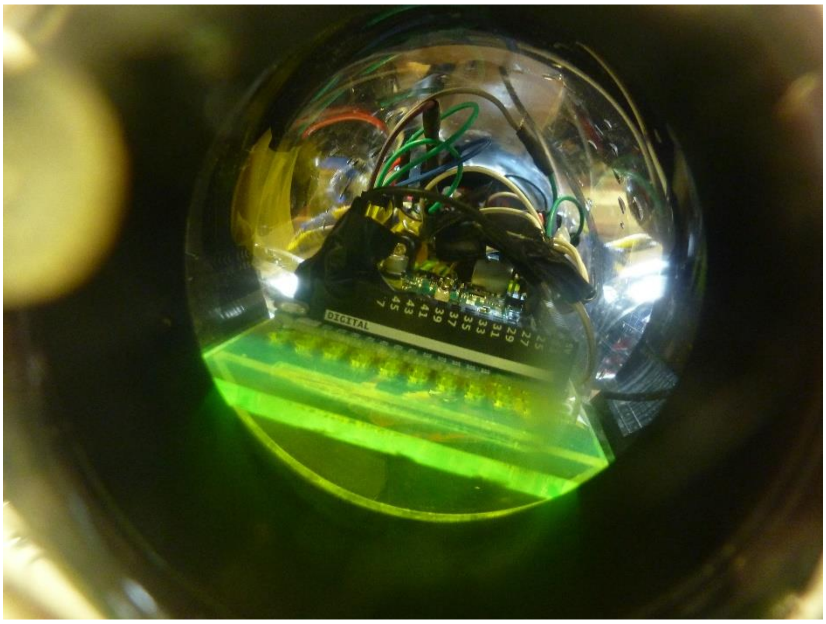
Pressurised Cylinder – We chose to use a pressurised cylinder to house all our electrical components on board the vehicle which allowed us to operate with a thin tether to allow for lightweight movement. It also provides natural ballast which helped us achieve the buoyancy desired.



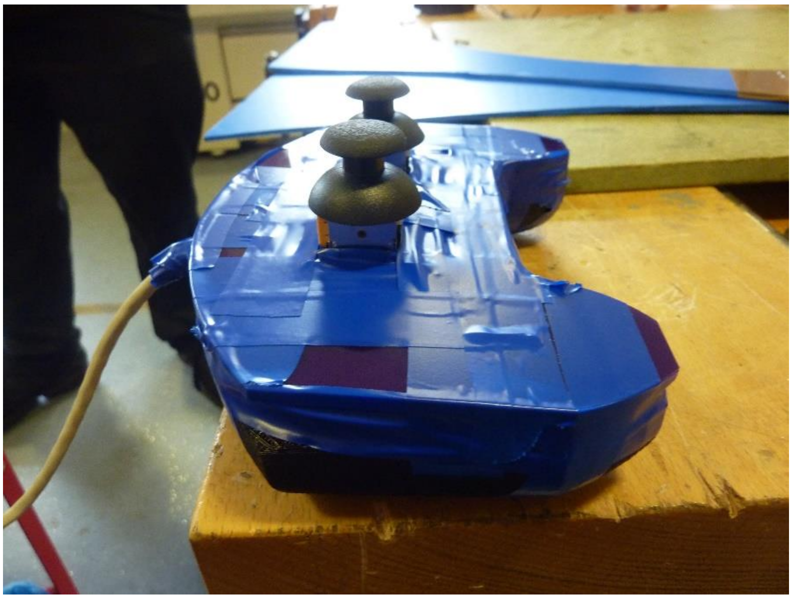
Foam – We used this to perfect the buoyancy of our vehicle to ensure it was the exact level of buoyancy we had intended. We coated it with a layer of enamel to make sure that it didn't soak up too much water to the point where it would be useless, and it was further coated with a layer of spray paint.



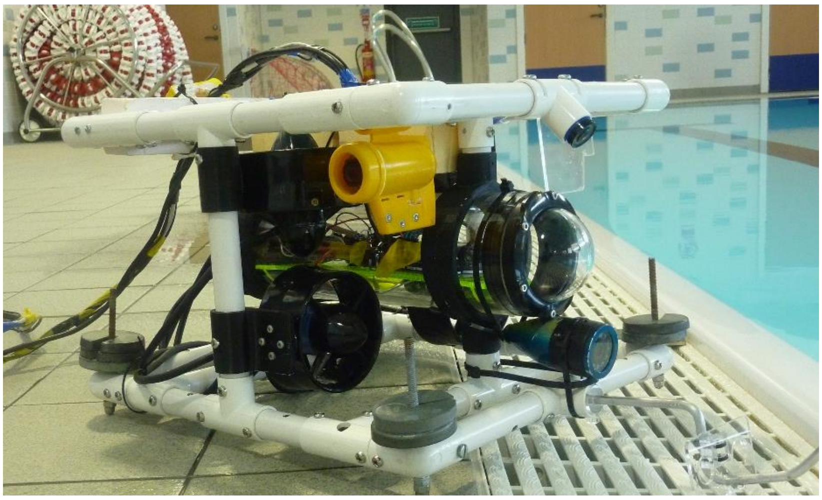
100g Weights – We used 100g weights because this allowed us to change our buoyancy in small increments. We installed metal poles and applied a screw thread on them to ensure that we could apply the weights and make sure they wouldn't fall off while the ROV was underwater in pursuit. The poles were installed in each corner of our frame to allow for weights to be installed without affecting the ROV's centre of gravity.



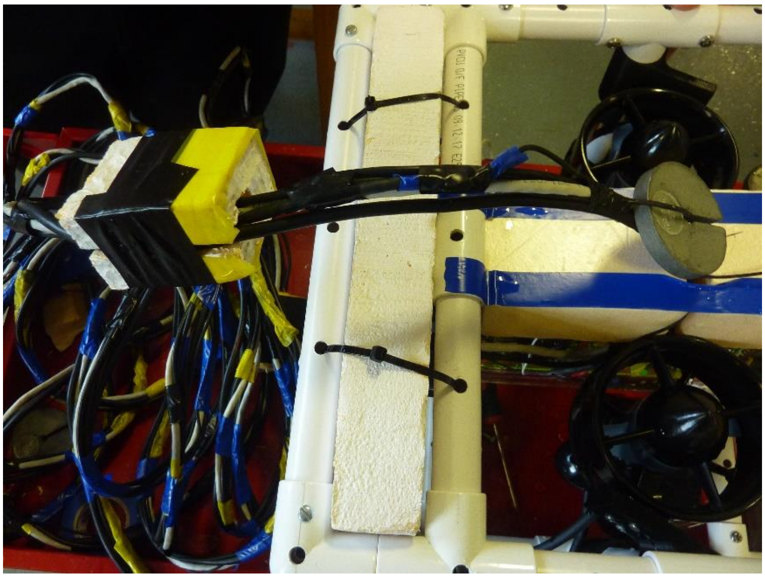
Arduino Programming – We decided to use Arduino to program our ROV, rather than use a simple switch on/ switch off circuit, as Arduino was the most efficient software to program the thrusters. The benefit of using the Arduino was that we were able to adjust the speed of the thrusters, to a desired speed for each challenge, very swiftly.



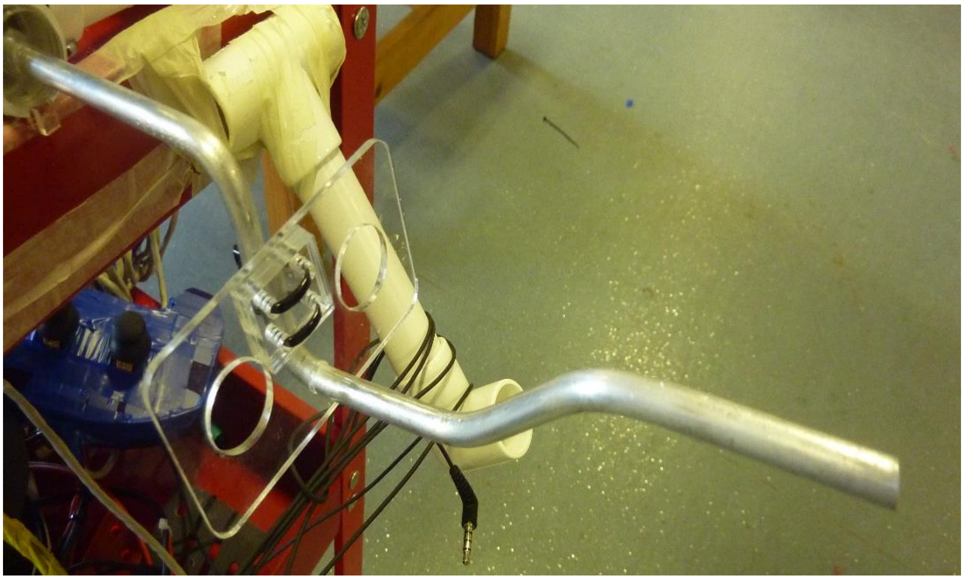
Controller – We decided to use two Parallax joysticks to control our vehicle as it was best suited to what we desired. This is much more useful as a singular joystick or using switches, as it allowed us to efficiently control the speed of the thrusters. We used a piece of strip board to connect our pins from the Arduino board to the controller by soldering them into the stripboard to confirm the pins are permanently secured. The stripboard sits in a controller shell which was designed on AutoCAD, then 3D printed to allow our pilot to control the ROV with ease.



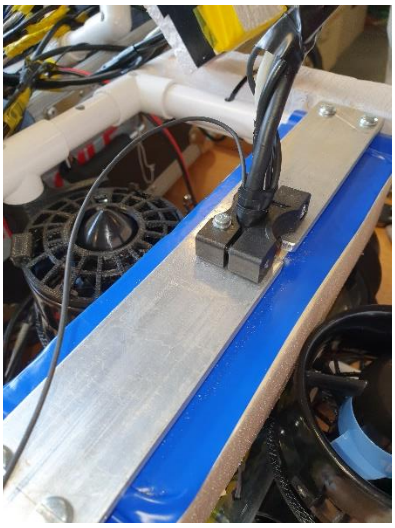
Camera – We have three cameras on-board our vehicle with each camera connected to its own screen on land. Our main camera is placed just below the pressurised cylinder and faces forward to give us a frontal view. We have a second camera to give us a crucial downward view of the hook and the pool floor to help the pilot when attempting tasks. Our third and final camera faces to the right to help us on one of the tasks which is to count and analyse marks along the pool wall, this camera position guarantees our success.



Tether – We have used a tether which includes an umbilical cable in which skinny wires are inside to connect the electrical components in our ROV to the Controller, it also consists of three camera wires and a cable for each of the four thrusters, the tether is 20m long and gives us the required length we need for each challenge. By housing our electrical components inside the pressurized tube we have considerably thinner tether than we would have had if components were on land.



Rod Tool – We have designed a tool for a specific tasks at hand. Our ROV has been challenged to pick up a trash rack and we also have to pick up a rock and check for species underneath it. We feel our rod is the most efficient and practical tool to use for these challenges. We are able to slot the rod through a gap and lift the trash rack up and bring it back to us at the pool-side. For the task in which we need to pick up the rock, we are able to flip the rock over and check underneath using our cameras. We simply acquired a metal rod and reduced it down to a suitable size to which it would fit on the ROV and stay within the camera's downward view, we then added a bump into the rod so that props could be lifted. It fits into our ROV as we have secured the rod into a hole in a cylindrical piece of wood, with epoxy resin, which fits inside the PVC piping.



Mechanical clamp- To ensure the security of the tether we designed a clamp the keeps the tether up right and away from the thrusters, this also helps prevent the it from being tangled.

Build vs Buy Justification

- We decided to build our ROV out of PVC Piping gathered around our school cupboard, rather than buying a new frame for our ROV because we needed to create a frame which allowed our pressurized tube to fit in.
- We decided to buy an Arduino Programming Board as it allowed us to electronically control our ROV with the utmost efficiency and control by sending different pulses to control our vehicle. We found this much better than creating a simple on/off program to control our thrusters as this allows us to travel a different speeds rather than one constant speed.
- We decided to build our brackets for the thrusters rather than buying as we have a 3D printer in our school and it only took a few hours to create them and attach our thrusters to our vehicle.
- We decided to buy our pressurised cylinder as we weren't able to create a suitable housing for our electronic components on the ROV. A pressurised cylinder was an appropriate alternative as it is able to feed wires through and connect our mains power supply and controller to our Arduino board, which in turn allowed us to operate our ROV more efficiently since we had a smaller and lighter tether.

New vs Re-used

- We decided to buy a further four thrusters instead of re-using thrusters available to us from a previous teams ROV. This decision was made because the thrusters we purchased could have their speed electronically controlled whereas the re-usable thrusters only operated at one speed. This was advantage as we can control when we want to travel faster or slower depending on the signal we send to the thrusters.
- We had the option of using the frame from the previous teams ROV but we decided to build our own as this allowed us to focus on building a frame so that our pressurized tube could fit so that our electronic component could be on board the ROV.

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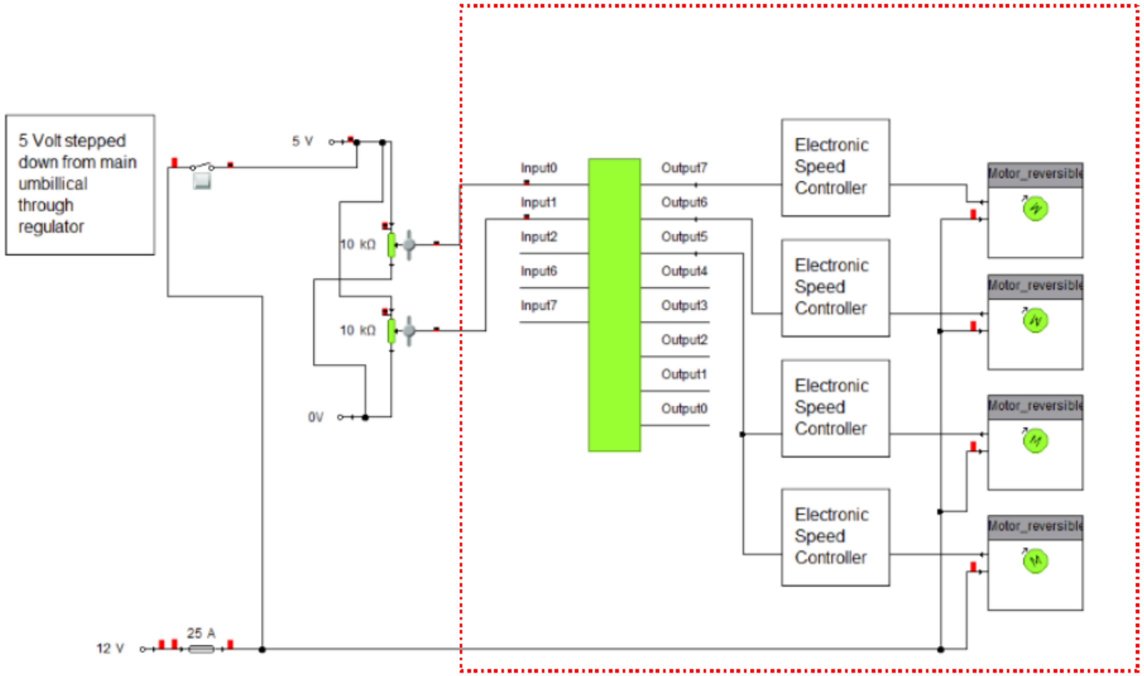


Anything in red box underwater

Safety Procedure

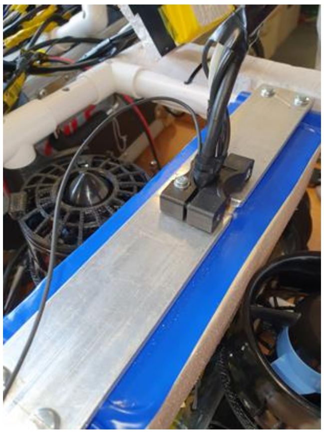
Whilst working on the Thrusters on the ROV, we had to take extra care when testing them to make sure no-one had their fingers in range of the blades to prevent injury.

We have put thruster guards on the thruster to prevent anything and anyone from getting caught in the thruster to prevent damage to the thrusters and the users.

When soldering we had to make sure we didn't keep the soldering iron unattended at any point so that no one accidentally burnt their hand. We took an extra safety measure to make sure that the soldering iron was re-placed in the holder to guarantee that it wasn't placed on any flammable material which would result in a fire.

The ROV was manufactured to have no sharp edges or anything which could damage the lining of the pool, in which we were provided with to test our vehicle.

To prevent damage to the tether we have attached a mechanical clamp to keep it tightly secure.



Testing and Troubleshooting

When working on The Discovery some mechanical, electronic and software issues arose from human and unknown errors. To identify issues if they ever occurred, and to prevent some, we had some steps in place:

- When making changes to the ROV we adjusted one part at a time so that if a problem was discovered we could be certain where it had originated.
- If an issue was discovered all wires and cables had to be checked to confirm there wasn't a loose connection which was behind the fault.
- The system was rebooted when an issue was discovered to determine if it was a random system fault.

Non-Technical Challenge

Since all our work was in school during timetabled class time we were fortunate enough to have plenty of allocated time for the design and manufacture of our ROV. The main problem we experienced was in getting time to test our vehicle in our school's pool which was a very difficult challenge. The problems we faced were:

1. Safety regulations - The head of the leisure department did not appreciate the idea of our ROV being tested in the pool, but after a frequent amount of persuasion from our mentor we managed to get permission to use the pool. An active lifeguard had to be on patrol whenever we tested our vehicle in the pool to prevent any mishaps.

2. As the schools pool is used for PE and is open to the public after school hours, we had to schedule our time precisely and efficiently to get the most out of our time.

3. We had to take an extra precaution not to damage the pool because any damages to the pool would have to be paid off by our mentor, which could cost up to $34,000. So when in the pool we had to be very careful not to damage the pool lining.

Technical Challenge

Our main challenge was to control our thrusters. We took a risk by using modern thrusters, blue robotics T100's, and these thrusters proved difficult to understand. Being school students we were never familiar with the programming software Arduino, the one used to program the thrusters. With a lack of knowledge we had to reach out for help to support staff at Blue Robotics and people with greater knowledge in Arduino. Once we perfected our program we discovered more problems in transmission signals which were being sent to the programming system on the ROV through our tether.

Another challenged faced was the buoyancy of our ROV. Our target was to make the ROV slightly positively buoyant which proved difficult since we had to plan out how we could achieve this. We found that the best way was to drill holes on the PVC piped frame of our ROV to allow it to flood and then add a foam beam at the top and weights at the bottom of our ROV, with this plan we found that one side was heavier than the other due to the placement of the Arduino board and so the weights and foam beam had to be adjusted to work for this placement.

What We Have Learned

Throughout our time working on the ROV, all the members included in our team have matured and have learned essential skills for the workplace environment. Since the project was completely new for everyone in our team, we have learned a lot from each member and gained new skills such as:

Engineering – managed to increase our knowledge in theoretical and practical engineering

Teamwork- working together, co-operating, initiative to take on task and complete it

Problem Solving – we found solutions to the problems in our controlling mechanism, we managed to solve our buoyancy problem, used different techniques to solve various problems in the ROV

Communication- being able to have team meeting, ask help from team member when needed.

Time Keeping- sticking to our schedule and making sure our task were getting completed every week and improving the ROV.

Reflection

There is always room for improvement and If we were to do this all again we would have a control system that we were more familiar with and easier to program.
We would also try and keep more focused on our time schedules. A few times we spent longer on a task than we should have which caused some delay to our time in the water. This restricted our pilot to get more used to the movement of the ROV.

Budget

Financial Report ROV			
Product	**Price**	**Quantity**	**Total**
FloPastOverfow Pipe White 21.5mm x 3m	£ 1.49	1	£ 1.49
Blue Robotics T100 thrusters	£ 90.34	4	£ 361.36
Alliminium End Cap 7 holes (3 series)	£ 10.63	1	£ 10.63
Dome End Cap (3 series)	£ 22.02	1	£ 22.02
Cast Acrylic Tube 11.75", 298 mm (3 series)	£ 34.92	1	£ 34.92
O-Ring Flange (3 series)	£ 18.22	2	£ 36.44
Emclosure Vent and Plug	£ 6.07	1	£ 6.07
M10 Cable Predetor for 6mm Cable	£ 3.04	6	£ 18.24
FloPast Bend Connectors 21.5mm	£ 0.79	8	£ 6.32
FloPast Overflow Tee 21.5 mm	£ 0.48	18	£ 8.64
Cameras	£ 48.00	3	£ 144.00
100g weights	£ 3.18	10	£ 31.80
RS Pro 1.75mm Balck ABS 3D Printer Filament 300g	£ 12.50	1	£ 12.50
Total Cost			£ 694.43

Acknowledgment

Grove Academy- Free use of pool, Free 3D Printing and Funding

NCR- Free electronics advice

MATE- hosting the event and letting us be a part of the experience

BP/ROVOP/SUBSEAUK*- Mate 2019 sponsors*

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