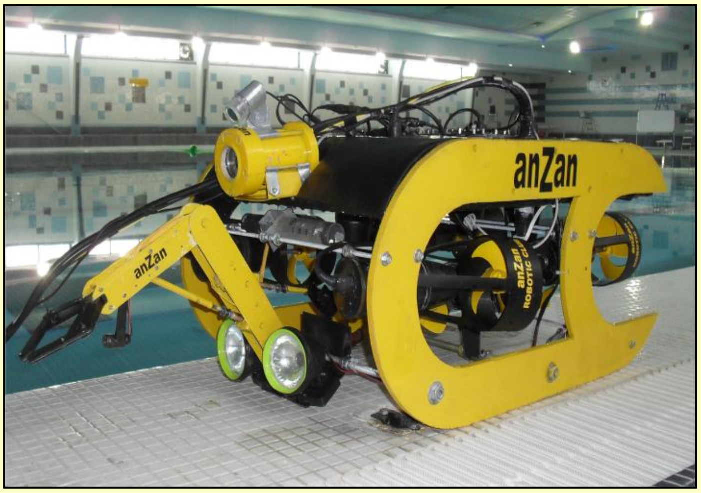
anZan

ROBOTIC CLUB

MATE International ROV Competition 2013, Explorer Class



Team Members

Soheil Kiani Electrical Designer	**Seyed Milad Fayazi** Mechanical Designer	**Peyman Shirmardi** Managing Director &Electronic Designer	**Ayub Kiani Fajr** Electrical & Mech Designer	**Farzin Moradi** Electronic Designer

Table of Contents

Table of Contents

Introduction:

Remotely operated underwater vehicle, commonly referred to as an ROV, is a tethered underwater vehicle. They are common in deepwater industries such as offshore hydrocarbon extraction.

While the traditional abbreviation "ROV" stands for remotely operated vehicle, one must distinguish it from remote control vehicles operating on land or in the air. ROVs are unoccupied, highly maneuverable and operated by a person aboard a vessel. They are linked to the ship by either a neutrally buoyant tether or often when working in rough conditions or in deeper water a load carrying umbilical cable) is used along with a tether management system (TMS).

The TMS is either a garage like device which contains the ROV during lowering through the splash zone, or on larger work class ROVs a separate assembly which sits on top of the ROV. The purpose of the TMS is to lengthen and shorten the tether so the effect of cable drag where there are underwater currents is minimized.

The umbilical cable contains a group of cables that carry electrical power, video and data signals back and forth between the operator and the TMS. Where used the TMS then relays the signals and power for the ROV down the tether cable. Once at the ROV the electrical power is split and distributed between different components of the ROV. However in high power applications most of the electrical power is used to drive a high powered electrical motor which in turn drives a hydraulic pump.

The hydraulic pump is then used to power equipment such as torque tools and manipulator arms where electrical motors would be too difficult to implement subsea. Most ROVs are equipped with at least a video camera and lights. Additional equipment is commonly added to expand the vehicle's capabilities. These may include sonar's, magnetometers, a still camera, a manipulator or cutting arm, water samplers, and instruments that measure water clarity, light penetration and temperature.

Actual Operational Profile of The anZan ROV Project (Table 1)**:**

features	**measuring features and their descriptions**
surface speed	around 1 meter per second
subsurface speed	around 2 meters per second
maximum operational & maneuvering depth	50 meters (due to cable length reduced to 30 meters)
depth maintaining method	4 motors and their propellers
propelling system	motor propeller which can make propulsion possible
special features	getting deep down into the water, doing combined movements, being able to maneuver highly, moving to the bottom, shooting pictures under water using a high-quality camera, being able to measure temperature & pressure in different depths, taking samples of water in different depths

Table 1

Chapter 1

The Body of Robot

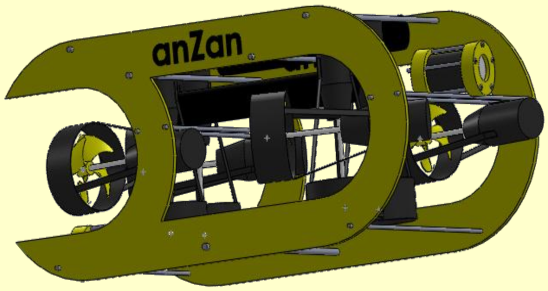


Figure 1.2

1.1. Calculating and extracting precise dimensions and geometrical shape (using Solid works software and pictures)

Since the performance of robot in any competition is of great importance and it should finish it with high maneuvering ability, the robot was designed in such a way that it could reach the standards of being developed in an operational and industrial scale. Thus, the following dimensions and features were introduced.

body dimensions	features
Main chassis	80*45*35 cm
Motor	diameter (60 mm) length (16 cm)
Camera	12 cm, diameter 80 mm
Propeller cover	Length 25 cm, diameter 4.5 inches
vane	Diameter 11 cm
shaft	Diameter 8 mm, length 12 cm

Table 1.2 The body of the robot

Specifications of measures of body shown in codes on the map (Figure 1.2)

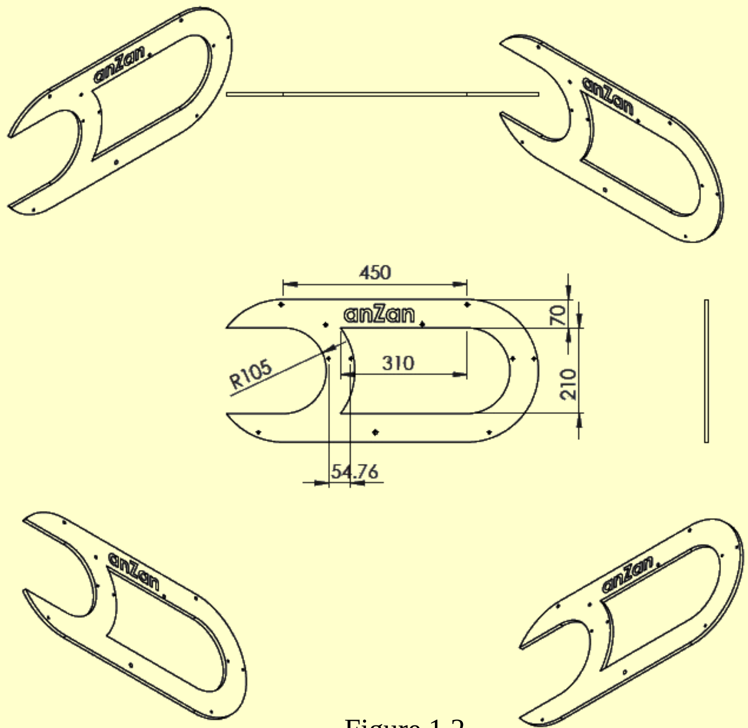


Figure 1.2

Real shape being built (Figure 1.3)

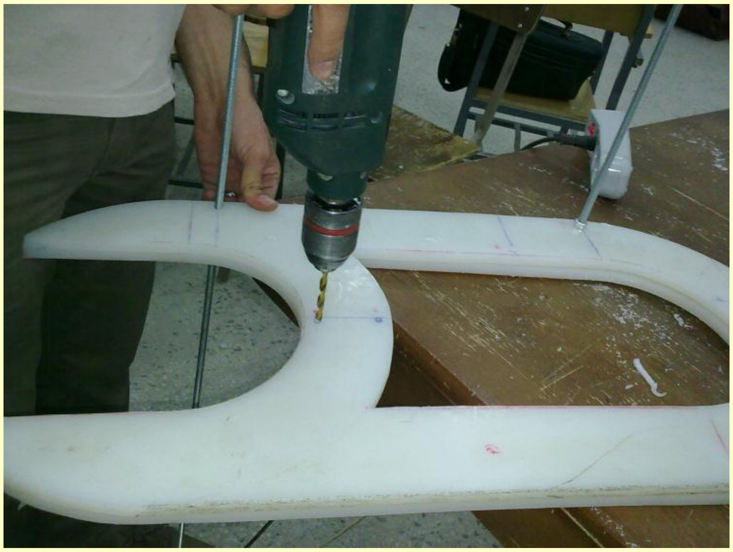


Figure 1.3

1.2. How to choose the shape:

To reach an efficient movement and maneuver and with respect to the angel of motor placement and work conditions of ROV robot including rescuing, extracting, repairing, the following shape considering the above-mentioned description was developed so that we could find proper room for installing different parts of the robot. Besides, water can move freely without hitting the chassis in order to achieve efficient movement and high maneuvering ability.

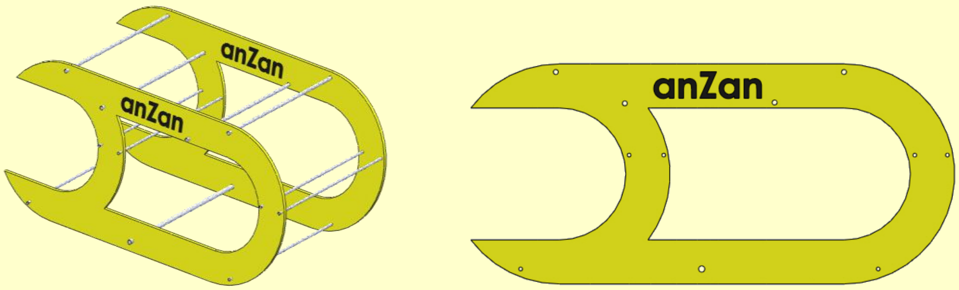


Figure 1.4

Real shape of robot and chassis (Figure 1.5)

Figure 1.5

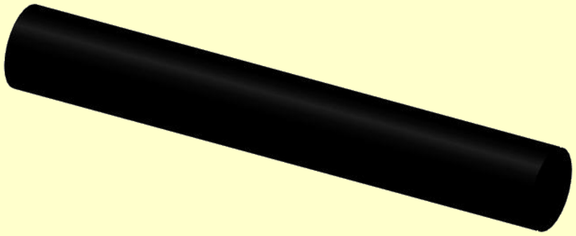
1.3. Specifying body material and how to build it

ROV robots' work condition is in such a way that oxidation and corrosion occurs very often. We decided to use 8 mms Teflon sheets for a better cutting job and high resistance against oxidation. (Figure 1.6)

. Figure 1.6

1.4. Mechanical control mechanisms (air containers)

These robots should have high stability so that they can be kept balanced in real situations and carry other objects. To achieve this, a number of air containers were installed on the upper part of robot with the dimensions of 35 cm and diameter of 2 inches so that the robot can reach a state of balance and floating. (Figure 1.7)



. Figure 1.7

Chapter 2

Propeller

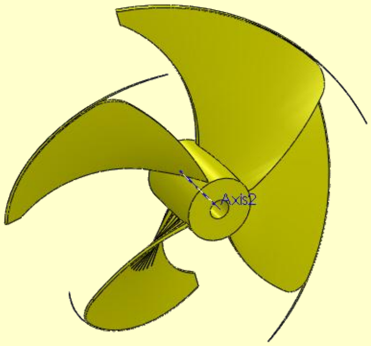


Figure 2.1

2.1. Calculation of propeller

To design a hydrodynamic propeller, it is important to have a number of considerations to increase propulsion and efficiency and decrease cavitation. It is essential that propulsion and wake reduction coefficients be calculated and the number of vanes be specified to reduce the vibration of shaft and motor.

Figure 2.2

2.2. Determining maximum diameter of propeller

This value is a coefficient of the height of buoy where the water reaches and it is determined using the following relationship.

$$D=AT$$

Where T is for buoy water reach and A experimental coefficient which depends on type of buoy and its value is about 0.7

Since the functional diagrams of propellers in water condition will be recalculated, the value of diameter in this condition for single propeller is 0.05 and for double propeller will be revised to 0.03. This way the maximum of allowed diameter is calculated.

2.3. Cavitation and bar specification

Cavitation is a factor of reducing the efficiency of propulsion. Therefore, it is necessary that condition of forming cavitation in submarines be calculated. Since the reduction of pressure in propellers' surface is the cause cavitation, specifying the proper value of bar can have an effect on the reduction of cavitation. Too much reduction of this parameter causes the increase of bar on the propeller and as a result cavitation will be formed which is calculated using Koehler formula.

$$\frac{A}{A} = \frac{(1.3 + 0.3\,z)T}{(p - p)D} + K$$

The empirical coefficient Wake		
0.5Cb - 0.05	For single screw	Taylors formula
0.55Cb - 0. 2	For twin screw	
0.3	Cb = 0.7	For moderate speed cargo ship
0.4	Cb= 0.8	For largo bulk carrier
0.25	Cb= 0.6	For container ship
0.1	Cb = 0.5	For twin screw
0.05	At cruising speed	For high speed frigate
-0.05	At full speed	

Table 2.1.The empirical coefficient Wake

The experimental thrust coefficient decreases		
0.6w	For single screw	Taylors formula
w	For twin screw	
$0.25w^{+0.14}$	For twin screw with bossing	
$0.7w^{+0.06}$	For twin screw with bossing	
0.3 Cb	For modern single screw	

Table 2.1.The experimental thrust coefficient decreases

Where Z is the number of vanes, T is the power of propulsion, P_O is the static pressure around the propeller, P_V is the pressure of steam in performance temperature, D is for diameter and K is for Koehler coefficient and it equals zero for double propeller.

In this respect, if the value of propeller propulsion with regard to propulsion reduction coefficient is calculated as 0.17 times

$$T=\frac{R}{1-t}=\frac{135}{0.83}\approx 163$$

and the value of static pressure of propeller in the worst condition on surface while it is 5 cm under water is considered 101300 N/m^2 based on atmosphere pressure and the value of steam pressure at 15 degrees Celsius equals 1700 N/m^2 and the size of propeller is based on its allowed maximum size, the value of calculated bar will be 0.21.

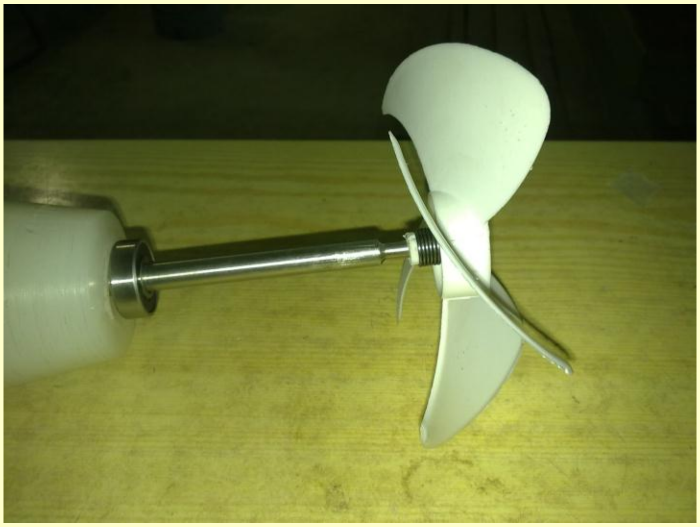


Figure 2.3

2.4. Choosing propeller arrangement

The favored arrangement for propellers is single propeller. Since pushing power resulting from propelled motors won't affect each another and stop turbulence of water stream on real propellers, rear and front propelled motors are placed with the angel of 140 degrees so that not only don't they have propulsion power but they can reduce wake formation on rear motors, increase the efficiency of propulsion. This will also make the rotation of robot to the right and left sides possible with good speed and quality. (Figure 2.4)

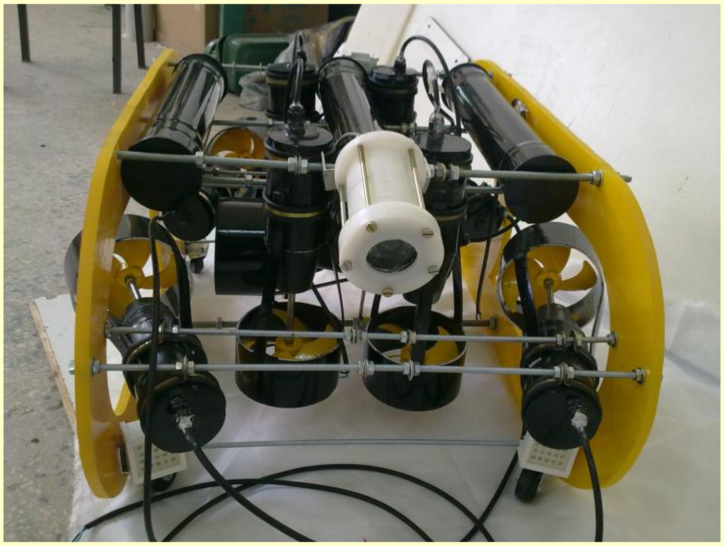


Figure 2.4

2.5. Propulsive mechanism

It is possible for the operator to have the needed propulsion for the robot to move forward, backward, left, and right using four motors on the side tied to the chassis horizontally.

For the robot to do twisting, reaching the surface, bottom, and floating so rapidly, four vertical motors were used on the chassis where the rotation of front double motors reverse the rotation of back double motor makes it possible for the robot to move in the 45 degrees angel. And with the rotation of four motors to the left and right, the robot can go up and down. Figure 2.5

Figure 2.5

Chapter 3

Sealing of motors

3.1. Sealing of motors

Motor is placed in a cylinder made of Teflon. Outer diameter of raw Teflon is 62 mms which was adjusted to the diameter of motor by 45 mms inner turning. At the front of motor package there is a pyramid material made of Teflon. A hole was made into the pyramid by inner turning with the diameter of 22 mms in which there are two seals and two ball bearings. (Figure 3.1)

Figure 3.1

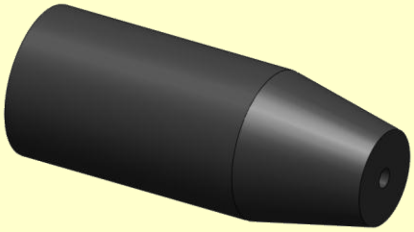


Figure 3.2.a view from sealed motor using Solid works software

3.2. Sealing the camera

A camera is placed in a cylindrical pack is composed of three parts, these three parts composed of a cylindrical with a diameter of 60 mm and two flange caps with outer diameter 80 mm come in a pack to be able to withstand high pressures.

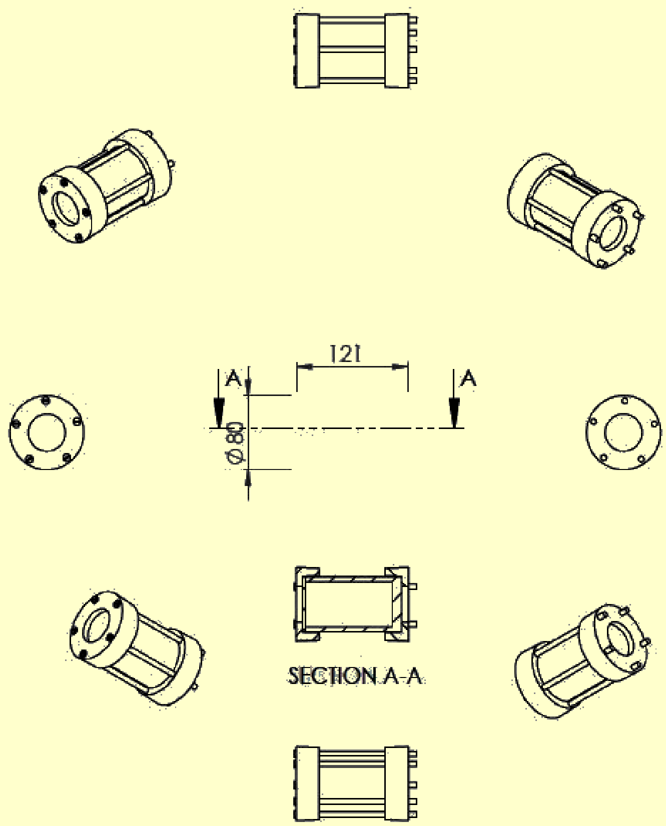


Figure 3.3. Pictures cad to sealing camera designed with the solid works software

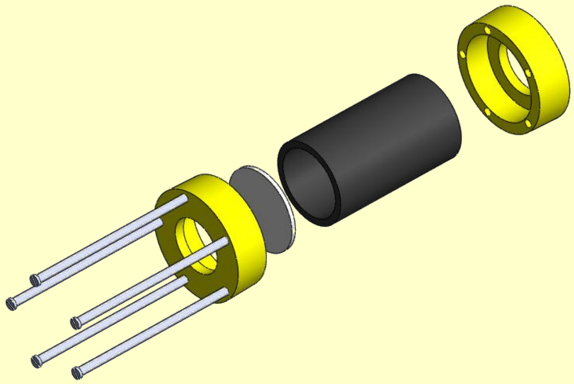


Figure 3.4. Sealing form designed with Solid works software

Figure 3.5. The actual model of camera sealed

3.3. Laser sealing

Red laser is placed in a cylindrical glass that has been sealed by glass adhesive. These lasers are used to maintain the position of robot underwater.

3.4. Innovation (engine sealing method and camera for depth)

With regard to sanctions and the lack of imported parts and no produce waterproofs devices to build robots ROV in the country as well as observation and experience building robots ROV that have been capable to withstanding high pressure to drill in high depth, the “anZan” team according to these needs has designed and made own initiative in order to withstand the high pressure sealing.

Chapter 4

Electrical equipment

4 .1. Calculate the energy required

In according to the numbers of the main engines of the robot (9n) the amount of energy to start the total engines with required energy to command circuits and other parts is calculated as follows.

Total energy required (w)	Required energy for each element (w)	Motors current at full load situation(A)	Motors current at no load situation(A)	Number	Piece
1126	114	3.2	2.5	9	Engine
3.6	12	***	1.5	3	LED (light lux100)
18	18	1.5	1	1	Pump
15	2.5	***	0.5	2	Laser

Table 4.1

4 .2.Determining the voltage source

Required voltage to the robot supplies from an Auto trans connected to AC power(220 V) by a 48 volt, 40 amp that its output connected to two rectifier 20 amp, one to supply up and down motors and left and right shift and another to feed front and rear engine and turning left and right.
There is used LED lights and lasers to detect of track the launch and a sampling pump from a PC power with 450 W supply voltage of 12 V (10 A) and 5 V (16 A).

4.3. Determining the required engine

Brush-type DC motors are used in motor manufacturing Bowler Germaine's Co. There are working by voltage dc 48 motors and 2.5 Amp current and 6,000 rpm and torque motors are 3 kg /cm.

In order to move forward and backward and turn left and right, 4-engine, move to up and down the 4 engine also and shift to right and left 1motor is need. Note that robot has the ability to maneuver to move up and down 45 degrees.

4.4. Control System

The robot is controlled by a joystick, which is made by the team members. There is used a 4direction key to control the movement forward and backward and left and right that this output key 5v applied to according to excitation relay and so relay send also to motors 35v supply voltage. And is used 2relays to change to the engine direction which its circuit is as follows (Figure 4.1)

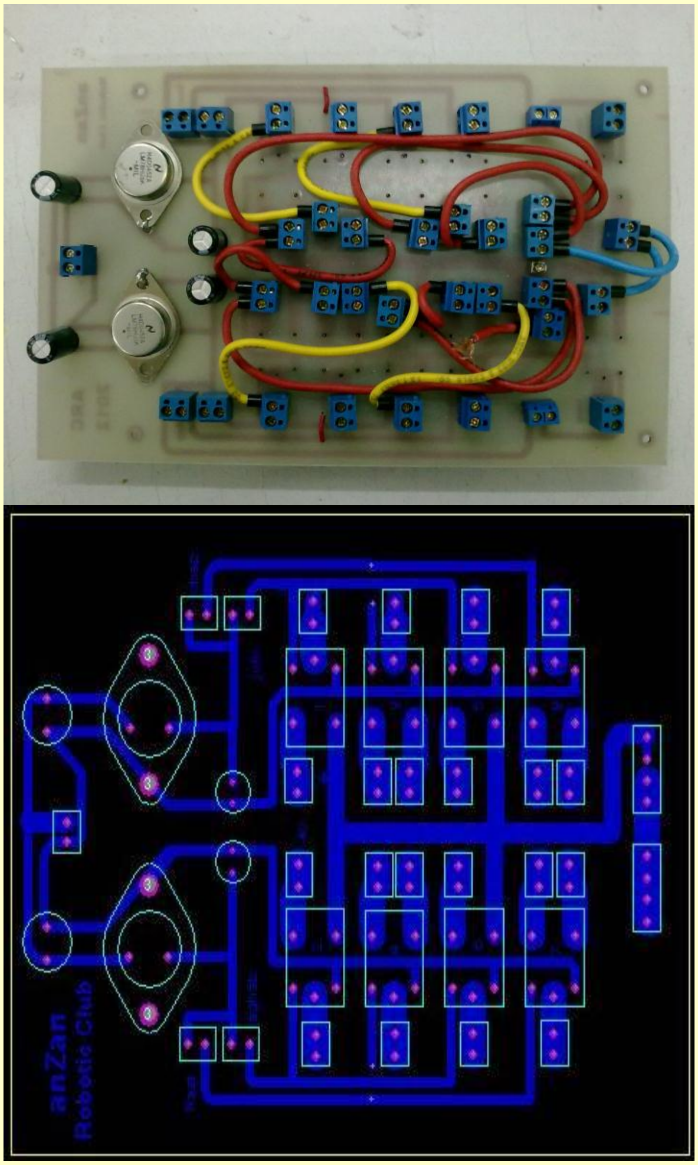


Figure 4.1

4.5. Monitoring and Cameras

There is used 2 cameras to monitor the underwater images of front and back robot. These cameras are completely handheld and its output input via coaxial cable to the DVR, 4-channel and can simultaneously record the image on the LCD, 47 cm is used. Cameras are HV by TVL 480 and ip66 with a voltage of 12 V and 1 Amp. (Figure 4.2)

Figure 4.2

4.6. Laser

There is used to better position movement two lasers in front of robot in order to prevent robot crash to edges, one placed at up right corner and another is placed at down left corner of robot, Lasers works by 100m range and 5v voltage and 0.5Amp.

4.7. LED

These devices used 3packs LED, a pack is included 20 LED, two packs are placed front of robot and next located back of robot , there are used to clear water under surface space to optimize robot control and sent images from robot. They work by 12v voltage and 1.2Amp current.

4.8. Temperature sensor

There is used a PTC temperature sensor for detecting the temperature below surface water on this robot which displays the temperature by a data logger mounted on joystick, and detection range of its temperature is from -50 to +150. (Figure 4.3)

Figure 4.3

4.9. Pressure sensor

This type of robot used Gauge pressure sensor module to detect pressure below the water surface at different depths. (Figure 4.4)

Product Comparison	Levelgage™
Accuracy	±1 or ±0.5% FS T.E.B.*
Custom Pressure Ranges	Yes
Available Pressure Range	0 – 3 thru 0 – 900 ft. WC
Compensated Temp. Range	10 80°C
Field Rangeability	No
Pressure Output	0 – 5 VDC, 0 – 10 VDC 4 – 20 mA
Temperature Output	No
Wetted Materials	316L SS, Polyamide, Fluorocarbon
Electrical Termination	Vented Hytrel Cable
Relative cost	Lowest

Figure 4.4

Chapter 5

Mechanical parts

5.1. Couple

Circuit between shaft and motor called couple and there has used to minimize vibration and losses from spring couple to focus shaft. (Figure 5-1)

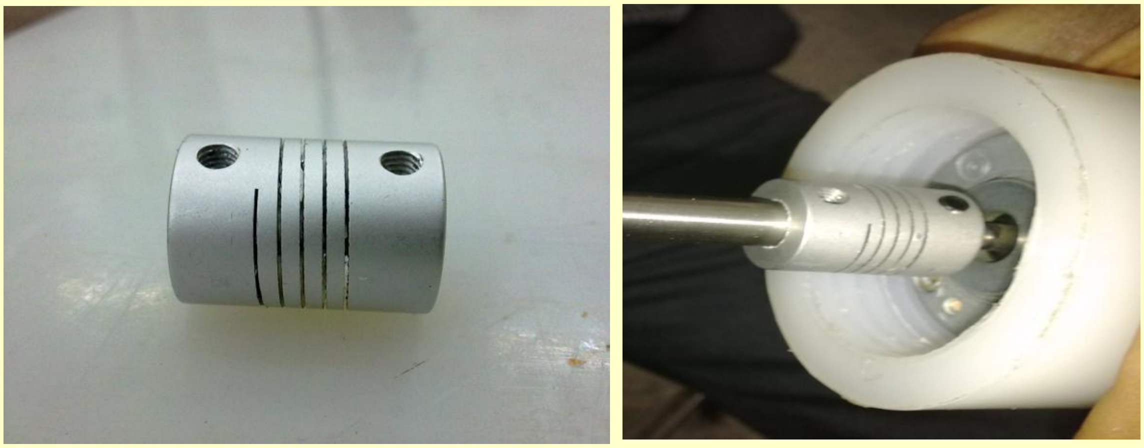


Figure 5-1

5.2. Shaft

Shaft is used to connect the engine to fan. This robot use from stainless steel hardware and sealed Shaft and being shaft smooth causes the least friction with bearing and seal to have the lowest retaliation. In tip of the shaft create a thread to insertion. (Figure 5-2)

Figure 5-2

5.3. Bearings

We use bearings to rotate center mate the shaft, there are used two bearings by gap4 cm from each other because large length. (Figure 5-3)

Figure 5-3

5.4. Seal

Seal is used to prevent liquids (water) on the engine compartment upon shaft. There is used of two carbon seal to avoid damaging effect of pressure and temperature at the robot. (Figure 5-4)

Figure 5-4

5.5. Lubricant

There is used Grail as a lubricant to reduce friction between shaft, bearing and to check reservoir grail has used also screw on the front cone of the engine. (Figure 5-5)

Figure 5-5

Chapter 6

BUDGET AND FINANCIAL STATEMENT

Expense Report				
$ 1 = 36200Rial				
sort	Device Name	number	$ Cost	Consideration
1	DC Motor	9	200	Buhler
2	Blade	9	10.11	
3	Camera	2	400.50	H-Vision-480 TVL
4	Computer Power	1	28.57	
5	Laser	2	5.71	
6	Temp Sensors	1	30	
7	Presser Sensor	1	22.85	
8	Relay	20	110	12 v -15 A
9	Regulator	4	6.28	L7812
10	Capacitor	8	1	
11	Rectifier	3	4.28	20A
12	Connector	40	2.28	2 pin
13	Press Key	25	5	On/off
14	Breaker	3	2	
15	LCD	1	3	2*16 Character
16	Joystick	1	120	
17	Data Logger	1	8	
18	Driver Motors	3	370	
19	Fiberglass	2m	45	
20	lamp	2	5.71	
21	Trance	1	8.57	
22	Source Power	1	370.50	
23	Microcontroller	4	11.42	Atmega32
24	PCB Board	2	20	
25	DVR	1	110	4 Chanel
26	Coaxial Cable	30m	21.11	
27	LCD Monitor	1	80	
28	Gripper	1	100	
29	Gearbox	9	257.14	
30	Teflon	20kg	140	
31	Wire	30m	70.71	
	Total Cost		**$ 2,571.42**	