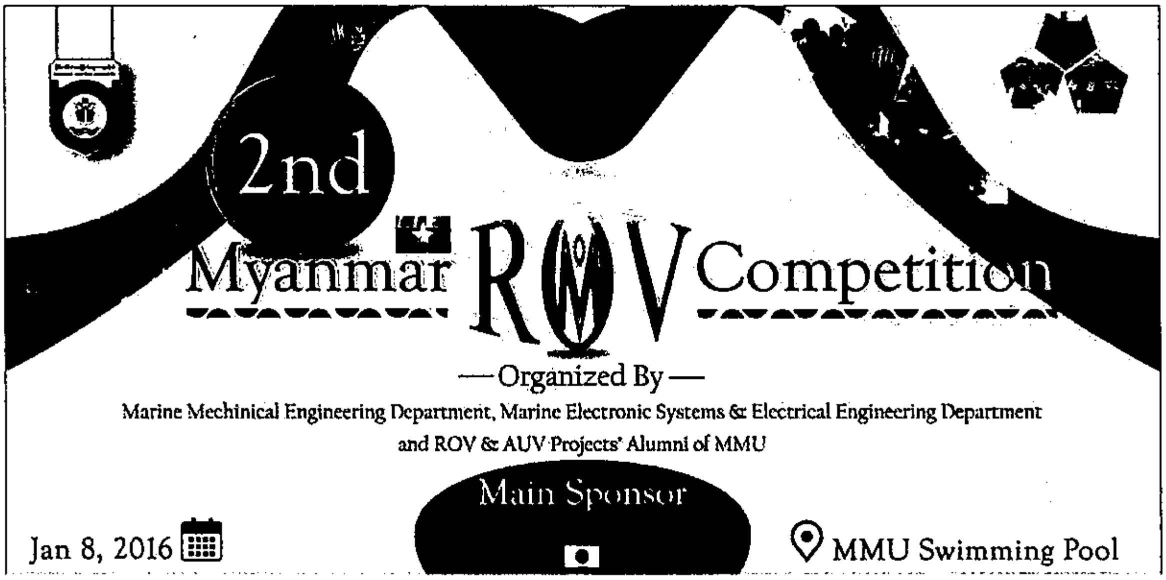
MYANMAR MARITIME UNIVERSITY

2ND MYANMAR ROV COMPETITION



Project members

Name	Major
1. Mg Ye Tint Lwin	MESE
2. Mg Okkar	MESE
3. Mg Ye Tun Toe	MESE
4. Mg Lwin Moe Aung	MESE
5. Mg Pai Mg Mg Thet	MESE
6. Mg Ye Mann Thwin	MESE
7. Mg Aung Zay Myo	MM
8. Mg Sett Aung	MESE

Facts

Dimensions: 33cm* 86 cm * 26cm

Maximum Operation Depth: 10 meters

Degree of Motion: 5

Sensors: Pressure sensor (Depth Sensor)

Gyro compass (Heel, Pitch)

Leakage Sensor

Voltage Sensor

Operating Voltage: 12 V DC

Operating current: 10A - 12 A

Power Consumption: 120 W- 360 W

Propulsion:(2 thrusters) for up & down movement

(3 thrusters)for forward & back movement

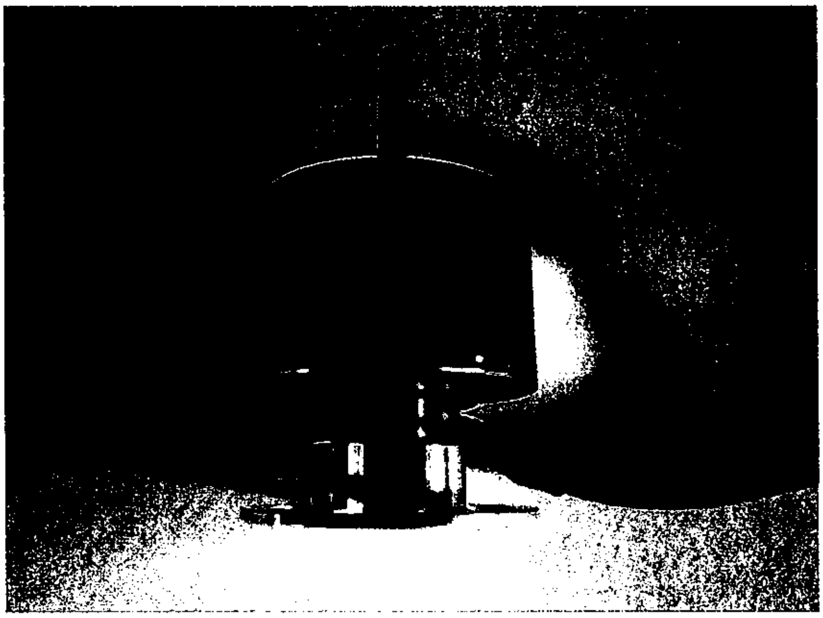
Controller: Joystick

Power supply: adapter which transform from main AC to Several DC voltages

Camera system: Webcam (Position fixed)

Main Components Specification

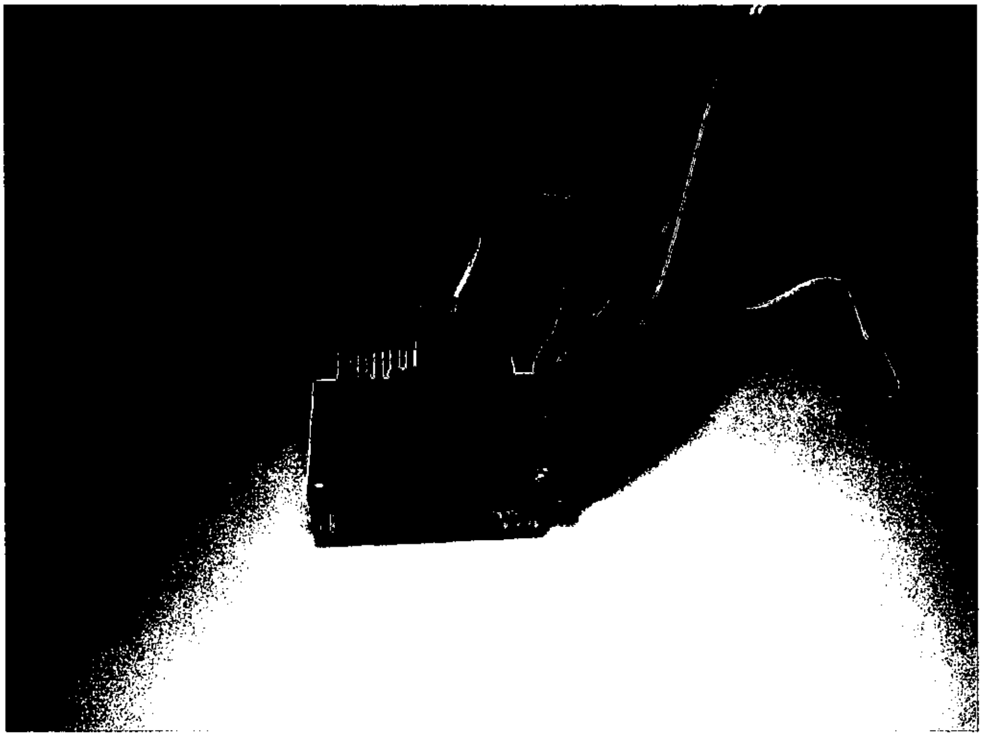
1. Brushless DC Motor



Specifications

- 800 kv
- Weight: 53g
- Shaft: 3mm
- Max Amp: 9.5A
- Max RPM: 7250

2.Electronic Speed controller



Specifications

- Model : HobbyKing 30A
- Input voltage: 2-3S Lithium batteries / 4~9 Ni-xx (We used 12V)
- Cont. Current: 30A
- BEC output: 2A /5V (Linear)
- Size(length X width X high): 45x32x20mm
- Weight: 51g

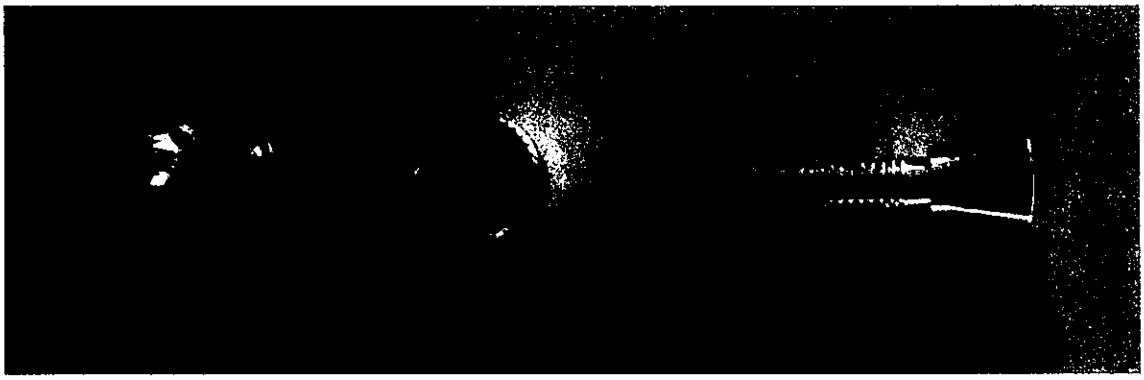
- Compatible with sensorless brushless motor.
- Supports highest motor speed 240,000RPM (2 poles), 80,000RPM (6 poles) and 40,000(12 poles).
- 4 step reverse force adjustment
- 5 step start force adjustment.
- 3 step brake force adjustment
- 5 step drag brake force adjustment,
- 4 step initial brake force adjustment.

Propeller

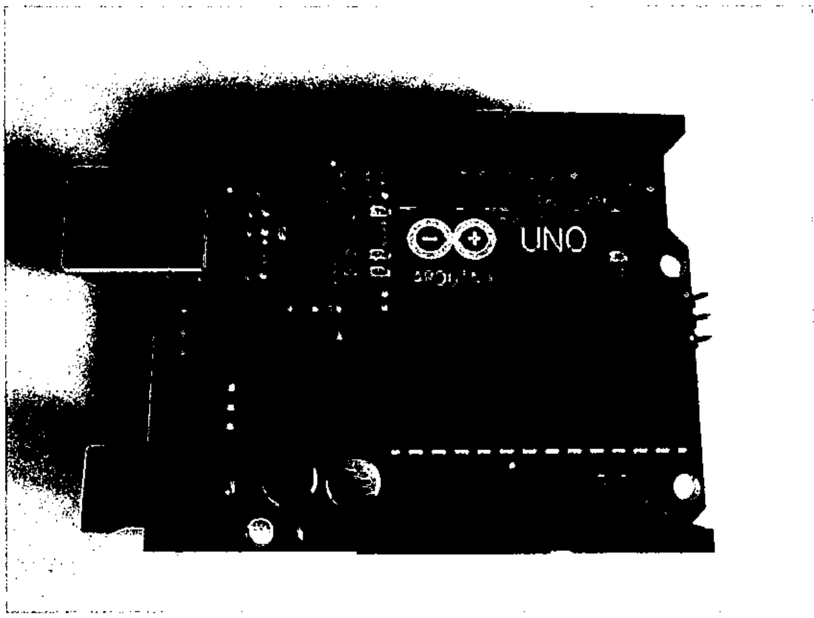
Specifications

- Diameter : 43 mm
- Material : nylon
- Pitch : 12 mm

Propeller hub



Arduino UNO



Pressure sensor

MPX4250DP

Specifications

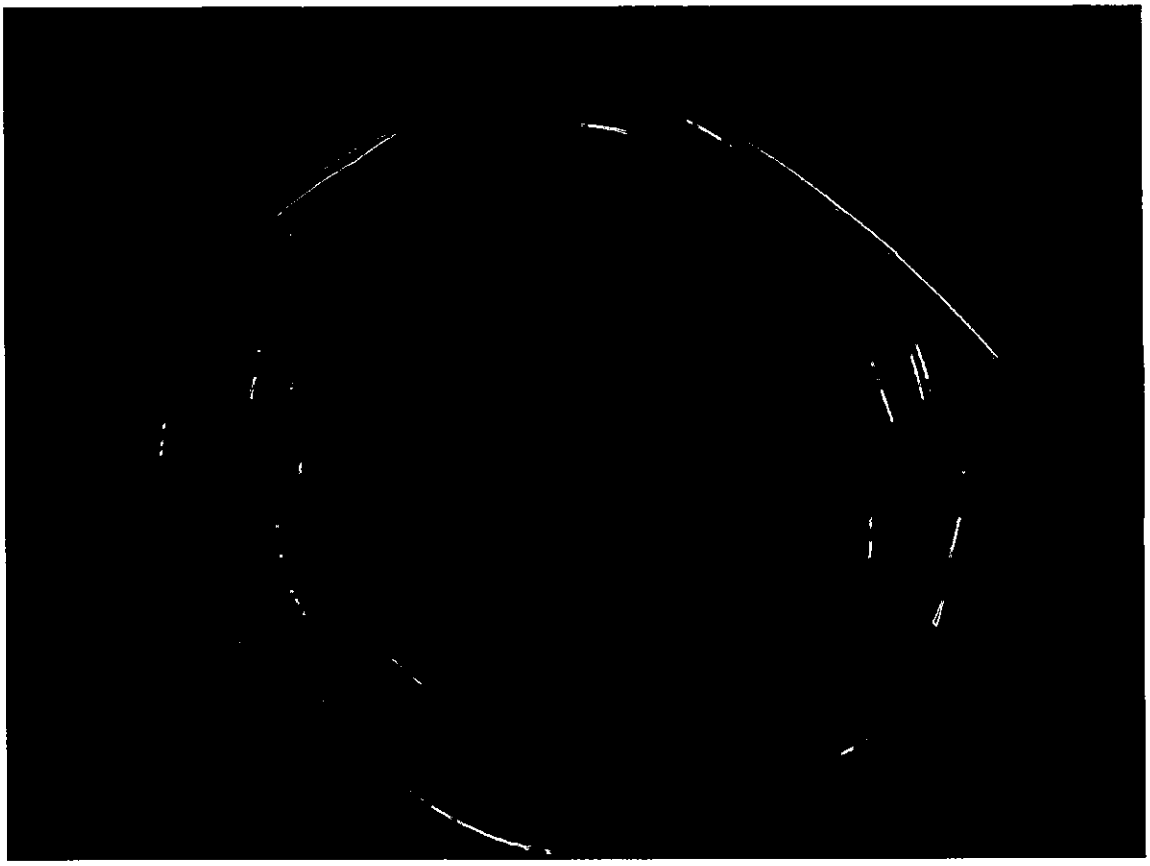
- Model No. MPX4250DP
- Max pressure: 250 kPa
- Resolution of depth from Arduino: 2.4 cm

MPU-9150 9 DOF Gyro & Compass

Specifications

- 9 Degree of Freedom IMU sensor
- 3 axis accelerometer, 3 axis gyro and 3 axis magnetometer
- I2C interface

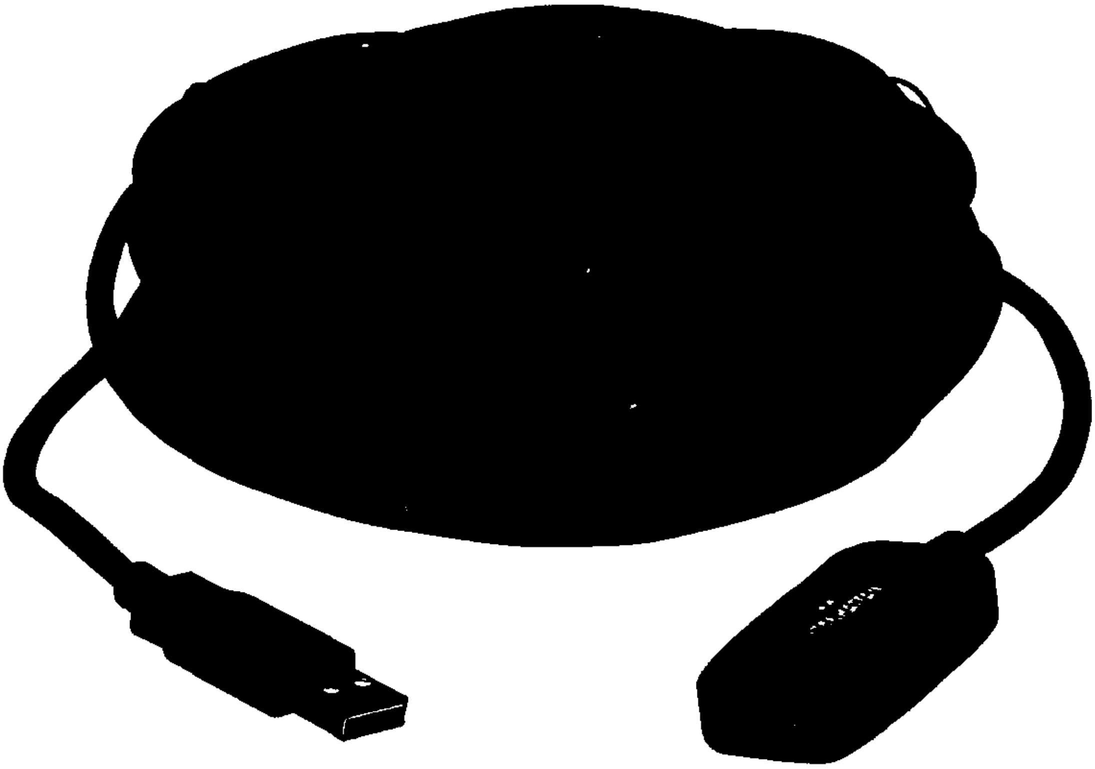
USB repeater cable 1



Specification

- Length: 10 meter
- Type: USB 2.0
- Active repeater: No

USB repeater cable 2



Specifications

- Length: 10 meter
- USB Type: 2.0
- Active repeater: Yes

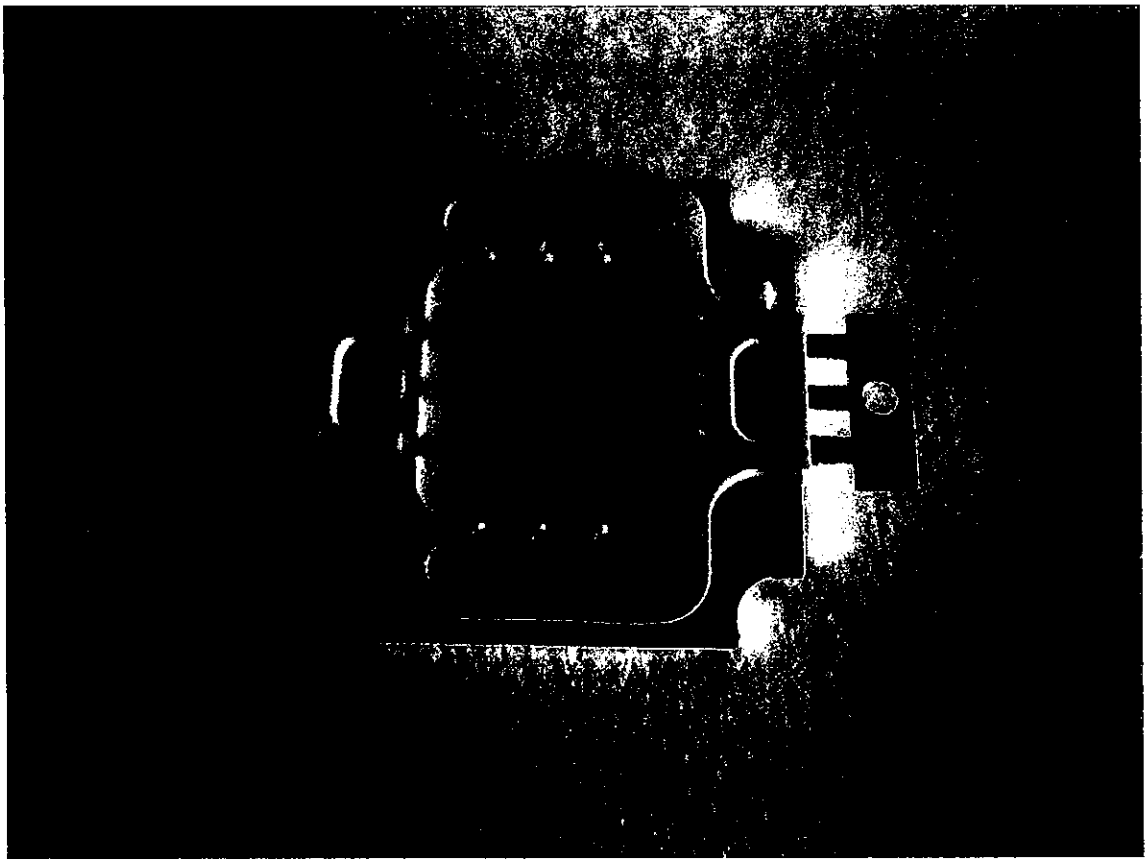
USB Webcam

Model: Logitech c720

Specifications

- Video output: 720p
- Interface: USB 2.0

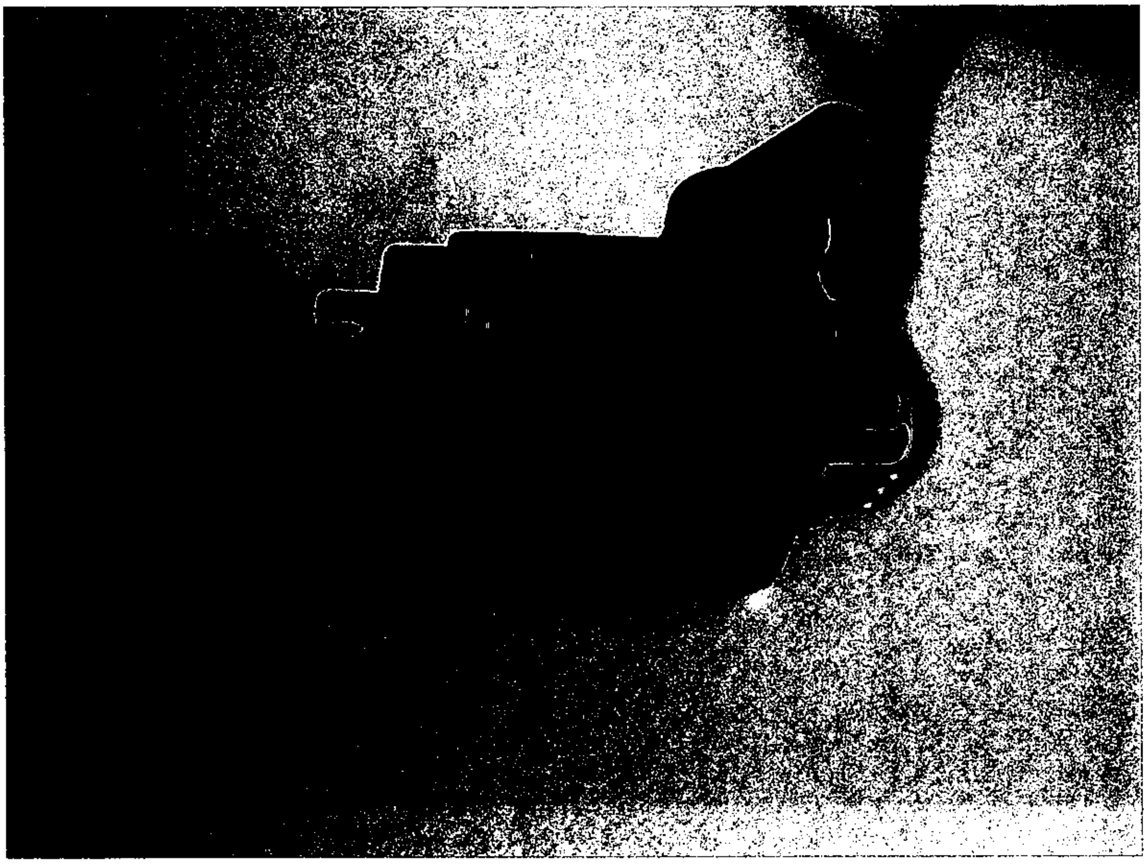
LED



Specifications

- Power: 10 Watt
- Forward Voltage: 9-11 V
- Forward Current: 1100 mA

Servo motor

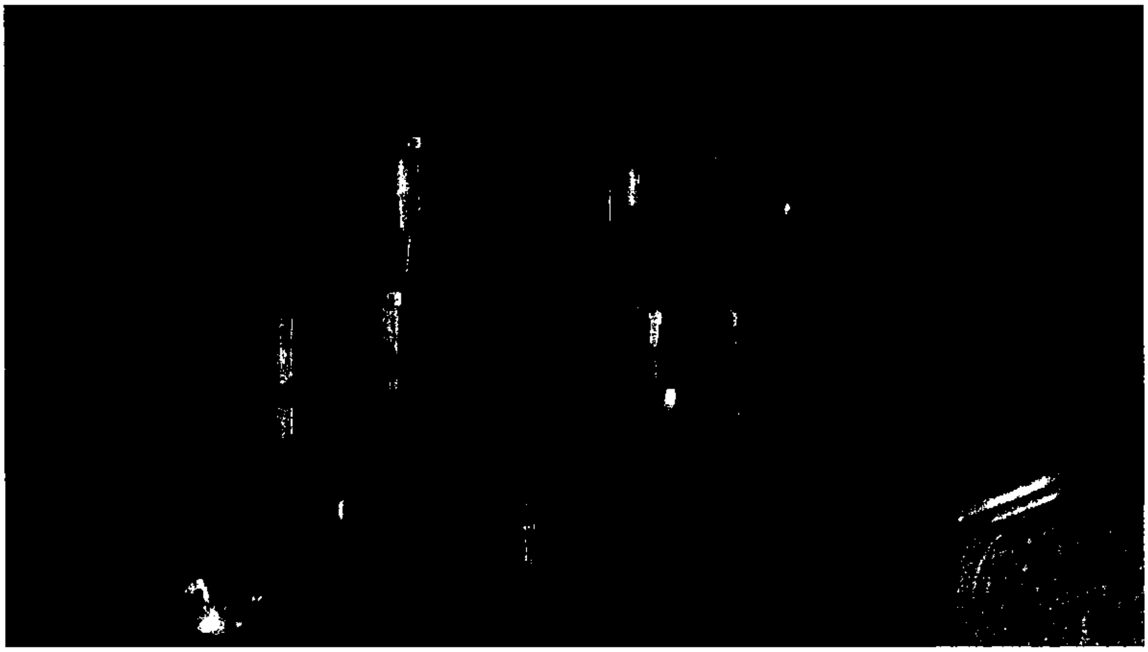


Specifications

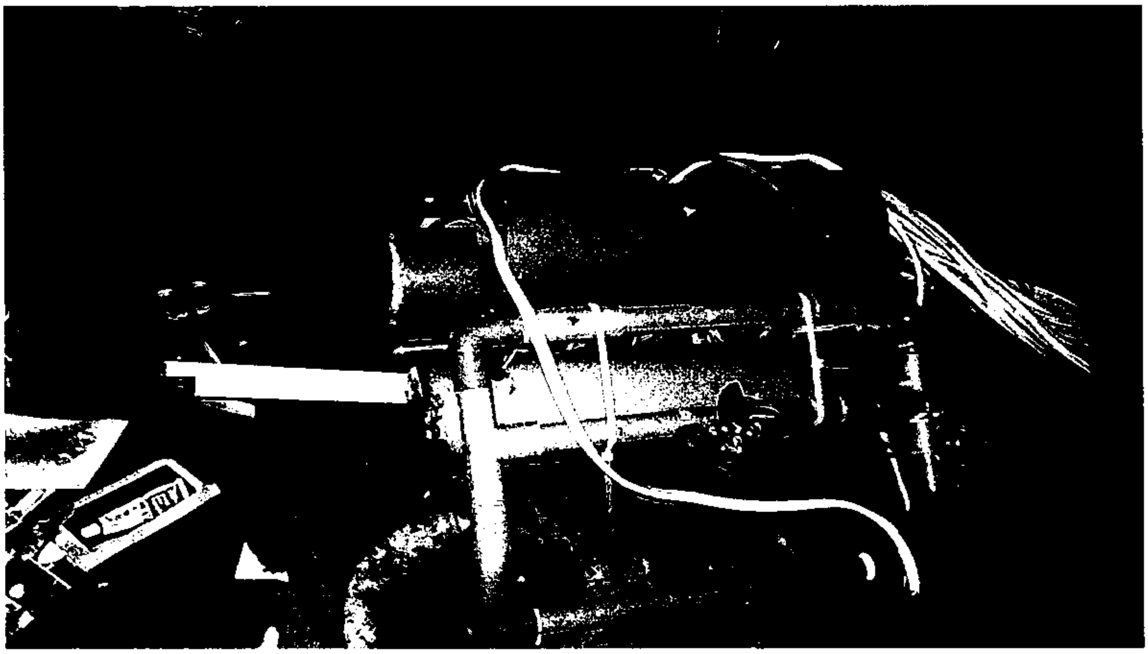
- Model: MG995
- Range: 0-170 Degree

ROV DESIGN

Frame Design



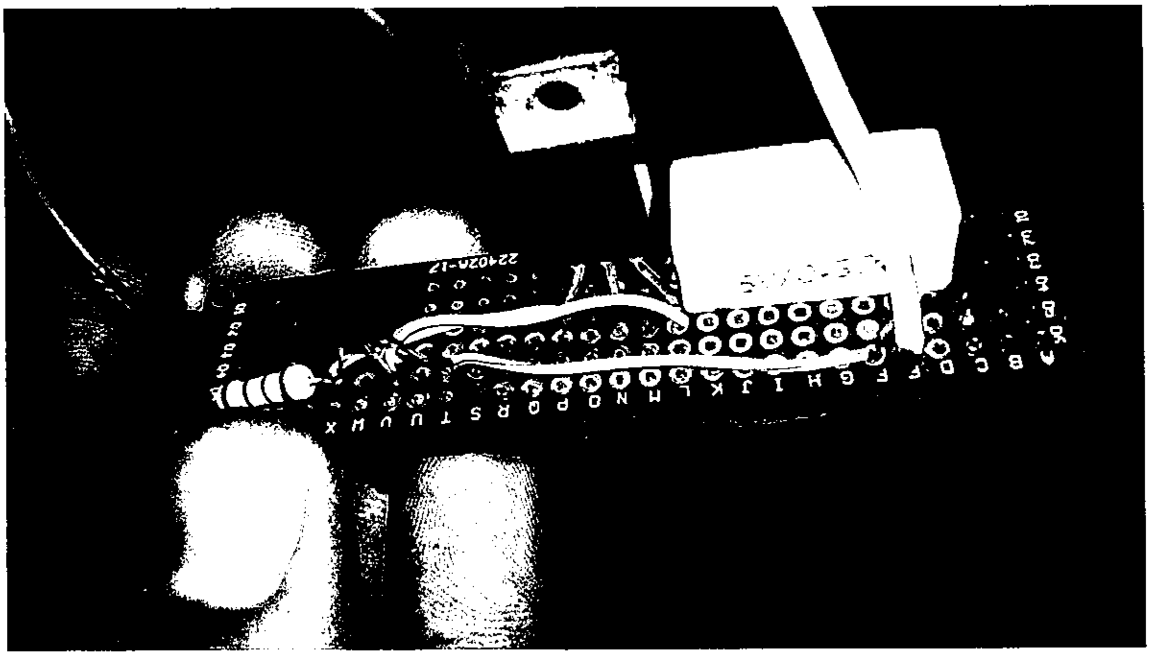
We use PVC pipes for the ROV body.



It contains 5 thruters in total. Three horizontal thrusters are used for forward, backward, left and right movement. The rest of five are used for up and down movement of the vessel.

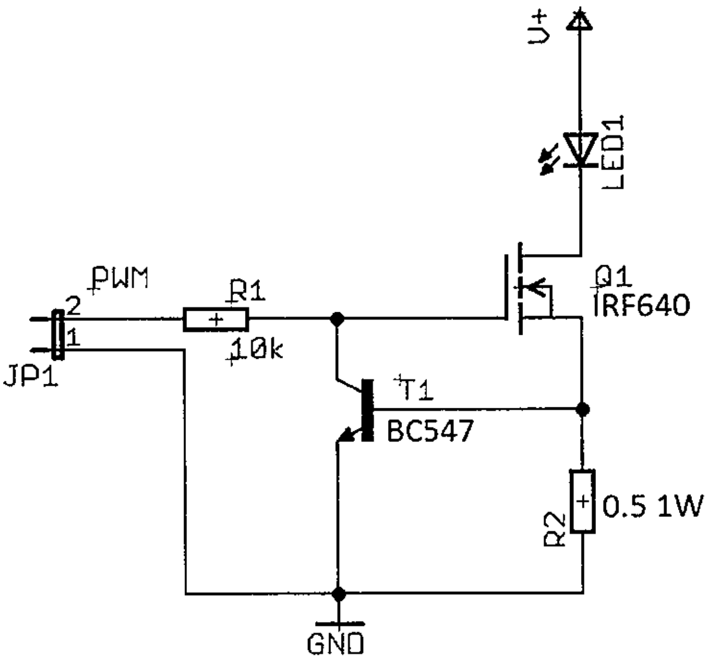
These are step by step photos for our ROV (Octopus 1).

Firstly, we made the simple supporting frame. We drilled some small holes on ROV frame for the water inlet and outlet through it.

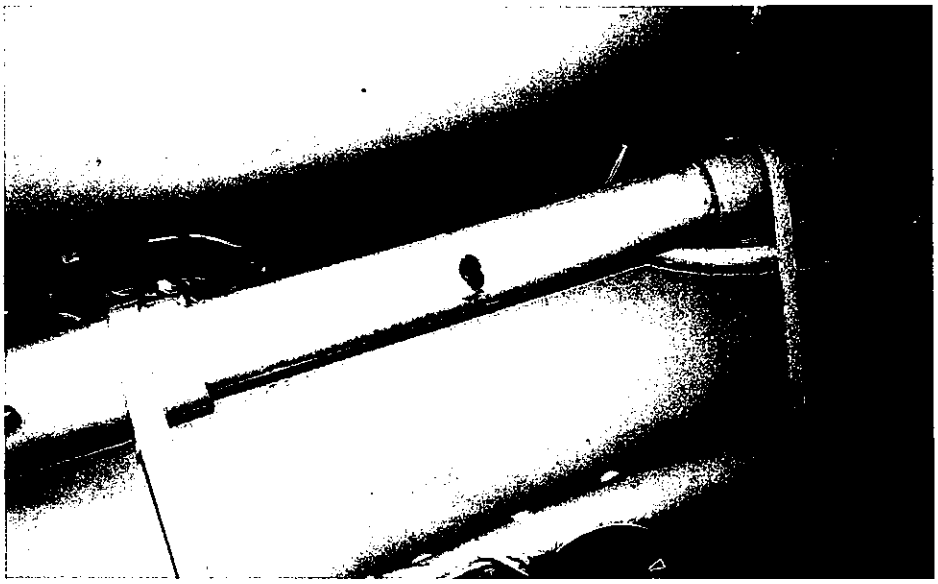


The circuit in the above figure is the high power LED driver circuit.

Here is the circuit diagram.

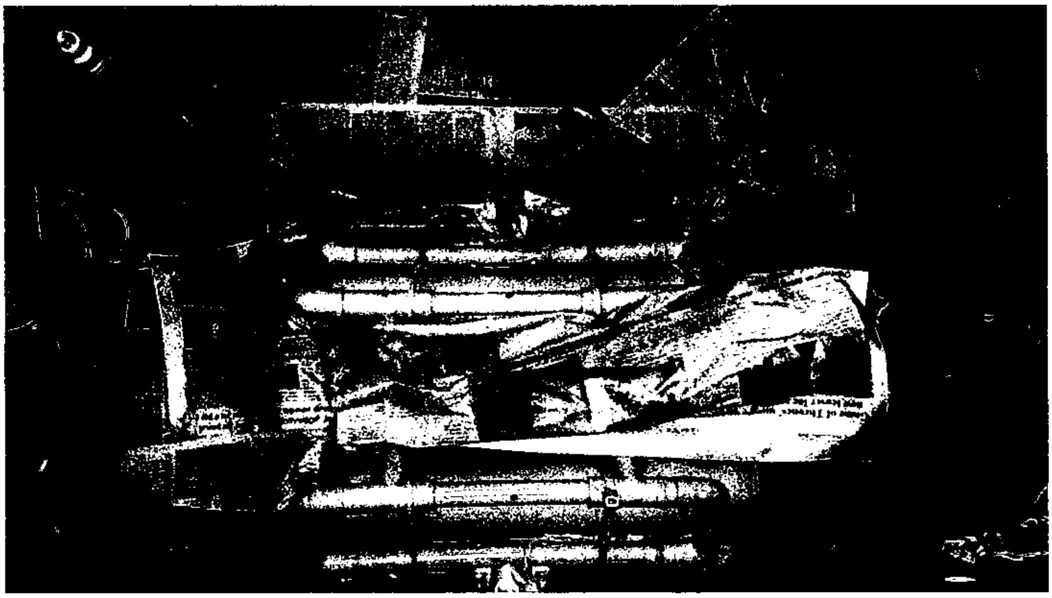


Water leakage sensor circuit

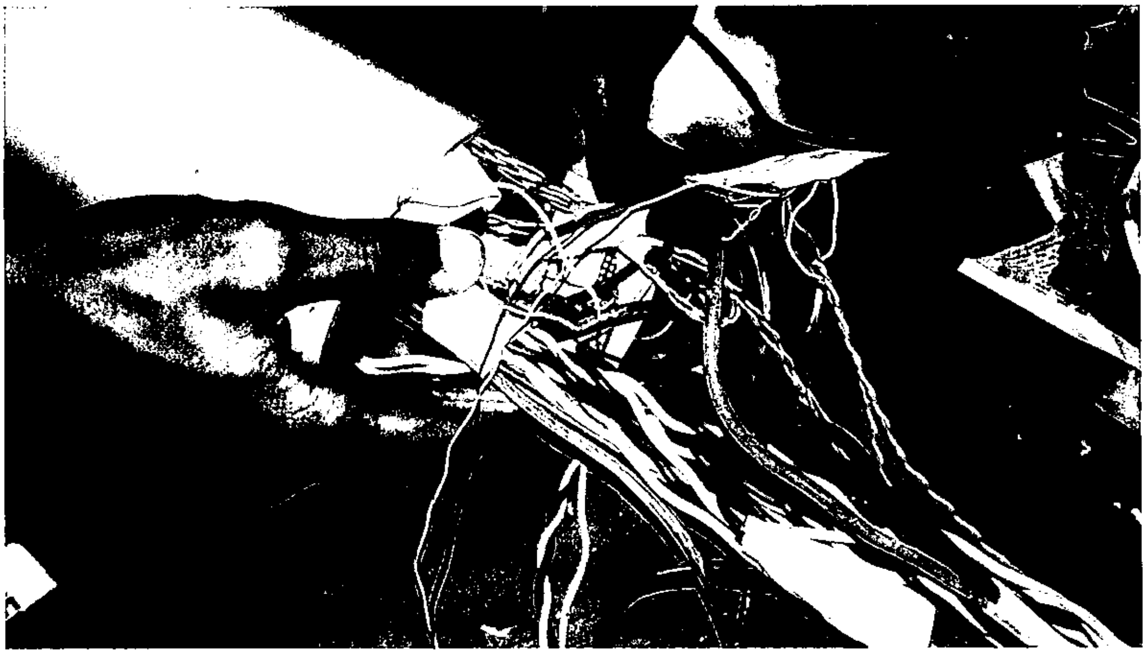


The red LED in the body frame will indicate whether the water enters or not into the body.

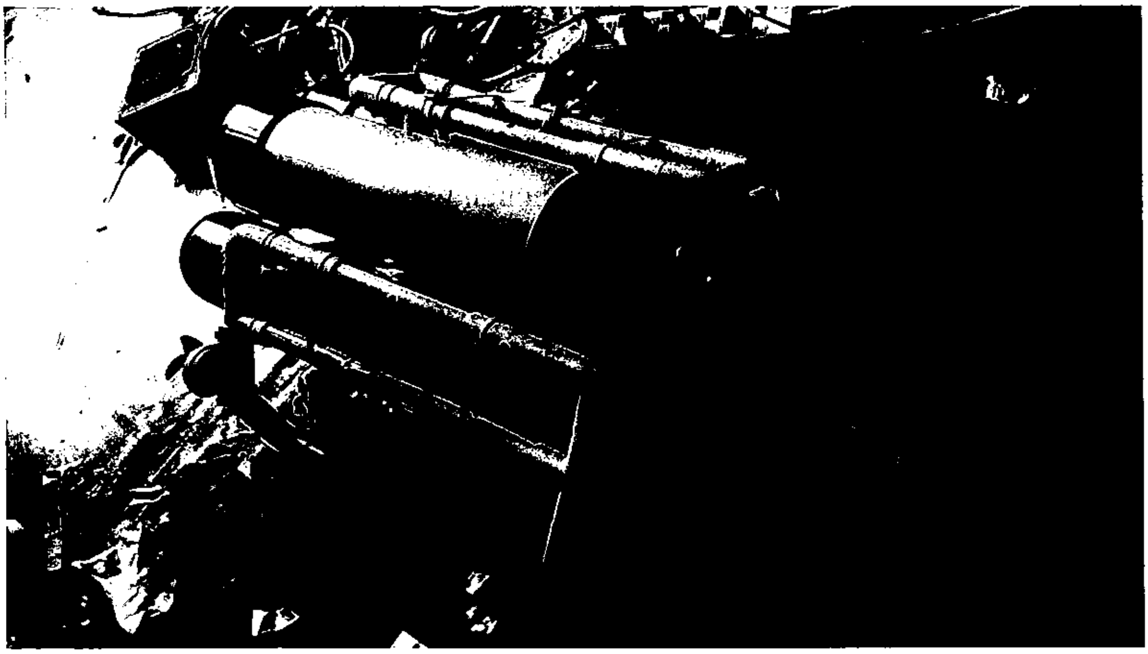
Common bus bar, ESC, Arduino board,etc…..



Modifying the blue color to yellow color



Placing the circuits into the ROV body



Complete Octopus 1

Conclusion and recommendations

We had a big trouble with water tight seal. It is our biggest problem. We have failed almost 4 times in sealing. As a result, we had error with camera system and some sensors. From this, we have known to make a better sealing technique. At first, we didn't have a water leakage sensor. As we got problems in sealing, we also install leakage sensor circuit. We can know easily there is no water or not in the circuit box.

For the arm and gripper, it is a very simple design and it is not very efficient. We have problem in sealing servo motor of arm and gripper. We should have a better and efficient design of arm.

We use two thrusters for up and down movement. For four thrusters, it is very easy to stabilize in up and down movement. For ours, we only have two.

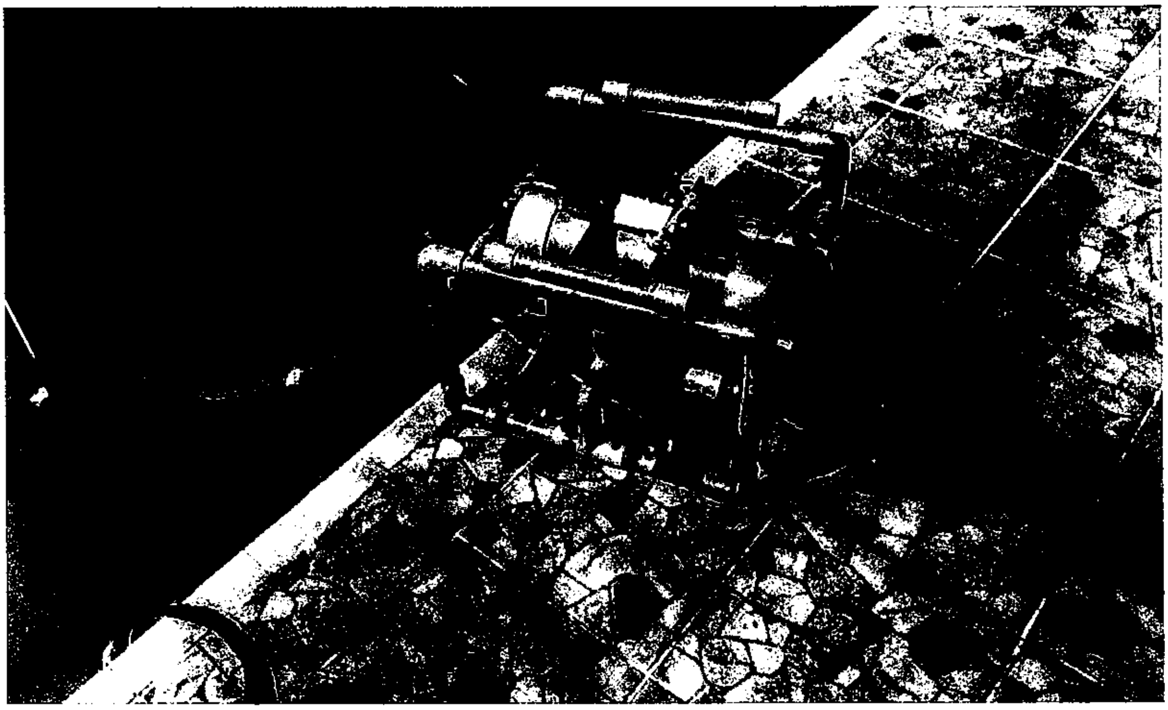
That is our second problem. We use some sands as ballast. But for up and down, the vessel is not stable. Even though we test the up and down thrusters by putting in middle of the vehicle, we still have problems. And then we tested by changing the ballast locations. We still have problems. Then we put a little heavy weight on each side of the vehicle because it needs more moment to stabilize it.

We also had problems in installing the circuits because we got less space than we expected. It is too complex in the circuit box. We must have a better design for our circuit box.

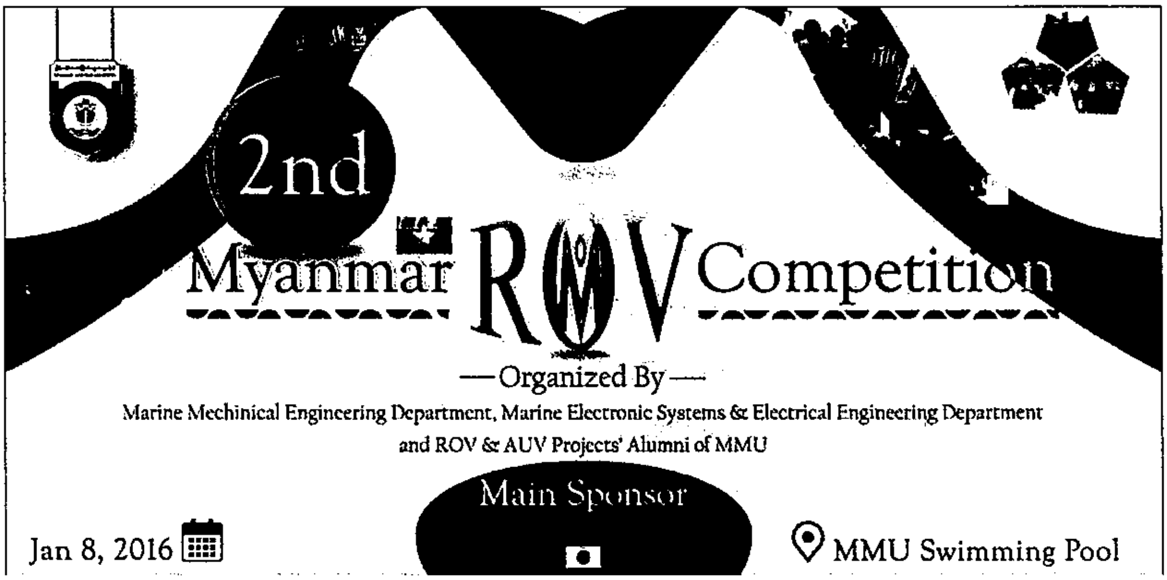
Octopus members

Department of Marine Mechanical and

Department of Marine Electrical Systems and Electronic



MYANMAR MARITIME UNIVERSITY
2ND MYANMAR ROV COMPETITION



Technical Report of ROV AQUA PRINCE

Team members:

- Tin Htoo Aung (ME-10th Batch, MMU)
- Kaung Oke Soe (ME-10th Batch, MMU)
- Kaung Myat Min (NS-10th Batch, MMU)
- Ye Naing Kaung (ME-10th Batch, MMU)

Table of Contents

List of Figures

List of Tables

Abstract

Remotely Operated Vehicle (ROV) is a vehicle which is used underwater control and driven from the surface through a number of tether cables. An ROV is equipped with one or more video camera, lights, manipulator arm, propulsion and navigation systems. Other equipments are fitted according to the mission or specification required, including; temperature sensors, distance sensors, water sampler, etc. Our ROV is built for the missions of the 2nd Myanmar ROV Competition.

Chapter 1

Introduction

The ROV Aqua Prince was designed for the missions of the 2nd Myanmar ROV Competition held at Myanmar Maritime University. The missions include to drive around the pool, to pick three rings underwater and keep them in a basket, and finally to pass through some gates.

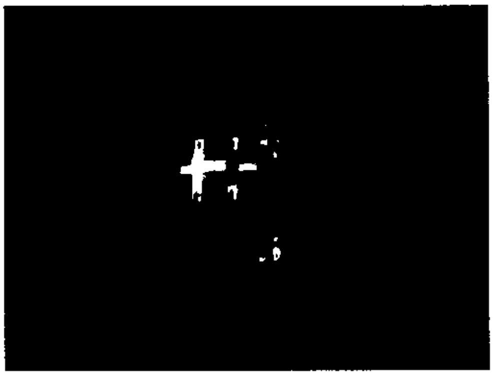


Fig 1.1 ROV Passing a Gate

Chapter 2

Summary of the ROV

2.1 The design of the ROV

The ROV has a simple box shape design. Firstly, we made the design of the ROV considering the buoyancy, propulsions, stability and missions.

2.2 The Frame

The frame is mainly constructed with PVC pipes, dimensionally 22 inches long, 18 inches wide and 16 inches high. Six motors are mounted on the frame for propulsions by means of the sockets of the PVC pipes. Inside the pipes, wires of motors are installed. Another mountings on the frame are the control box, the robotic gripper, camera and lightings.

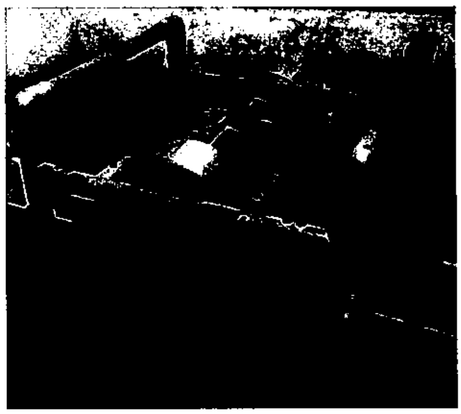


Fig 2.1 The Frame of the ROV with Robotic Arm Attached

2.3 Buoyancy

Buoyancy is one of the most important factors for the construction of an ROV. It helps to float the ROV on the surface of the water and also to dive and rise up while operating. If the buoyant force is greater than the weight of the ROV, the vehicle will float on the surface of the water while there is no operation and this is called positive buoyancy. The condition that the buoyancy and the weight are the same is the neutral buoyancy and it needs external forces to float the ROV. The negative buoyancy is when the buoyant force is less than the weight. It is easier to sink with negative buoyancy, but require much power to float back. In the ROV Aqua Prince, the control box itself is used as the main buoyancy tank and the two enclosed top side frames are also act as buoyancy tanks for the positive buoyancy effect and help the stability of the ROV.

2.4 Propulsion System

Six 1000kv brushless motors controlled by ESCs (Electronic Speed Controllers), are used as thrusters. They are mounted on the frame of the ROV, 2 for forward movement, 2 for reverse and 2 for upward/downward movements. The motor speeds can be variable according to the requirement of the movement of the ROV. 2 motors on the opposite corners of the ROV are driven to turn left or right.

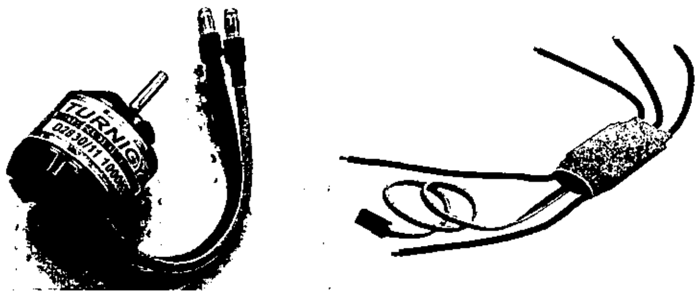


Fig 2.2 Brushless Motor and ESC used in the ROV

2.5 Navigation

A 'gy-85' sensor is used to indicate the heading, speed of the ROV.

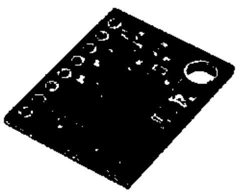


Fig 2.3 A 'gy-85' Sensor

To control and view the environment conditions of the ROV from the surface, a 1.3MP web-cam, which is enclosed in a waterproof plastic box, is used. Three LED lights are fitted on the frame of the ROV to view clearly in deep water where there is no natural light.

2.6 Robotic Gripper

According to the missions of the competition, a servo driven gripper is attached to pick up things underwater. It is cut from an acrylic sheet and assembled with bolts and nuts. It is driven by a 5V micro servo motor which is kept in a waterproof box powered by a separate battery.

Fig 2.4 Robotic Gripper of the ROV

2.7 Control Box

It is an enclosed 4 inches PVC pipe. Inside the box are microcontroller, electronic speed controllers and sensor.

The Arduino Mega 2560 is used to control the thruster motors and the gripper.

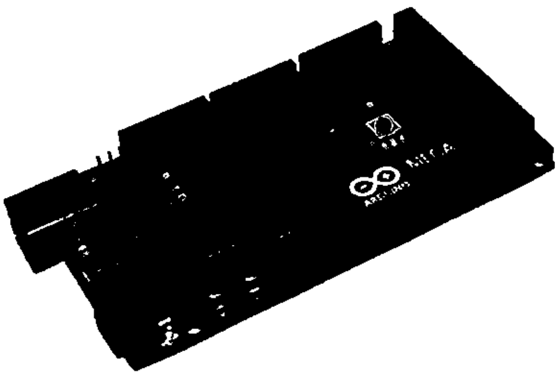


Fig 2.5 Arduino Mega 2560 used

The ROV is controlled from the surface by a computer or even enabled to control by an Android phone or tablet. A monitor is used to view the images from the camera of the ROV. There are two tether cables, one for the control signal from computer to the ROV and one for the video.

Inside the control box, we insert some heat sinks in case of overheating of the electronics and damage the system. To absorb some water mist and dampness while operating underwater, some sponge and silica gel are also installed. In case of electric shock, a fuse is also fitted inside the control box to prevent damaging the motors, electronics and the computer on the surface.

2.8 Overview of the ROV

The ROV Aqua Prince is just a simple homemade ROV for hobby use in swallow water. It can be upgraded for further purposes. It can show a way to build an ROV with low budget.

2.9 Upgrading and Future Plan

We are willing to upgrade the ROV to perform more tasks such as depth sensing, water temperature and pressure sensing, distance sensing and detect salinity or alkalinity of water, effectively.

2.10 Safety

Safety is the most important for an ROV, not only constructing but also operating. We had to take care in every steps of construction because there are so many ricks which can be encountered, including electric shocks, accidents that may damage the ROV or hurt the person. Safety precautions must be understood and done in every step.

2.11 Cost Analysis

Table 2.1 Cost Analysis

No	Item	Quantity	Price/Piece (MMK)	Total Cost (MMK)	Remark
1.	PVC Pipes	30 feet	250/foot	7,500	
2.	Pipe elbows	14	200	2,800	
3.	Pipe T joints	16	250	4,000	
4.	4" PVC pipe	1.5 feet	1500	1,500	
5.	4" pipe cover	2	1500	3,000	
6.	Brushless motors	6	15000	90,000	
7.	Brushless ESCs	5	10000	50,000	
8.	Arduino Mega 2560	1	16000	16,000	
9.	gy 85 sensor	1	10000	10,000	
10.	Propellers	6	6000	36,000	
11.	Camera	1	13000	13,000	
12.	Robotic gripper	1	3500	3,500	
13.	Servo motor	1	6000	6,000	
14.	Data cables	2	8000	16,000	
15	Wires	-	~20000	~20,000	
16.	Other materials	-	~10000	~10,000	Screws, nuts, bolts, ropes, etc.
TOTAL COST				289,300	

According to the above table, it only cost about MMK 300'000 and therefore we can say that this ROV is a cheap one.

Chapter 3

Construction of the ROV

Firstly, we decide the design of the ROV and make a drawing with AutoCAD. After confirming the design and dimensions of the ROV, we started working for the frame.

The frame is made of PVC pipes and therefore we cut the pipes into desire lengths and assemble according to the design using pipe elbows and T-joints. The pipes are drilled to let water inside the frame to achieve good stability. The pipes are fastened with seal tape, glues and screws.

The motors are mounted on the frame by screwing on the frame. The wires of the motor are kept inside the pipe and to the control box.

The most important part of the ROV, the control box is made of a 4 inch PVC pipe and closed one end by its cover and the other end's cover is drilled a hole for wires to enter the box. Through that hole, wirings to the motors from ESCs, the main power supply cable and the control tether cable pass. To ensure the hole to be watertight, we made the sealing by using glue, silicon, rubber sheets, studs and epoxy.

The electronics, the control board, motor ESCs, the sensor are kept inside the box together with some heat sinks and sponge. They are tied firmly together and then glued to the interior of the box to keep them not to move while running in the water in case of damaging them instantly which may lead to electric shock. After installing all the electronics, the box was closed well and made sure the box waterproof.

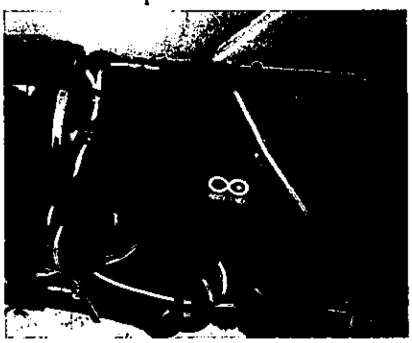


Fig 3.1 The Control Board of the ROV with all Wiring

A program to control the ROV was installed to the board. The program includes the code to control the speeds of the motors, and to control the gripper.

Finally the gripper which was made of a laser cut acrylic sheet, was attached to the ROV.

The ROV was tested in a pool for several times and made some adjustments to make ensure for the missions.

Chapter 4

Conclusion

We got much knowledge about the underwater robotic systems and also understood the difficulties of building an ROV by participating the 2nd Myanmar ROV Competition. And we would like to share our experiences of building the ROV. We also want to upgrade our ROV for further abilities.

Finally, we would like to thank again our teacher, Dr. Thu Han Htun, who helped and motivated us from beginning to end to accomplish our project well.

Fig. 7 ROV Aqua Prince on the Day of Competition

Acknowledgements

Firstly, we want to express our deepest gratitude to the Rector, Dr. Myat Lwin. And we would like to thank Dr. Thu Han Htun, the Head of Marine Mechanical Department, who helped us to be able to participate in this 2nd Myanmar ROV Competition.

We would never have been able to finish our dissertation without the participating eagerly of our group members, help from senior friends and the supports from the persons who are responsible from Myanmar Maritime University.

REFRENCES

- SeaPerch ROV Build Manual
- SeaPerch ROV Construction Manual
- Linn Benton CC 2014 ROV Tech Report
- ROV Manual by doug.levin
- CAMS 2010 Ranger Tech Report
- HMC5883L 3 Axis Digital Compass IC
- Arduino Mega2560 R3 sch