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PUI CHING MIDDLE SCHOOL MACAU

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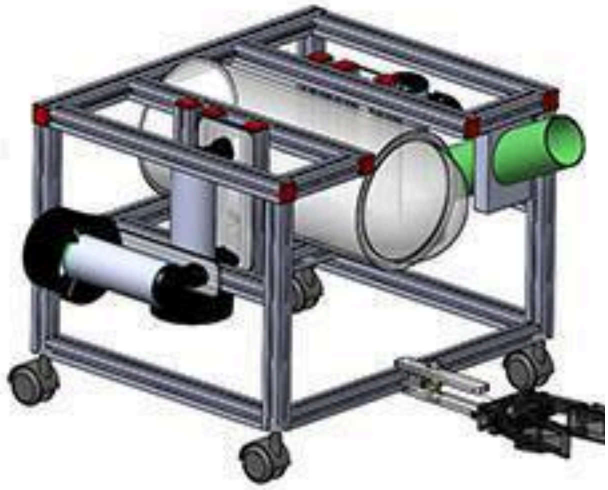

Abstract

The Macau Pui Ching Middle School ROV Team is interested on exploring and contributing to the marine environment. While studying the science of marine engineering and environment, we discovered the potential and the necessity to explore the ocean environment. Therefore, we employed the knowledge we have learnt from the past three years and build ROVs with various functionalities which specialize in different aspects, such as observation ROV, oilfield-inspecting ROV, Science experimental ROV, and they all have the same goal, which is investigate and benefit the marine environment.

This year, our goal is to investigate the underwater oilfield in the Arctic area, which is severe because of its low temperature and harsh environment. Other from this, offshore-oilfield investigating includes several tasks, from inspecting and repairing the underwater oil pipes, to maintaining the oilfield, and these tasks require an ROV with all-rounded features such as the ability to gather specimens from underwater, removing corrupted parts of the oilfield, and maintain the whole facility.

To achieve the goal, we integrated our previous technologies and created the ROV, Noah. Noah is equipped by several new and special features which are specialized for our mission. First, we designed an interchangeable frame which can be changed into different modes depending on different missions. Then we installed pneumatic mechanism for the manipulators for the first time. Also, a newly designed waterproof mechanism is implemented in order to secure the control system conveniently under the water. Lastly, we have prepared a phone application which is for system configuring.

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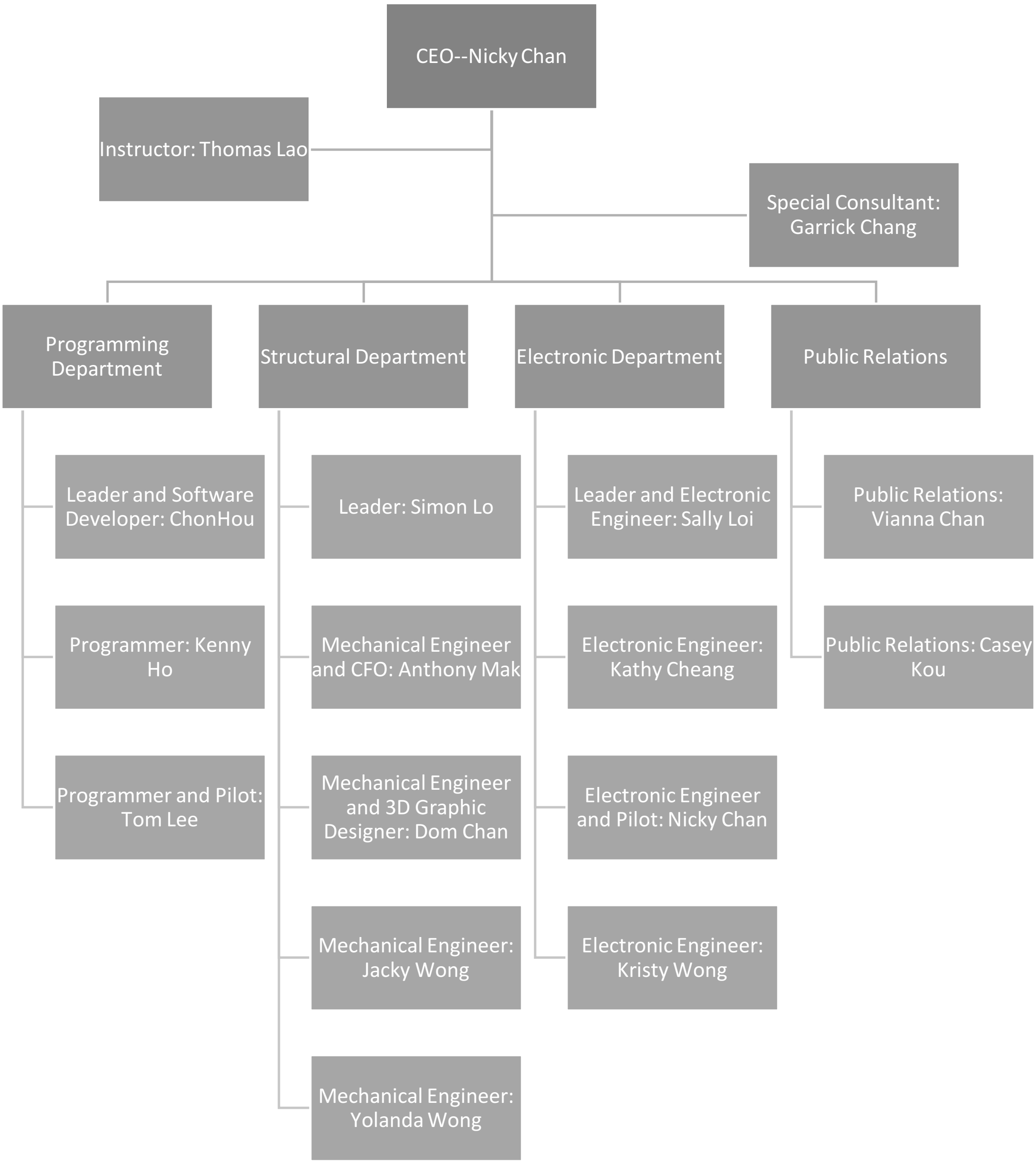
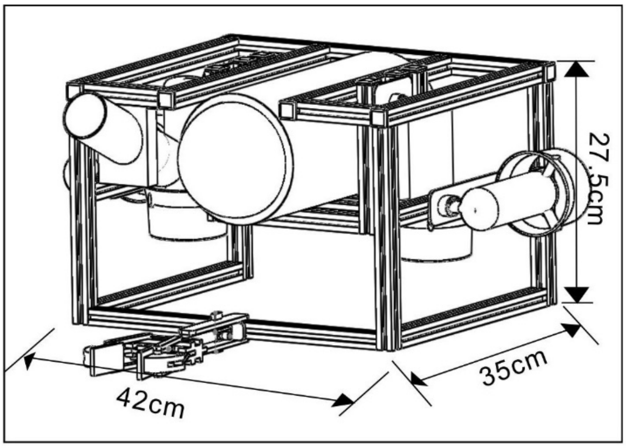
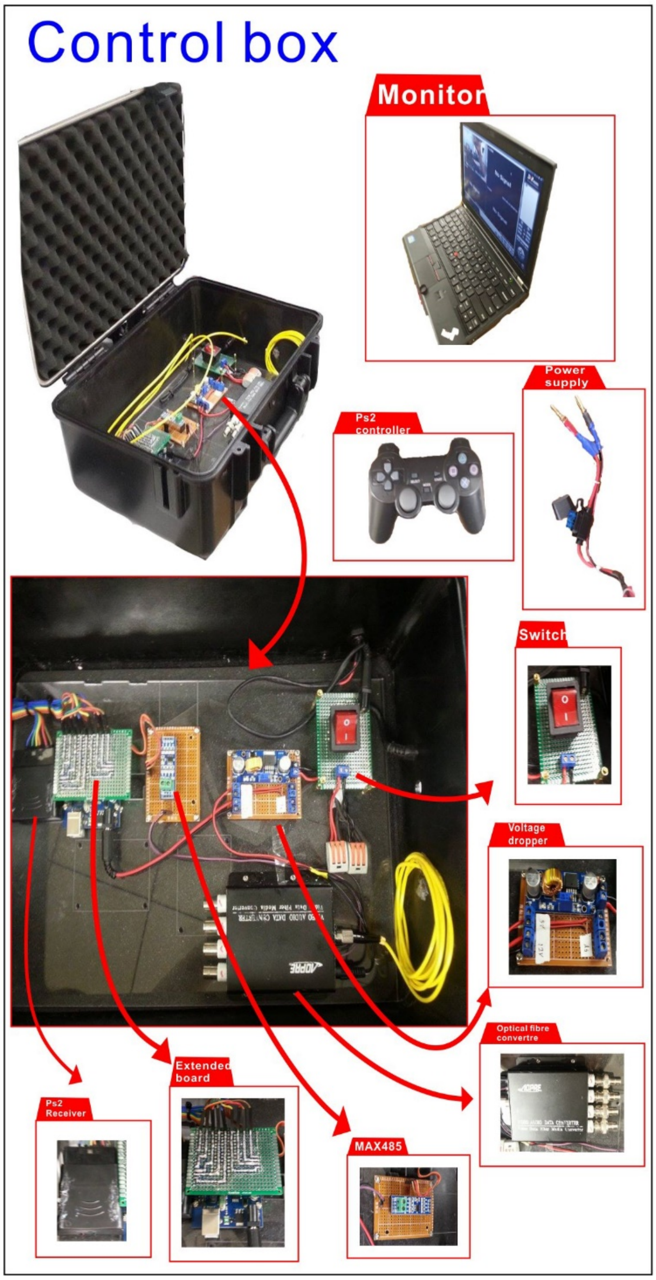
Company structure



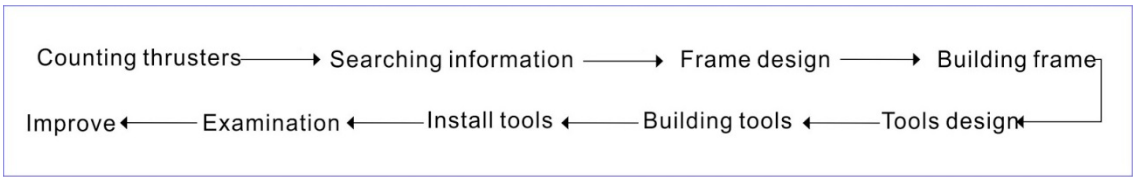
Overview of Noah





Design rationale

This year we have designed a multifunctional ROV so that we can do as many missions as we can. To build up the frame, we have first counted how many thrusters we use and the length of the housing. Then we design the frame according the statistics we get above. After building a stable and solid frame, the next problem is the mission task. In order to achieve the missions, we have designed a lot of different tools to achieve the missions. Although the tools can help us to complete the missions, they also bring us the complex control for the ROV. So that we have drawn out some indentations on the aluminum bars to install the tools by using screw. The screws can tightly attach the tools to the ROV so they wouldn't fall out easily. Since we can install and uninstall the tools quickly, we decide to separate the tools and arrange it to group to group. Different group of tools can be used to achieve the missions in different tasks respectively so that we can carry the least tools and control the tools easier. Therefore we can complete the mission easily and quickly.

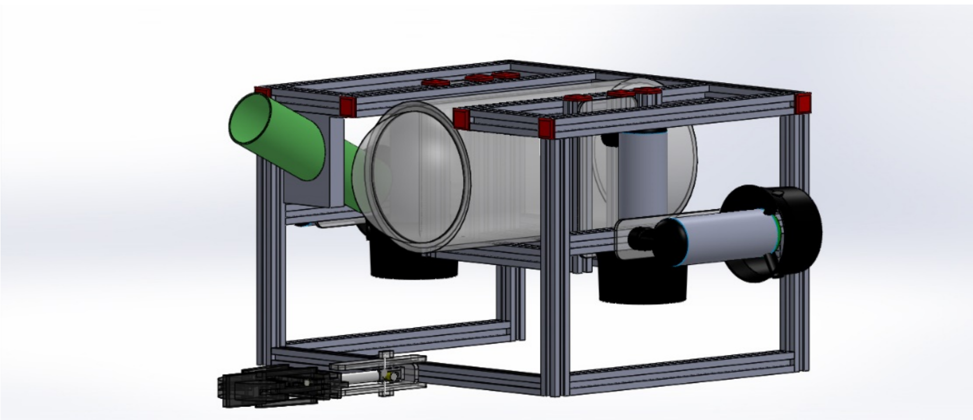


Overall vehicle system

1. Frame

To design the frame, we first take some time to figure out how we operate our ROV during the mission. The reason is to build a ROV which we can operate it smoothly.

After discussing how does our ROV look, the members who responsible for designing start to draw the sketch of the ROV on paper. Then we choose the most suitable one for the mission. Since we don't want our ROV seem so dull, we have made some changes. We change the housing to a smooth cylinder to replace the traditional square one.



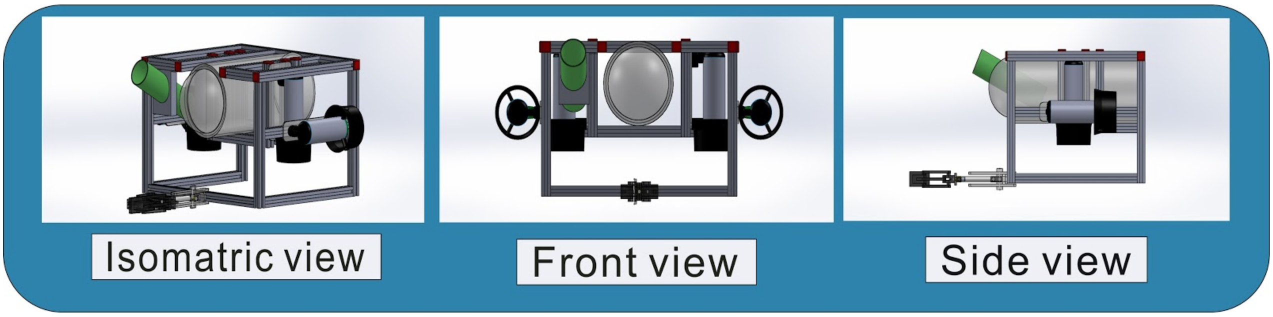
3D Model of Noah

Considering the maximum size of the ROV and the stability of the thrusters. We design a frame which sized 42cm x 35cm x 27cm.Therefore we can operate it stably and it can fit in the tube.

After designing the frame of the ROV, we start to draw a 3D script by using SolidWork. It is very convenient so that we can draw the script fast and easily. The reason of creating a 3D script is that it can help us to build our

ROV correctly and show the others what does our ROV look and what our plan is. Another benefit is that we can build our ROV more stably and more firmly.

After drawing the 3D script, we start to build up the frame by using aluminum bars. The reason of using aluminum bars is that aluminum is a stable material so we can build up a firmly frame. Also aluminum can't get rusted, so we do not need to worry about rusting. All the aluminum bars are connected firmly and tightly, so the pilot can operate the ROV easily and without any worries about getting disintegrate.



3D Model of Noah

2. Buoyancy

Buoyancy can keep our ROV moving steadily and being in suspension. This year we designed to use a new material with a new technique, we use high density Styrofoam sheets wrapped with CFRP or Dupont Kevlar fabric respectively instead of using big PVC tube in the years before. Firstly, high density Styrofoam are much lighter than those tubes. Secondly, they occupy less volume. Lastly, their buoyancy are stronger, which can afford more weight, and this is the main reason why we use high density Styrofoam sheets as floating plate. Due to the low robustness Styrofoam sheets, we have to harden the sheets, so we spread epoxy mixed curing agent for a layer on them and used CFRP or Dupont Kevlar fabric to wrap them after sometime. Then we spread epoxy mixed curing agent on for one more layer in the next day. After waiting another day, these Styrofoam sheets will become very strong, and then they can be installed to the frame.

1 Mixing the epoxy

Process of Making the Protection of Styrofoam Sheets

Step 1: mix a certain amount of epoxy, about 15% and 10% toughening agent and reactive diluent by weight of epoxy evenly as group A.

Step 2: prepare half curing agent by weight of epoxy.

Step 3: mix curing agent, about 2% coupling agent by weight of epoxy evenly as group B.

Step 4: mix group A and B evenly. After group A and B are mixed, chemical reactions will occur. When the temperature of mixture increases to approximately 42°C to 50°C, it is ready to be spread on the sheets.

Step 5: spread the mixture on the high density Styrofoam sheets evenly.

Step 6: use the suitable size of CFRP or Dupont Kevlar fabric to cover the Styrofoam sheets and wait until the mixture to dry. Repeat step1 to 5 for at least 1 time, depending on the rigidity of the carbon fiber.

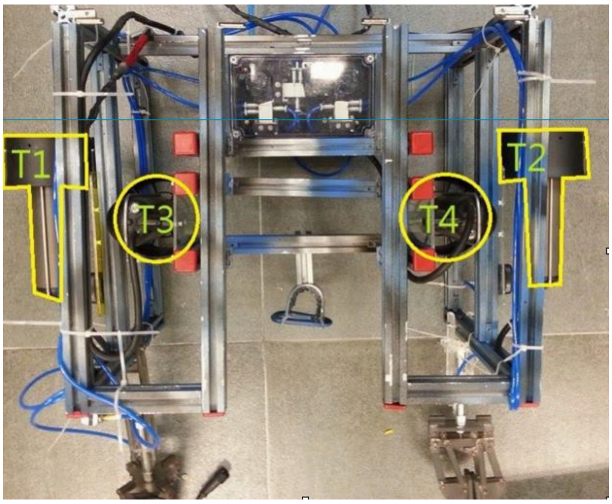
2 Wrapping the CFRP

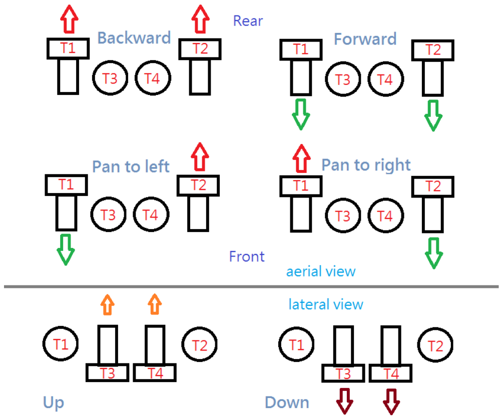
3 Checking the Temperature

3. Propulsion

We use four Seabotix BTD150 thrusters for propulsion system: two for vertical movement and two for horizontal movement. The propulsion system of our ROV is an important part of our ROV, it allows the ROV to move steadily. We've made several small acrylic sheets to fix the thrusters on to the frame. Since there are several thrusters for us to choose, such as the Seabotix thrusters and waterproof pumps, we have to test each thrusters respectively. The Seabotix BTD150 thrusters can operate continuously under 2.8A. On the other hand, rule 500GPH/1890 LPH Bilge Pump is used as our rotator, although it is much cheaper than Seabotix thrusters, their output is somehow weaker, so it is not stable enough to take part in the propulsion system.

Thruster's allocations of Noah

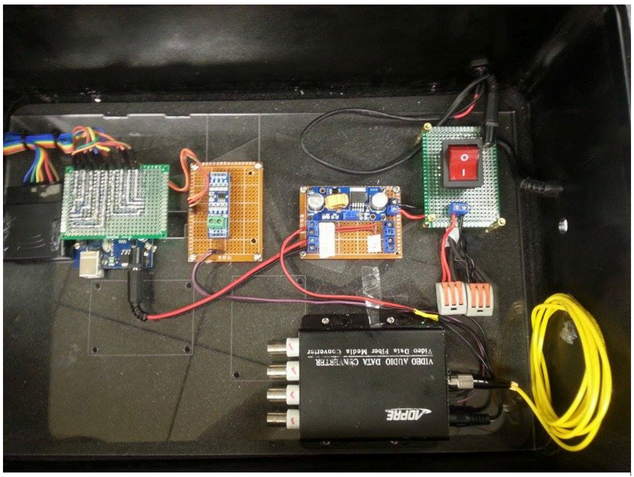




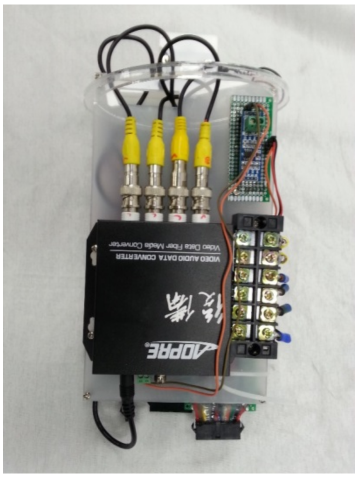
As shown in the figure, if the horizontal thrusters (T1, T2) are both operate as the clockwise, the ROV will move forward; operating reversely, it will move backward. On the other hand, one rotating clockwise and the other one rotating counterclockwise, the ROV will rotate.

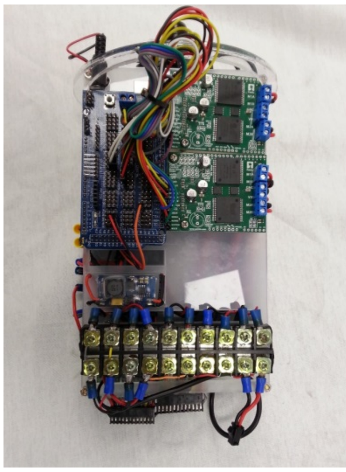
4. Control system

The control system we made included onboard control and underwater housing. Onboard control included electronic component, Arduino UNO, PS2 signal receiver, MAX485, and optical fiber converter. For the purpose of arranging the wires neatly, we choose the shortest path from the component to the side of control box and drill holes to let the wires to pass through. Safety is also important for making a ROV for a slight careless mistake may ruin the whole ROV.



Onboard Control System





Underwater Control system

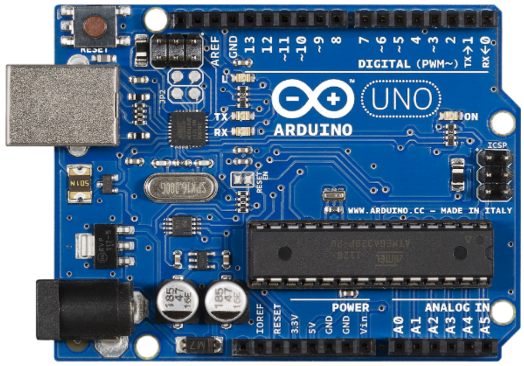
So we have installed a main switch to cut the power supply off immediately when some accident occur. Moreover, we have added a fuse and a capacitor to stabilize the electric current.

Our underwater control system is mainly composed by Arduino Mega, Pololu Motor Controller Boards, MAX485 boards for communication, an optical fiber converter, and lastly a voltage dropper.

The Process of the whole control system is as follows:

First, the control system receive commands from PS2 through PS2 receiver. When the Arduino Uno in the control system receives the commands, it will transfer the commands to the Arduino Mega inside the underwater control system through MAX485 board and optical fiber. Finally, the underwater Arduino will turn on different thruster via motor control board according to received-commands.

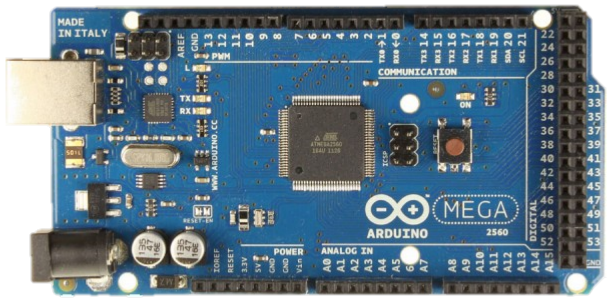
Arduino UNO and MEGA



Arduino Uno

Power: 5V or 12V
The Arduino UNO and Arduino MEGA are placed onshore and underwater control system respectively. Arduino Uno is used to receive PS2 commands and send it to the Arduino Mega via serial communication. Their size are small enough to fit in with the control box and they have enough numbers of ports to suit the control system.

Arduino is a MCU (Micro Control Unit). It has different feature for us to manipulate, such as digital I/O, analog I/O and Serial communication. It is easier to program with Arduino than any other MCUs. Ashore Arduino UNO would receive PS2 Gamepad signals and send them to Arduino Mega under water via serial communication. We use Arduino UNO in the control system because it has 19 ports. In the control system, we need only 4 ports for ps2 receiver and 2 ports for the Max485, so the ports are enough for us. Also, it is used in our Sensor System and the manipulator system.

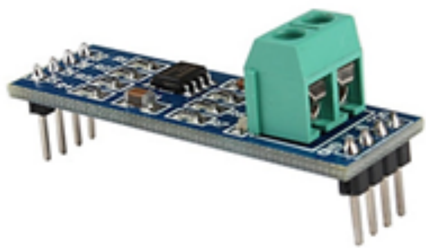


Arduino Mega

Arduino Mega 2560 can receive input data and output signals to control different hardware. Arduino Mega Sensor Shield is also used to expand more VCC and GND ports so that it can support more hardware power

MAX485

Power: 5V
MAX485, which can communicate between long distance up to 2 km, is placed both onshore control system and underwater control system. It is used for long-distance communication between Arduino Serials. RS485 format is included in MAX485 and the data is transmitted in two ports, one with positive and the other with negative. They communicate with each other by switching the voltage difference. It can avoid signal attenuation while communicating. If we use Arduino serial to communicate directly, the data may not be able to transmit. MAX485


MAX485 Board

Optical fiber

Optical fiber is used for signal and video transmission because of its flexibility and long-lasting ability. It is a transparent fiber made by drawing glass (silica) or plastic which is more stable than a copper wire. It can offer a longer distance and a higher frequency band and can transmit control signals and video signals at the same time. An optical fiber converter is placed as a transformer of the optical fiber and used to transfer commands and videos.


Optical Fiber

Motor control board

Pololu Dual VNH5019 Motor Driver Shield of Arduino.
We use a new motor control board named Pololu Motor Driver. It can deliver a continuous 12 A (30 A peak) per motor. This motor driver shield and its corresponding Arduino library make it easy to control two bidirectional, high-power, brushed DC motors with an Arduino or Arduino clone. And it can control two motors on one board but will not output the power unstably.


Pololu Motor Driver Shield

5. Tether and wiring

Compared to last year's tether, we use a thicker and longer tether this year. As we've added pneumatic manipulators, we have to install an air tube to maintain the pneumatic mechanics. So the tether includes two optical fibers, an air tube, a power cord and a steel wire for protecting the fragile fibers. Furthermore, the tether we use this year is 30m so that Noah can dive deeper to complete the mission at the bottom easily. In addition, we use the PET weaving mesh tube to tie the tether up. It is more safety than only using cable ties.

Tether

6. Camera

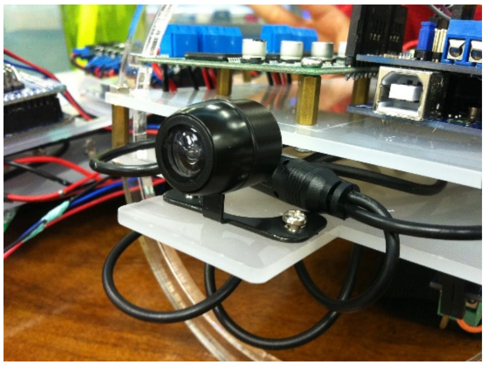
The selection, function and position of camera will greatly affect the pilot to complete the task efficiently. In Noah, four camera are attached in order to provide the information of its surrounding environment. This year, we installed two new types of camera which are the fisheye camera and the Micro Monitoring camera.

The fisheye camera, which has a view of 170 degrees and really small in size. We use them to inspect the tools as they can offer a wide panoramic of view. So that we can know the surroundings of the tools and do the task accurately.

A Micro monitoring cameras are used as Noah's front camera. Also, it is used for length calculation. We first decided to use fisheye camera to estimate the length. But then we found out that it produces strong visual distortion. So Fisheye camera is not a suitable one to do the calculation. Thus, we use micro monitoring cameras which provide original image so that we can calculate length by proportion.

All cameras work on 12V and 3RCA AV wire is used for digital signal transmission. It first send the data to the underwater optical fiber converter. Then, the data was sent to the onboard optical fiber converter through the fiber. After receiving the data from converter, a video data collector will display the image simultaneously on the computer. With this camera system, we can eliminate the need of switching the screens.

Micro Monitoring Camera



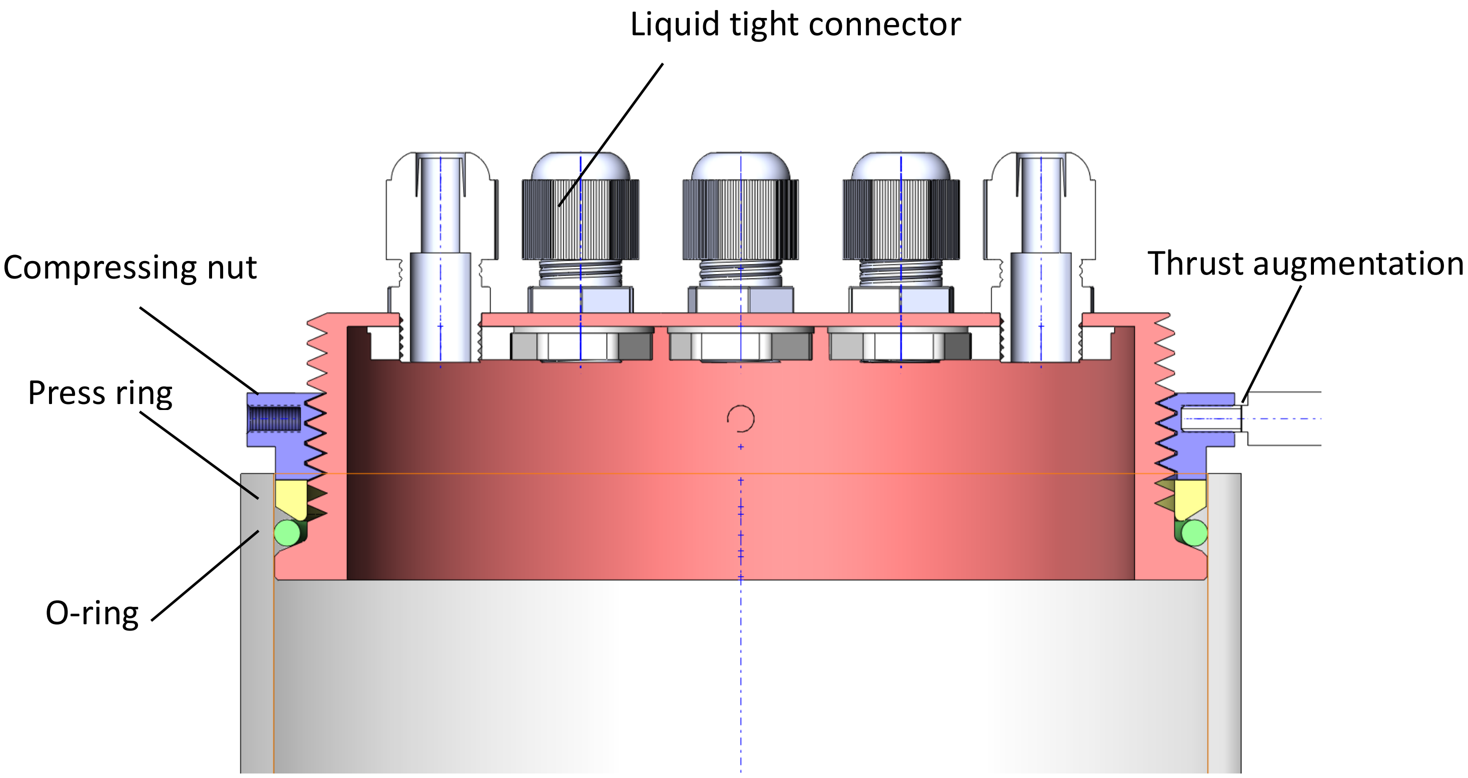
Fisheye camera

a. Newly Designed Water-Proof Screw Thread Mechanism

For the underwater mechanism of our previous ROVs, we use a fixed O-ring, then place it between the aluminum cap and the acrylic tube, and use screws to tighten it. But with the screws and rings, there are so many small parts and they are really troublesome. So we take a step further and integrated all the small parts into one aluminum cap.

As shown in the figure, the aluminum cap has different layers, the top one is an aluminum ring with a screw thread mechanism, and it will drop down when we turn it. Below the aluminum ring is and O-ring, so if turn the aluminum ring, it will gradually drop down and squeeze the O-ring, then the O-ring will expand and press the interior of the acrylic tube.

While making this design, we first design and illustrate it in SolidWork as a 3D module, then we delivered it to a factory and let them help us to make it.



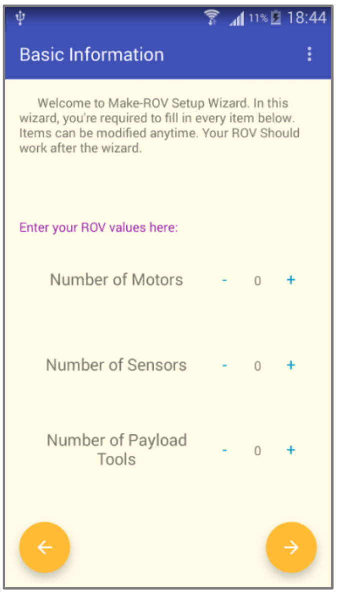
Waterproof screw thread mechanism

b. Phone Application For Setup Assistance

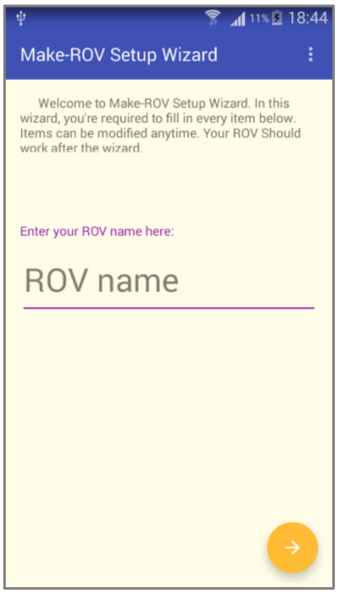
Apart from the control system, we've also designed an android phone application for users to configure the ROV. Since programming is essential while configuring or modifying the system, but many people may find programming really difficult, so we hoped that we can only change the parameters instead of the whole program while setting up the ROV, and this app is our solution. In this app, we can configure the ROV's basic info and the thruster's allocation.

Basic Info

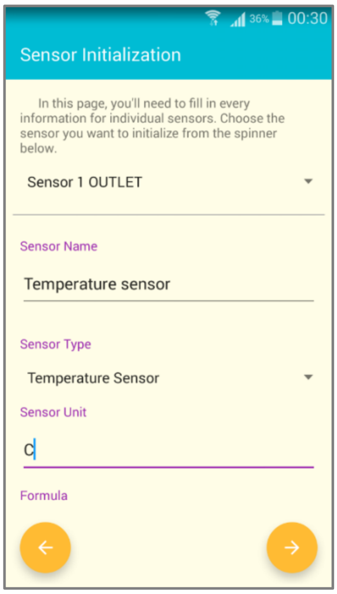
First, in the first two-step, we can setup the name and the number of sensors of the ROV. We can modify the values by pressing plus and minus buttons.
Then, it is for us to configure the details of the sensors, such as its name, type and unit.



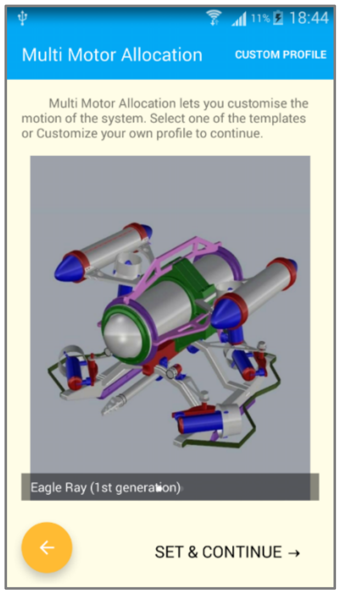
Setting Number of Components



ROV's name



Sensor Data



Thruster's allocation

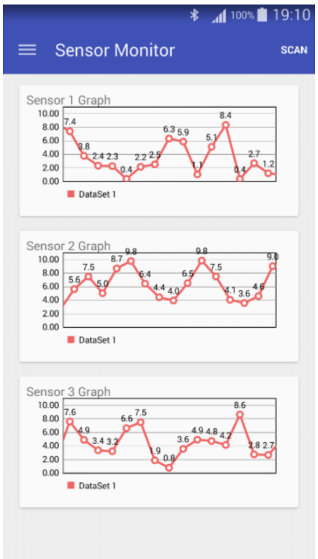
Thruster's allocation

Next, it is for us to choose the thrusters' allocation of our ROV. Since ROV can have various thruster placements, and different thruster placement means different propulsion system. It means that the system needs to know which thruster should be turned on when it moves. We have provide several allocation samples for users to choose, such as the 7-thrusters mode and this 4-thrusters mode. Other than choosing these allocation samples, users can also create their own allocation and configure individual movement respectively.

After configuring, all settings will be exported in the SD card. When we insert the SD card to the onshore control system, all settings will be applied to the ROV and everything is done.

Sensory Data Monitor

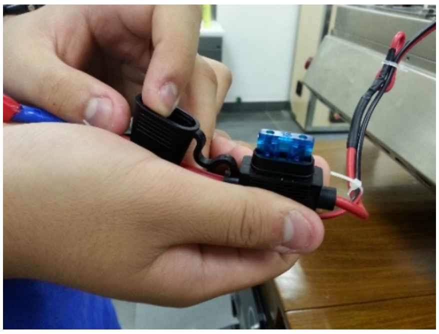
The control system can send the sensory data to the phone through Bluetooth, and then the phone will illustrate the data into graphs.



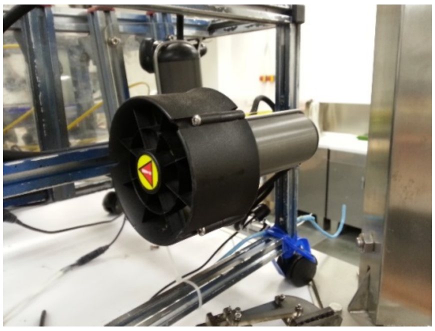
Sensor Data Monitor

7. Safety

Our ROV were designed specifically for safe to use. For personal safety, we have prepared some safety gears such as goggles, ear protectors to protect our eyes, ears and other body parts. So that we would not hurt and shaved. In order to protect the blade of the thrusters, there are shrouds covering the thrusters' blades and a caution mark to remind people to always keep a high safety awareness while working with thrusters and propellers. We installed some caps on the corners of the aluminum bar to cover sharp corners of the aluminum bars, so this can prevent our hands being hurt by the sharp edge. We also use a 20 AMP fuse for our ROV system to prevent an electric failure.



Fuse



Thruster's shroud and caution mark

Safety Goggles

Design rationale: Task

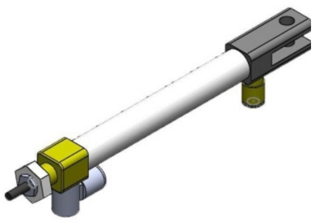
a. Manipulator

Manipulator is one of our payload tools of the ROV, since the Seabotix manipulator last year needed a lot of power to operate and it was very slow. We decided to make our own manipulators with the pneumatics kits, it is cheaper than the Seabotix manipulator and it can grab things faster. We used CorelDraw to design a sketch. It is made by acrylic sheets printed by the laser cutter. We can make more spare components so that it can be repaired easily anytime. There are several steps to make this manipulator.

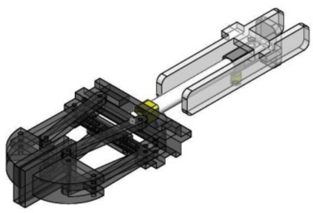
Firstly, we should printed it in the laser cutter. Then, we should ensure that the parts are completed. After that, we need to make up them with glue. Finally, we have to pack the manipulator carefully to avoid being destroyed.

Pneumatic Manipulator

Manipulator Controller



Pneumatic Kit



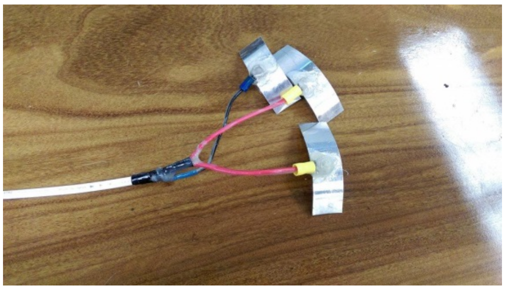
Manipulator Grabber

We separate the manipulator controller from the onshore control system, so two pilots can control the movements and manipulators respectively. It does help decrease the chances of making mistake and let our pilots concentrate in particular. For the manipulator controller, we made a small box with an Arduino Uno, hardware buttons, switch and pneumatic components inside. The hardware switch is for switching power on and off while the hardware buttons control the manipulator open and close. When the open-button is pressed, the Arduino will control the pneumatic components and then it will pump the air into the manipulator and the manipulator should open.

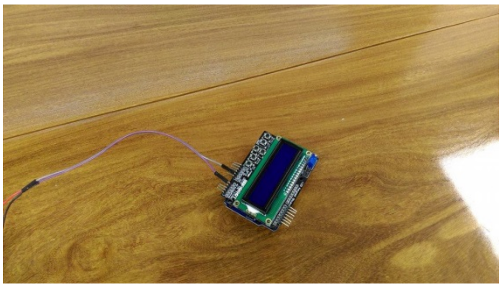
b. Lighting System

did Since we need to do the missions under the deep water. It is too dark that we can't see anything underwater. Therefore, we decided to use the light to assure that we can do the mission properly. In the past, we used the light bulbs on our ROV. Yet we found that it is not bright enough and it can just illuminate the vicinal reaches. Therefore, we made up our mind to use LED line as it is brighter than the light bulbs that it cannot only illuminate the vicinal reaches clearly but also see the whole space plainly. Meanwhile, we can put it on any places we want. Such as now, we put it on the whole frame of our ROV and it can illuminate the place all around our ROV, so it shows that the LED line is very convenient.

LED Line



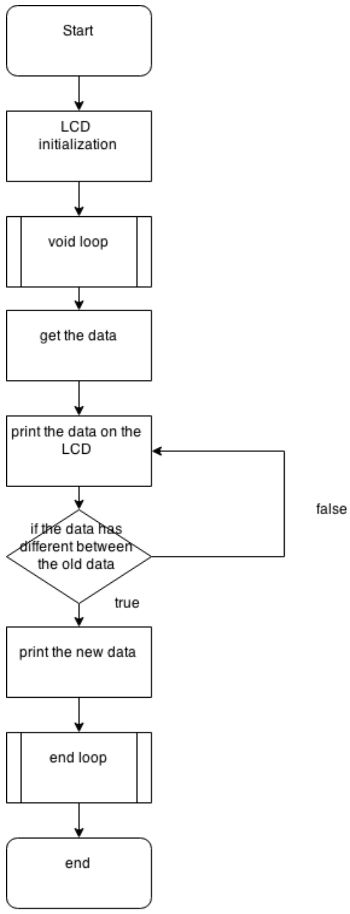
Voltage Sensor



LCD Monitor for Voltage Sensor

c. Voltage sensor

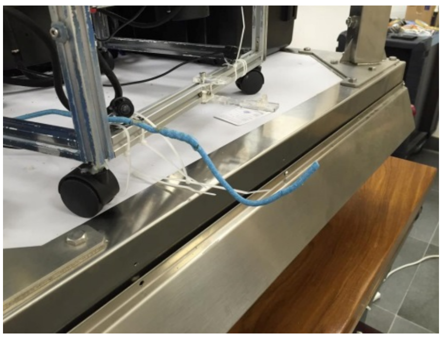
Voltage sensor is an independent system. We use Arduino for our voltage sensor. Arduino has some analog read ports for us to getting back the data. Moreover, we also can show the data on the LCD monitor through the Arduino. We have two branches for detecting the anode and one more for the ground. Using this sensor, we can finish the mission quickly and successfully.



d. Extractor (Ping Pong Pump)

This tool is designed for the task-one's mission for collecting algae, we first tried to collect them through a net when we competed in Hong Kong but the net didn't work at all. And we came up with an idea after the competition, we made an extractor combined with a bilge pump, a bottle and a funnel, and we can easily extract the algae.

Extractor



Hook

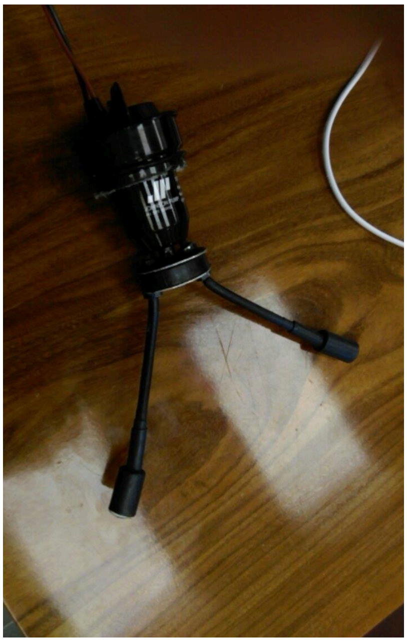
e. Hook

Instead of relying on our manipulator to complete the tasks, we decided to try an alternative method to maneuver objects. In the three years' experience, we have often been challenged by picking things up and collecting samples. So we modified some cloth hangers to make its shape transformed like hooks. Hooks do not require any mechanical manipulation, which makes them simple to install, also, we can lift the urchin (O-ball) easily.

F. Rotator

According to the mission, we have to figure out a way to turn the valve of the oil pipes under the water, so we designed a rotator, which is a waterproof pump with an acrylic plate and four PVC tubes. But when we tested it under the water, we found out that the parts of the rotator create so much drag that the rotator cannot turn properly. Because of this reason, we changed our design, which is attaching only two thick screws. With this new design, we can now turn the valve easily without creating too much drag force.

Our Teammates testing the rotator

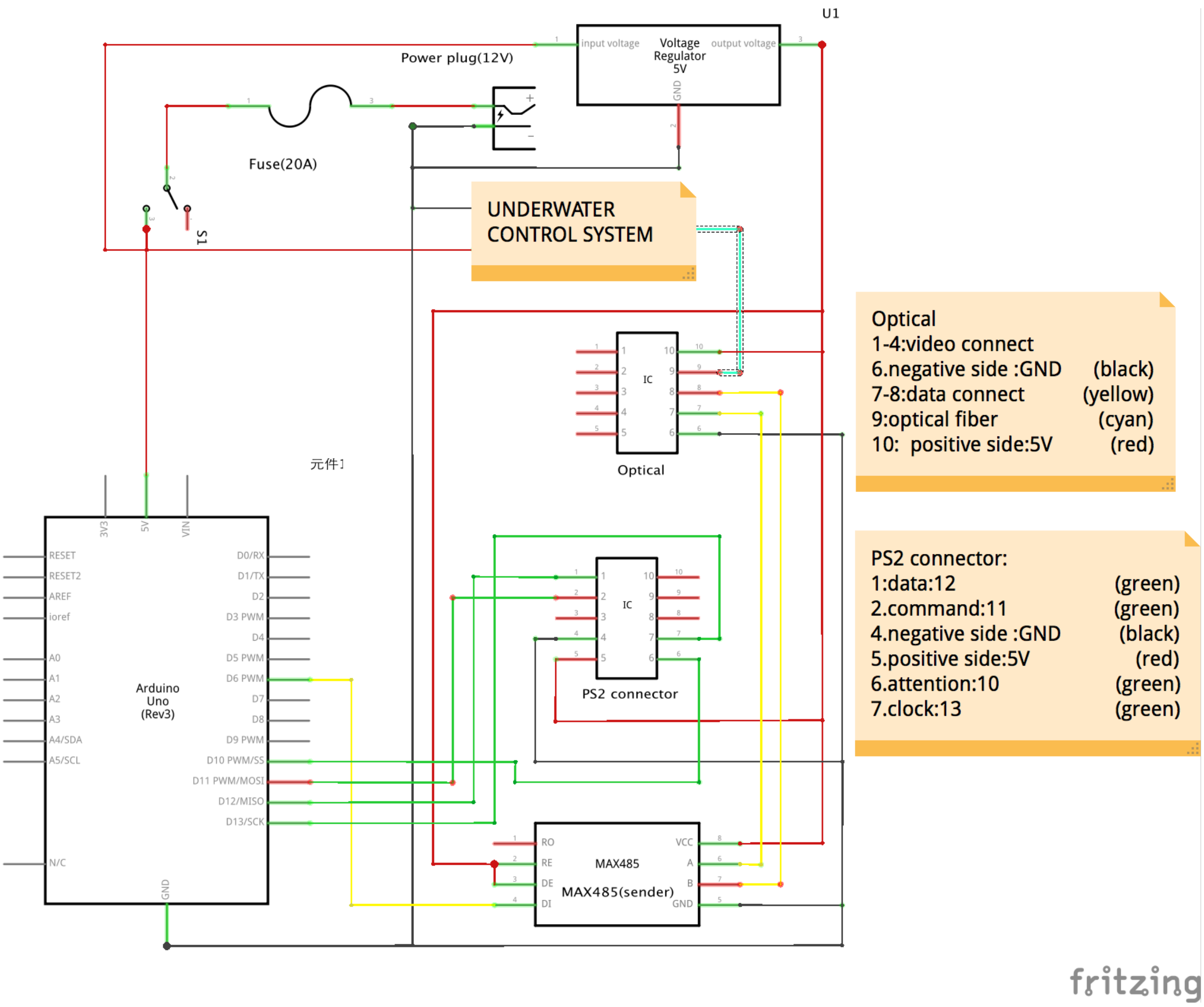


New Rotatot

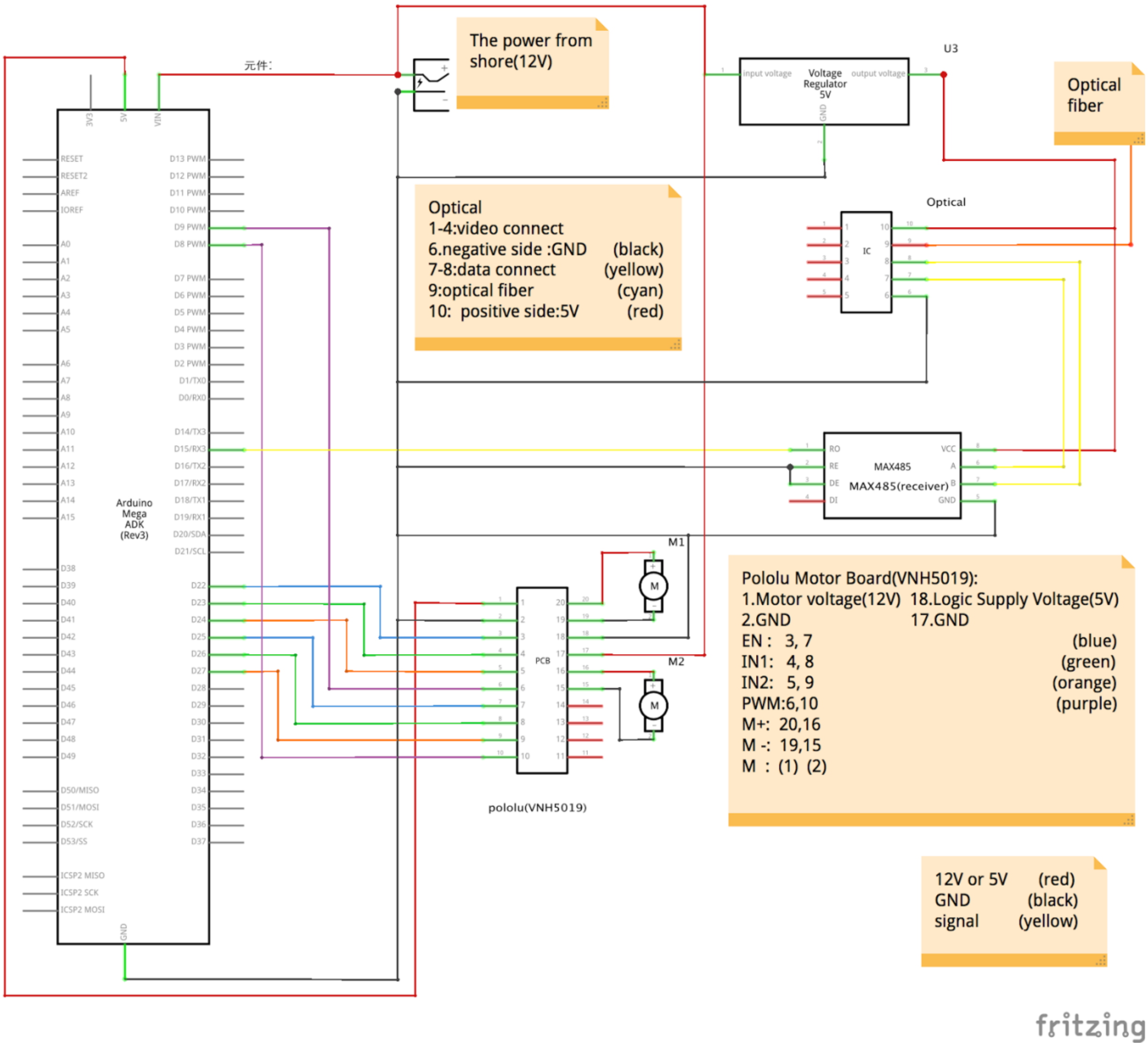
Old Rotator

Electrical schematic

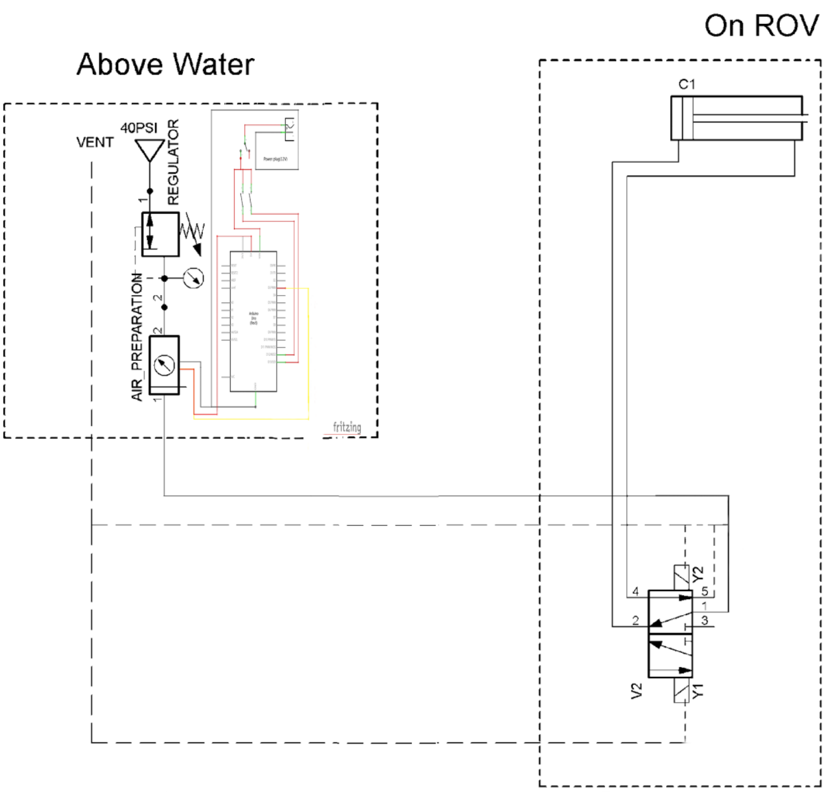
Shore



Control system (UW)

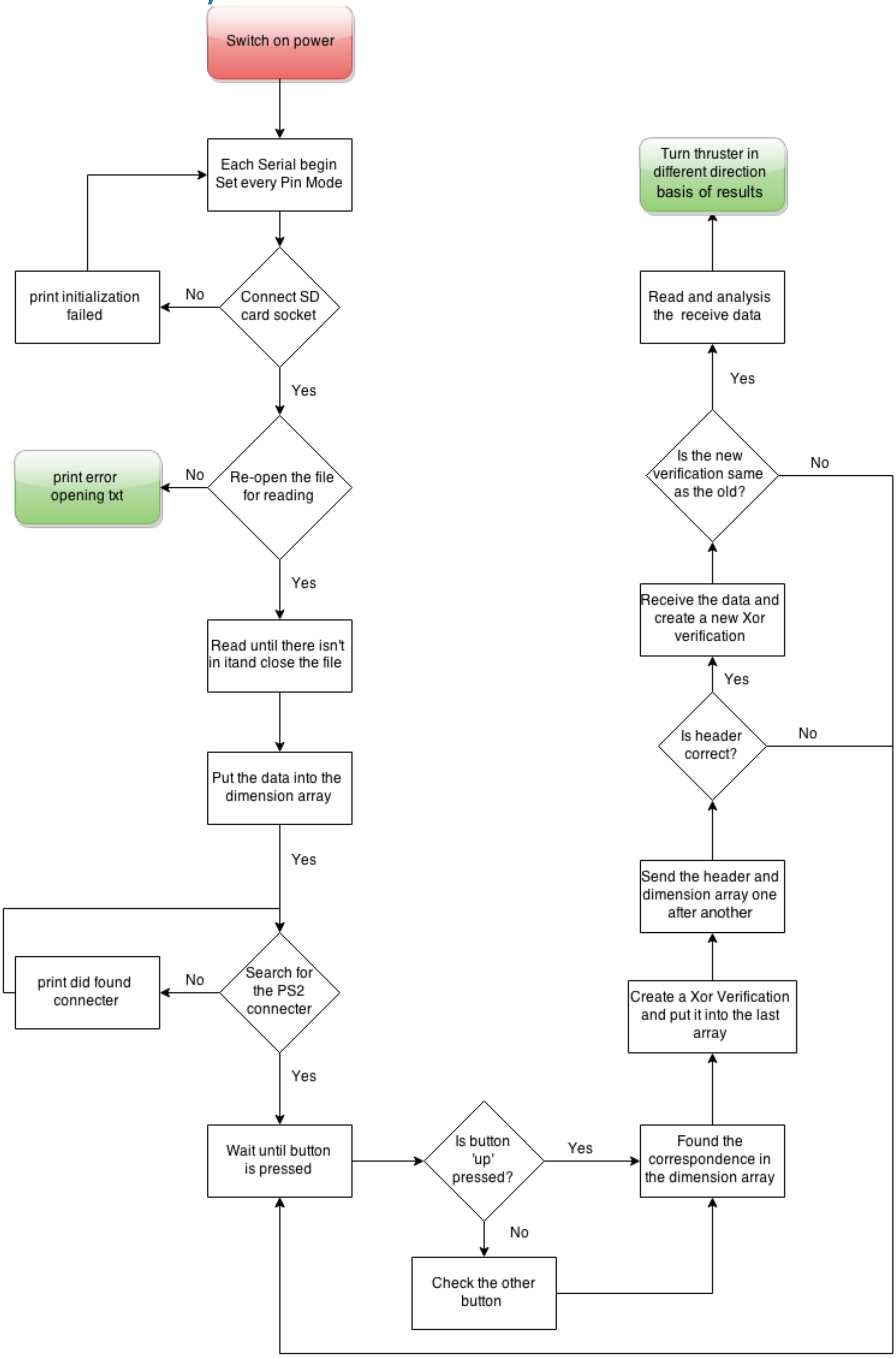


Pneumatic Manipulator SID

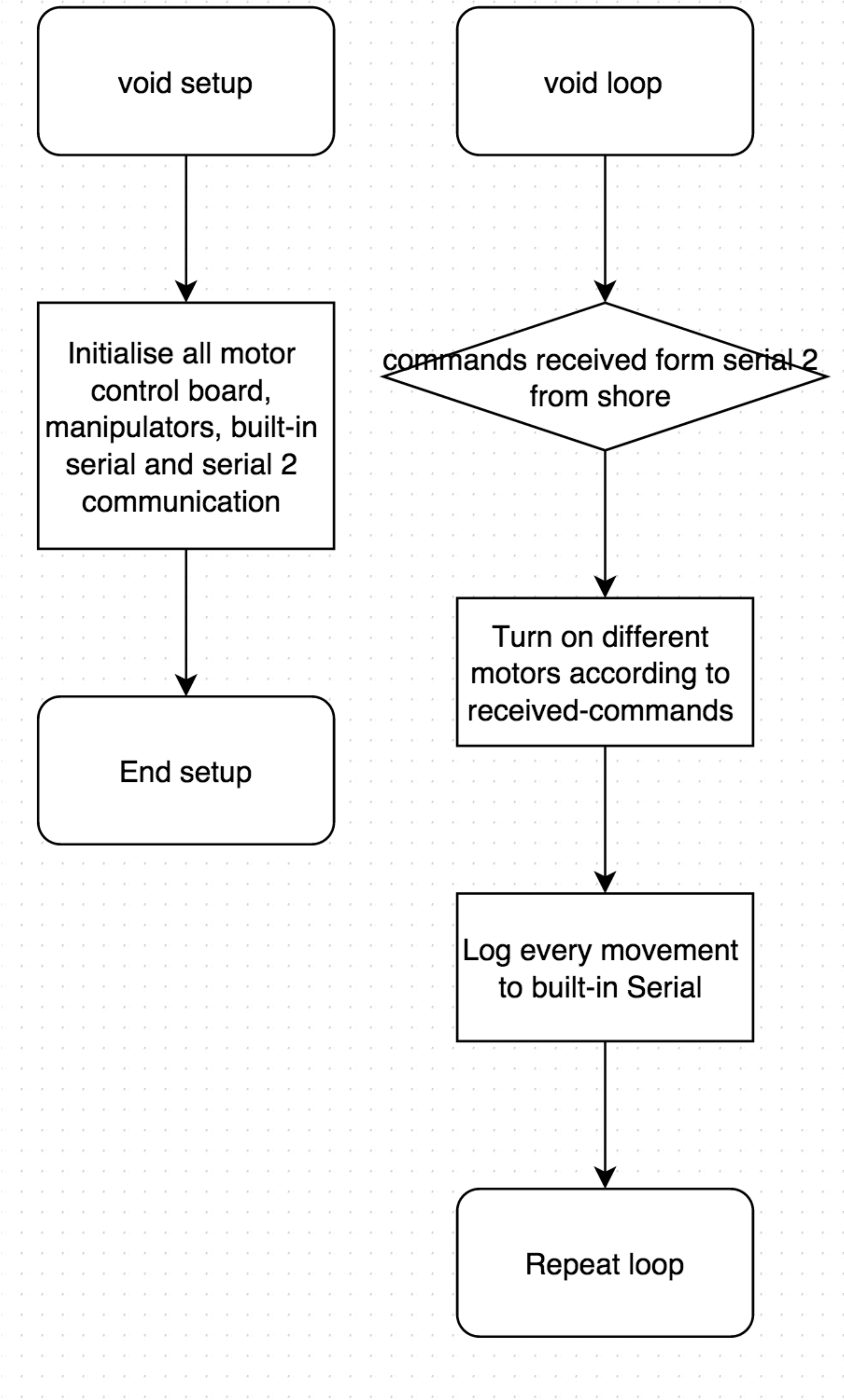


Program flowchart

Onshore Control system



Underwater Control System



Challenges and lesson learned

Challenge: Technical

According to the missions, we need to calculate the length of those PVC pipe, this is the biggest challenge for us in completing the missions. Once we try to use a software call Pixel stick to deal with this task, but we still don't know its operations clearly after a period of attempt. Finally, we gave up using Pixel stick and found another way to calculate the length. Such as using the camera to calculate the length by proportion. Its principium is that we first calculate the proportion between the real length and the length on the screen through the known length. Then using the proportion, we can calculate the real-length of the pipes. This method has been tested for several times and is proved that it works.

Challenge: Non-Technical

Since our teammates are all secondary students. We have so much work to do every day and also we have several tests each week. Thus we need to have a good time management between making ROV and our study. Because of various considerations, two of our teammates has already abort the team and work hander on their study. Both of them have a great experience of producing manipulator. So, before he left our team, he teach some of the members to design and produce the pneumatics' manipulator by themselves. As a result, we have designed a suitable manipulator for the mission task.

Lesson: Technical

Carbon fiber- In the past, we use the PVC pipe to make our buoy but the weight of it would affect the buoyancy of our ROV. Meanwhile, it can't be changed the shape for fitting our ROV. Therefore, we decided to use carbon fiber to replace PVC pipe for making our buoy. In the process of making buoy, we have learnt the element of it, the benefit of it and how to do it better.

Pneumatics kit-The Seabotix manipulator is so slow and it needs a lot of power to operate, so we made our manipulator with the pneumatics kit to replace the Seabotix manipulator this year. In the process of making this manipulator, we have learnt that the pneumatics kit can make the manipulator pick up the things rapidly, the working theory of the manipulator...etc.

Lesson: Non-Technical

After several months of working and cooperating, our sense of solidarity is becoming stronger. A team cannot be raised up by only one person, so improving the communication between each other is very important. We rarely communicated with each other at first. This made our team has a slow progress. Besides, we always didn't know what to do when we are at our workshop. Our instructor noticed that and helped us know each other better through group discussions and different group works.

Further improvements

Based on our ROV, we still have plenty parts to improve, and we will discuss it in three different aspects, the structural aspect, the electronic aspect and the programming aspect.

First, the structural aspect, minimizing the size of the ROV frame and its control system is always our main objective. With a smaller size, not only it can increase its mobility, but also allowing the ROV to be eligible to explore different extreme and harsh environment. So we would like to reform our frame to a modular design. With the modular design, we can have a better way to manage the components and the functionality of the ROV and preventing the ROV to have too much redundant components.

On the electronic aspect, we can still have improvements to minimize the size of the control system. Generally, changing the boards into a PCB (Printed Circuit Board) is a very effective way to minimize the size of the circuit boards and increase its stability. Actually we have already tried once before, which is integrating four motor controller boards and adding pins which is modified to attach to the Arduino Mega. But unfortunately, the stability of that PCB is very low, it may have some problems occur while operating in analog mode, also it may overheat after longtime operation. So it is still a long way to integrate all the electronic boards.

Lastly the programming aspect, our current ROV system is an open loop system, which means we give the commands and the ROV runs it, no feedbacks and no algorithms to analyze the feedbacks. If we build up the system to a closed loop system, we would enhance the ROV's stability by programming in some controls such as PID control. With the PID control, we would first get the angular movements and the tilt of the ROV with a gyroscope, then compensate it through the PID control.

Reflection

Nicky Chan

As the CEO of the team, I have the responsibility to look after my teammates and control the team. At the beginning, I was afraid that I could not be competent to this job well. But I was trying my best to be a CEO. Although sometime made some decisions poorly, I was evolving gradually after several failure and attempts. Leading my team to enjoy the fun of building ROV.

Simon Lo

First of all, I think I have learnt how to make carbon fiber boards of our ROV. It is a good challenge for us. We have a great team-working finally. Although it is not perfect enough for us, it is a good try for us.

Daniel Lau

After making the ROV, we learnt how to use the pneumatic suit to make the manipulators and other payload tools. Although it really takes time to learn a new way to make tools, we put a lot of time to try and learn, so at last we did it.

Tom Lee

After I had joined this team, I have learnt many useful skills here. Such as how to get along with other different people, how to programming, some electronic knowledge, etc. And the most important thing is that I have learnt how to protect the ocean!

Dominique Chan

As a SolidWork illustrator, I have improved the skills of creating 3D-script and how to build up a more stable frame for the ROV. My team may not be the best but I hope we will get a good result during the competition.

Anthony Mak

It has already been the third year to take part in this competition, and I am still learning more and more new technique about ROV, although I cannot always in the best state, I always try to do my best.

Jacky Wong

This is my second year joining the ROV team. Although this team has some new members, we still can do the best to our ROV and build up our team spirits.

Teamwork

As a team with 15 teammates, we have organized our team into three main department, the Structural Department, the Electronic Department and the Programming Department. Each department has a leader to follow up the progress of the teammates in the department. The three departments have different fields to focus on, and with all the different parts, we will integrate it to a whole ROV.

First, the Structural Department is responsible for designing the mechanical part of the ROV, such as the frame, the thrusters' allocation, and various payload tools which are specialized to complete the mission given by the MATE competition. Also, the structural department is in charge of maintaining the ROV in training and actual competitions, since they have a more thorough understanding to the framework of the ROV and also how to attach and detach the components.

Next, for the Electronic Department, they mainly design and construct the control system of the ROV, including the onboard control system, underwater control system and the tether.

Moreover, for the Programming Department, they are responsible of programming the control system of the ROV, so it has a close connection with the Electronic Department. Also, they are in charge of making the voltage sensor, which is used in the offshore oilfield production and maintenance.

All the departments have individual group meetings twice a week, which allows the department leaders to check the schedules of the teammates, also let the teammates to discuss about the present challenges and see whether we can come up some solutions.

Above all the departments, there is a CEO to manage and coordinate the work for the departments, also he is responsible for gather the department leaders and manage the current problems of the team. Apart from the CEO, there are also independent positions such as the CFO and the PR, the CFO is in charge of managing the financial expenses of the team, monitoring the expenses such as buying electronic components or expenditure of fieldworks such as training and competitions. And the PR is responsible for contacting our sponsors and planning our itinerary of competitions.

Financial Report

Position	Category	Name	Reuse[piece(s)/bot	Newly Purchased[p	Total Amount[piece	Expense per Each(l	Total Expense(l
Underwater	Structure	Seabotix Thruster	6	0	6	740	4440
Underwater	Structure	20 * 20 European Standard,6mm Width Industrial Alum	3(m)	0	3(m)	2.06	6.19
Underwater	Structure	Aluminum Angles	12	0	12	0.21	2.51
Underwater	Structure	20*20 European Standard Corner Slot Connectors	16	0	16	0.21	3.34
Underwater	Structure	2mm * 3mm pneumatic hose pipe	0	15(m)	15(m)	0.16	2.42
Underwater	Structure	Aluminum Plates	0	1(pack)	0	24.99	24.99
Underwater	Structure	Nylon Cable Tie	0	3(packs)	3(packs)	0.52	1.55
Underwater	Structure	Pneumatics Kit 2 - Double Acting Cylinders	0	2	2	229.95	459.9
Underwater	Structure	Hexagon Tip Set Screws	1(pack)	0	1(pack)	0.97	0.97
Underwater	Structure	Weicon Epoxy Minute Adhesive	0	1(pack)	1(pack)	12.58	12.58
Underwater	Structure	Araldite Epoxy Adhesive	0	3(packs)	3(packs)	1.45	4.36
Underwater	Structure	Acrylic Sheets	2	0	2	0.48	0.97
Underwater	Structure	Light	0	1	1	0.45	0.45
Underwater	Housing	Cable Gland PG7	22	0	22	0.52	11.36
Underwater	Housing	Fixed Terminal Stations	0	2	2	16.14	32.28
Underwater	Housing	Desiccant	0	1(pack)	1(pack)	4.84	4.84
Underwater	Housing	tampon	0	3(packs)	3(packs)	3.76	11.28
Underwater	Housing	O-ring	0	1(pack)	1(pack)	1.33	1.33
Underwater	Control System	Arduino Mega	1	0	1	6.29	6.29
Underwater	Control System	Arduino Sensor Shield v5.0	1	0	1	1.37	1.37
Underwater	Control System	Pololu Dual VNH5019 Motor Driver Shield for Arduino	0	2	2	49.95	99.9
Onboard	Control System	Arduino Uno	1	0	1	3.31	3.31
Onboard	Control System	MAX485	2	0	2	0.36	0.71
Onboard	Control System	PS2 Controller	1	0	1	3.07	3.07
Onboard,Underwater	Control System	Video Audio Data Converter	0	2	2	13.3	26.6
Onboard,Underwater	Housing,Control System	Multi-core Wire (red)	2(packs)	0	2(packs)	16.14	32.28
Onboard,Underwater	Housing,Control System	Multi-core Wire (black)	2(packs)	0	2(packs)	16.14	32.28
Underwater	Mission Props	Light Pump	1	0	1	8.69	17.38
Underwater	Mission Props	Bilge Pump	0	1	1	36	36
Underwater	Mission Props	775 DC motor	0	1	1	3.19	3.19
Underwater	Mission Props	Funnel	0	1	1	1.5	1.5
Underwater	Mission Props	PVC Tube	1(m)	0	1(m)	8.69	17.38
Underwater	Mission Props	PPR Pipe Fittings	8	0	8	8.69	17.38
Underwater	Mission Props	Pressure Transmitter Sensor	0	1	1	44.79	44.79
Underwater	Mission Props	Hanger	0	1	1	1.25	1.25
Onboard,Underwater	Structure,Propulsion,Control System	Screws, Screw Nut	some	0	some	4.84	4.84
Onboard	Electronics	Voltage Transformer	2	0	2	3.71	7.42
Underwater	Electronics	30mm Nylon Webmaster	1	0	1	1.95	1.95
Cable	Housing	Optical Fibre	0	2	2	23.39	46.78
Cable	Housing	PCT-215 Wire Connectors	4	0	4	0.65	2.6
Underwater	Housing	Round insulation terminal	16	0	16	0.03	0.48
Underwater	Housing	Three Core Wire	4	0	4	0.5	2
Underwater	Housing	Four Core Wire	3	0	3	0.69	2.07
Underwater	Housing	Gardner Bendar Liquid Tape	0	3	3	5.99	17.97
Underwater	Camera	Mini Surveillance Camera	0	4	4	6.45	25.8
Underwater	Buoyancy	UV Light-cured Shadowless Glue	0	1	1	8.55	8.55
Underwater	Buoyancy	CFRP	0	2(m)	2(m)	16.13(per/m)	32.26
Underwater	Buoyancy	Dupont Kevlar fabric	0	1(m)	1(m)	28.55(per/m)	28.55
Underwater	Buoyancy	Masking Tape	0	5	5	0.4	2
Underwater	Buoyancy	Black Bright Type Pouring Sealant(include group A: ep	0	2(packs)	2(packs)	14.19	28.38
Underwater	Buoyancy	Toughening Agent (Dibutyl Phthalate)	0	1(kg)	1(kg)	9.19	9.19
Underwater	Buoyancy	Reactive Diluent (4-butanediol Diglycidyl Ether)	0	2	2	1.13	2.26
Underwater	Buoyancy	Coupling Agents(Y - aminopropyltriethoxy Silane)	0	1	1	4.03	4.03
Underwater	Buoyancy	Protective Polishing Agent	0	1	1	8.71	8.71
Underwater	Buoyancy	Antioxidants	0	1	1	6.94	6.91
Underwater	Buoyancy	High Density Styrofoam	0	1	1	Donated	Donated
				Expense of Resue:	4618.15	Expense of NewlyP	987.41
						Total:	5605.56
				Travel Expense:	28000		

CURRENCY : USD

Acknowledgement
Our ROV Team would like to thank (In no particular order):

MATE Center and The IET: Thank you for holding the competition.

SolidWork: Thank you for offering this software.

Monetary Donations (Macau foundation, DSEJ of Macau, FDCT of Macau): Thank you for sponsor our traveling fee.

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Help us to join the ROV competition.

Thomas Lao and his lovely family
Thank you for giving us opinions, the support from the spirit and giving up his time after school.

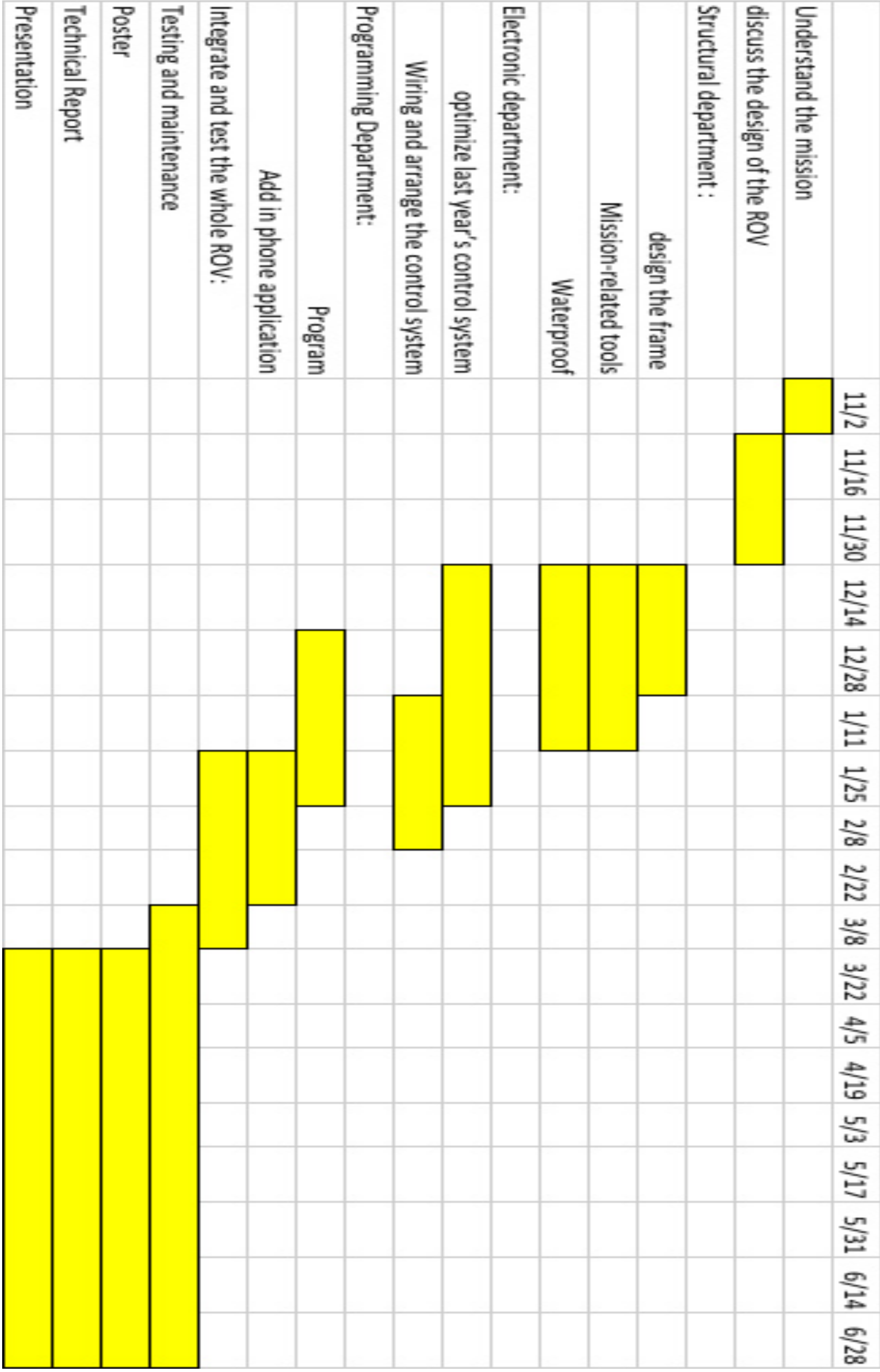
Bevis Leong &Chongman Leong
Thank you for spending such a long time on teaching so much valuable technique for us.

Our families
Thank you for supporting, encouraging and allowing us to study on what we doing.

References
https://www.pololu.com/product/2502

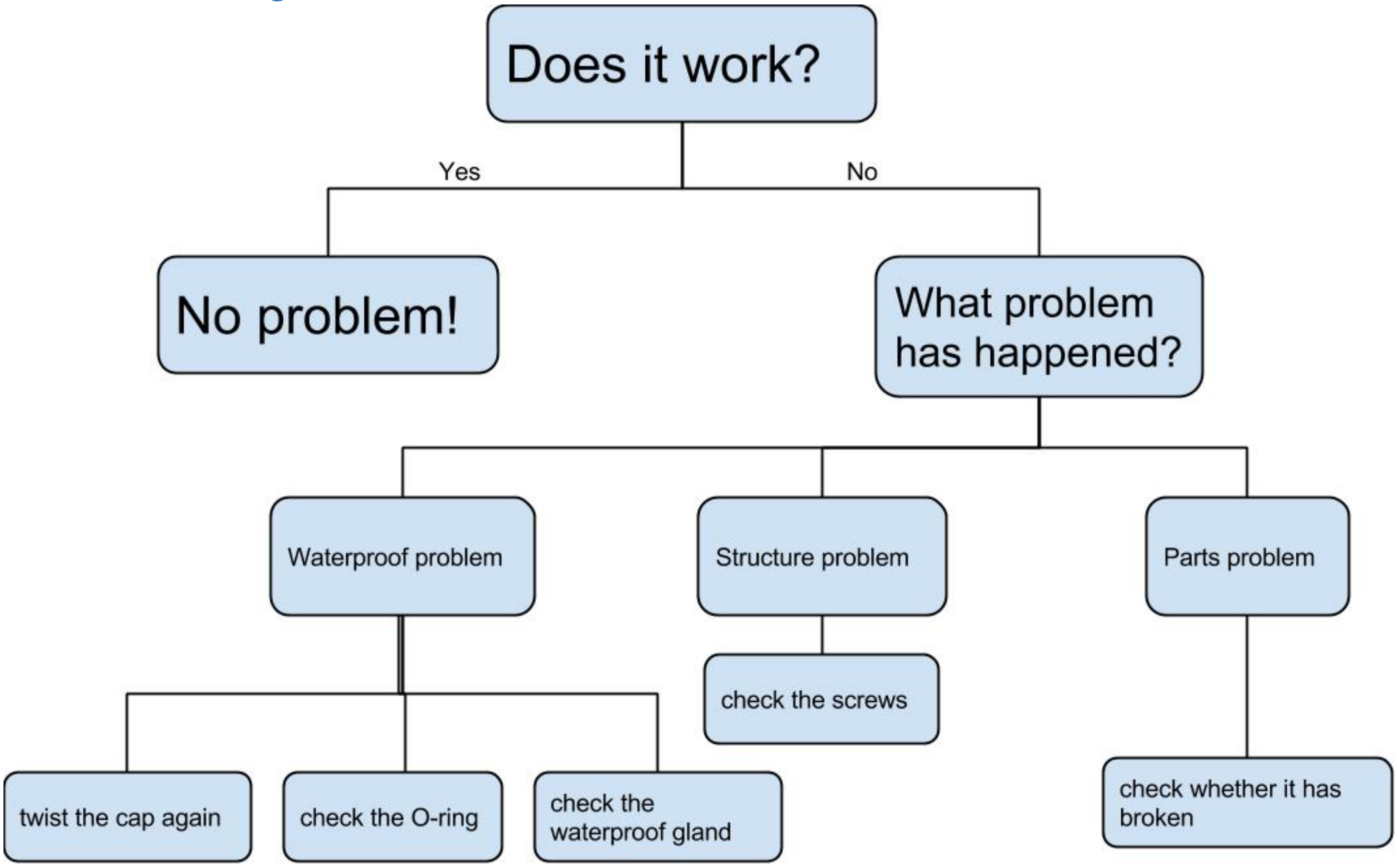
http://www.justinlewis.com/index.php#p=-1&a=0&at=0

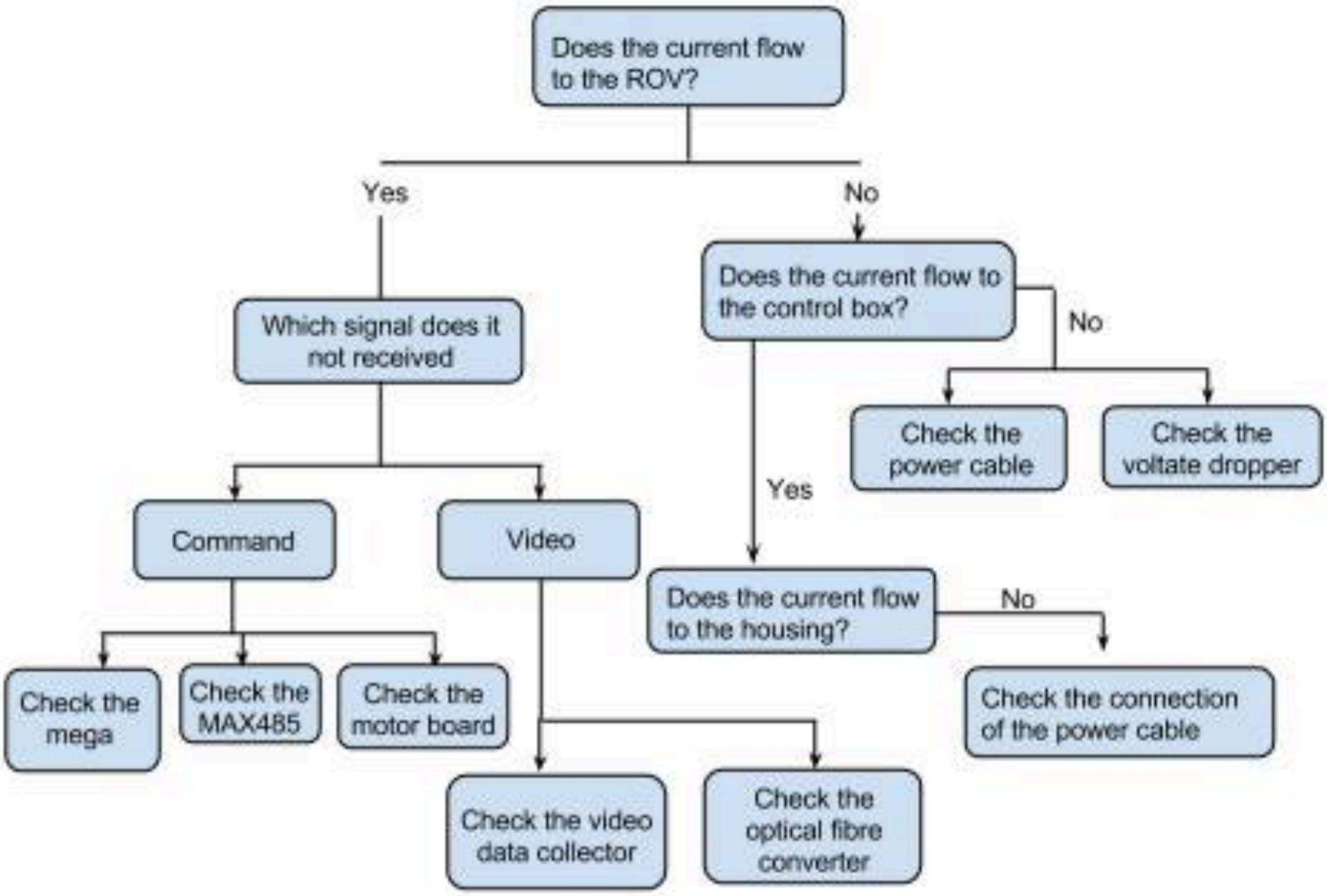
Schedule



11/2
11/16
11/30
12/14
12/28
1/11
1/25
2/8
2/22
3/8
3/22
4/5
4/19
5/3
5/17
5/31
6/14
6/28
Understand the mission
discuss the design of the ROV
Structural department :
design the frame
Mission-related tools
Waterproof
Electronic department:
optimize last year's control system
Wiring and arrange the control system
Programming Department:
Program
Add in phone application
Integrate and test the whole ROV:
Testing and maintenance
Poster
Technical Report
Presentation

Troubleshooting





Safety Checklist

Safety Checklist:	√	Remarks:
Vehicle Inspection		
1. Check the angles of the ROV and fix them if they have sharp edge.		
f. Inspect the plugs are vent plug.		
g. Inspect/ secure hull end caps for full engagement.		
h. Check the thrusters are installed stability.		
i. Remove the plugs for maintenance after testing in the water.		
j. Check is it waterproofed before testing in the water.		
Electrical		
1. Check the main switch is off when it is not having a testing.		
2. Protect all the connectors with dummy plugs.		
6. Use a 25 AMP fuse on the positive side of the main power supply.		
7. Ensure the import voltage are plugged stability.		
8. Inspect that the ROV can be controlled.		
System checked out		
1. Ensure the ps2 controller and the control system are in off position.		
2. Switch on the power supply and make sure that center trim adjust knob.		
3. Open the computer for using the camera.		
3. Switch on the PS2 controller.		
4. Test the position of the thrusters and the manipulator.		