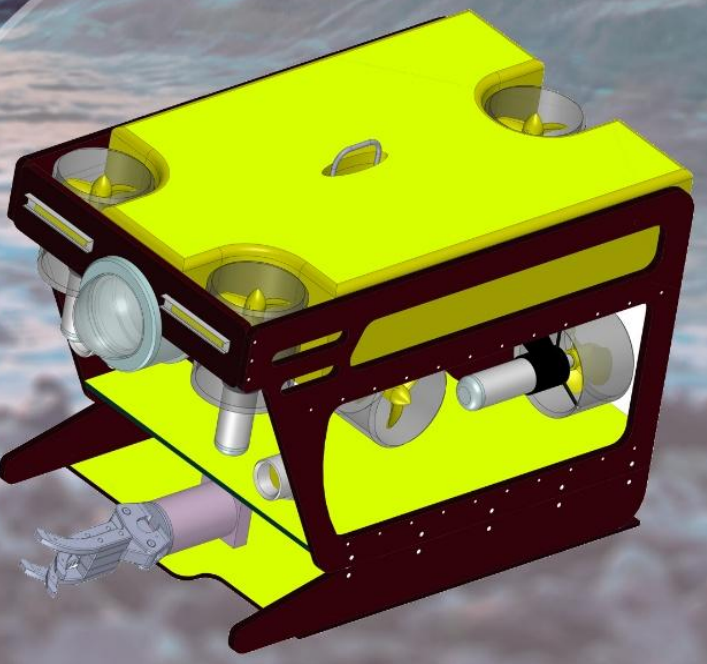
ACIPENSER



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A. Abstract

Underwater world has always been one of the most unknown and complex places for human being. Scientists believe that our knowledge form the underwater world is only 10% whilst in comparison with space that is 40%. Therefore, they have always looked for more knowledge and more access to it. Submarine robots as inseparable part of underwater research; have done a great deal in helping the research. Marine industries and underwater world research have made considerable progress using this technology. Submarine robots have different duties such as: monitoring internal dangerous environments of nuclear reactors, maintenance of complex underwater installations, inspection of dams, detection of environmental pollutions, etc.

Mechatronic Research Labratoary is one of the pioneer centers in the field of robotic industry in Iran and Asia which has more than 10 years of experience on different types of robots. Submarine robotic team of islamic azad university is one of the 15 teams of the Mechatronic Research Laboratory (MRL) that has a 5 year experience.

B. Mechanical design

Due to the high sensitivity of submarine robot design, we decided to prepare the different parts as starting from an idea and then constructing them. First, the project is brought on paper as an initial idea and then it is implemented by using Solidwork software. Finally, it is constructed by mechanical members based on the selected material and considered form.

B.1 Frame

Factors such as high pressure withstand capability, lightness and flexibility are considered for robot design based on previous experiences. The frame material is PTEE which has proper strength and low weight. On the other hand, it has proper flexibility for cutting. The frame has two stages, the first one for placing the arm and equipment and the second one for placing thrusters and, camera and electronic part. The frame size is 45.5*43*70 and its weight is 56 Kg. Layout design has been done by Solidwork software which is one of the most powerful mechanical engineering softwares. Final cutting is done by CNC device and mechanical members.

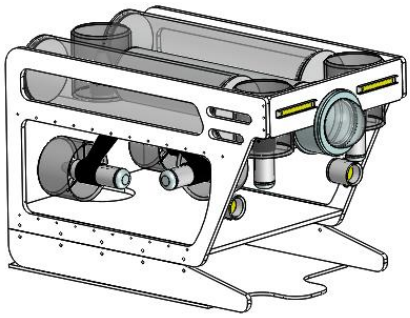


Figure 2 –Frame complete

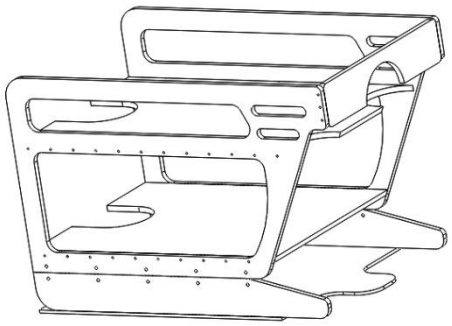
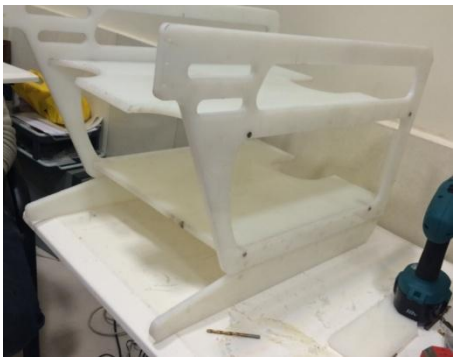


Figure 1 –Frame Design Salidwork



Frame 3- Final Frame

B.2 Buoyancy

Buoyancy control is done by three cylinders, two of which are made of plexi and one is made of aluminum. The electronic part is placed inside these cylinders and also helps the robot Buoyancy by producing negative weight. The cylinders are connected to each other by high pressure hoses.



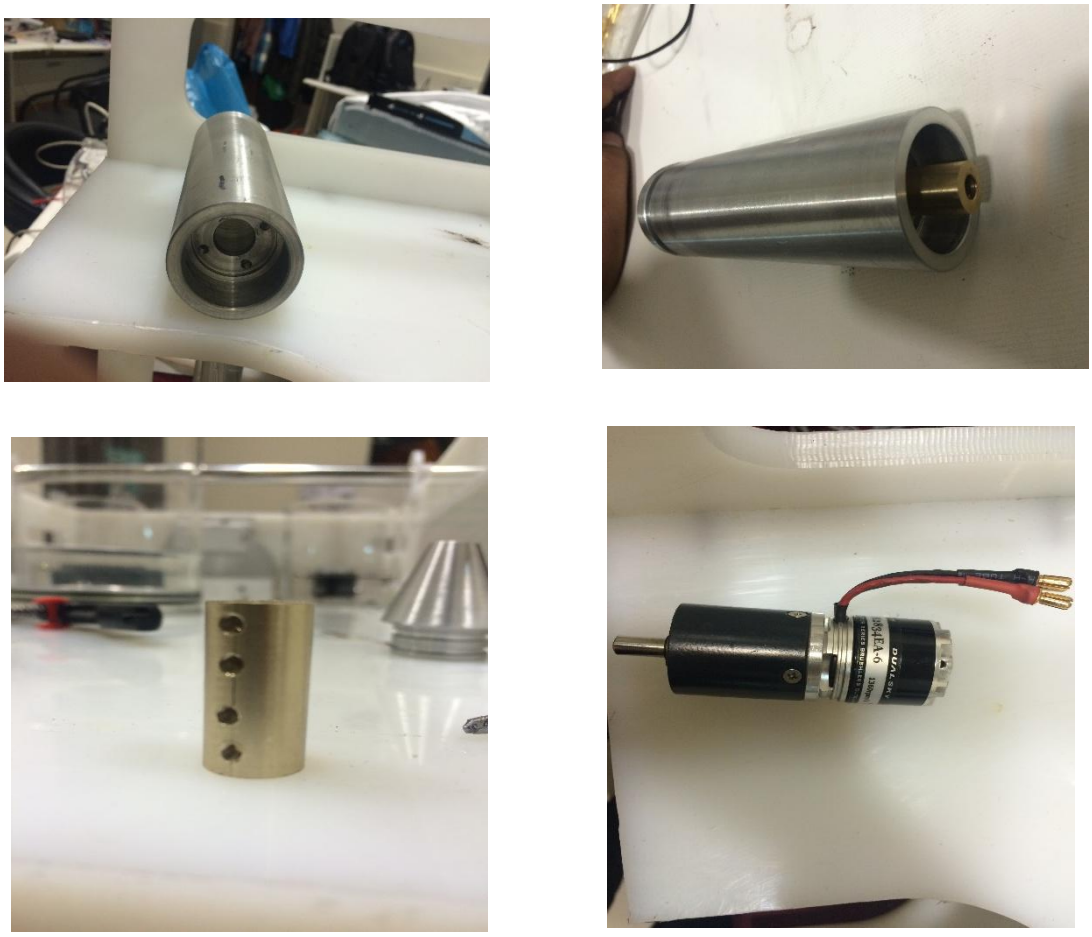
B.3 Thruster

The robot has 6 thrusters, two of which are for forward movement, 3 of which are for vertical movement and one of which is for lateral movement. The motors are brushless with coupled gearbox. Each thruster consumes approximately 9 A and has 150 W power consumption. We have used 3D for making propellers and all the thrusters have been tested by fluids analysis softwares.

Thruster dsign in solidwork

B.4 Housing

The housing of motors is made of aluminum. These housings have been designed for 16 bar pressure. The photo of a collector by which the motor shaft and gearbox are coupled, is shown in the figure.



Motor and housing

B.5 Cover

Housing material is composite which has been cut based on the design of motors.

Buoyancy Cover

B.6 Robotic Arm

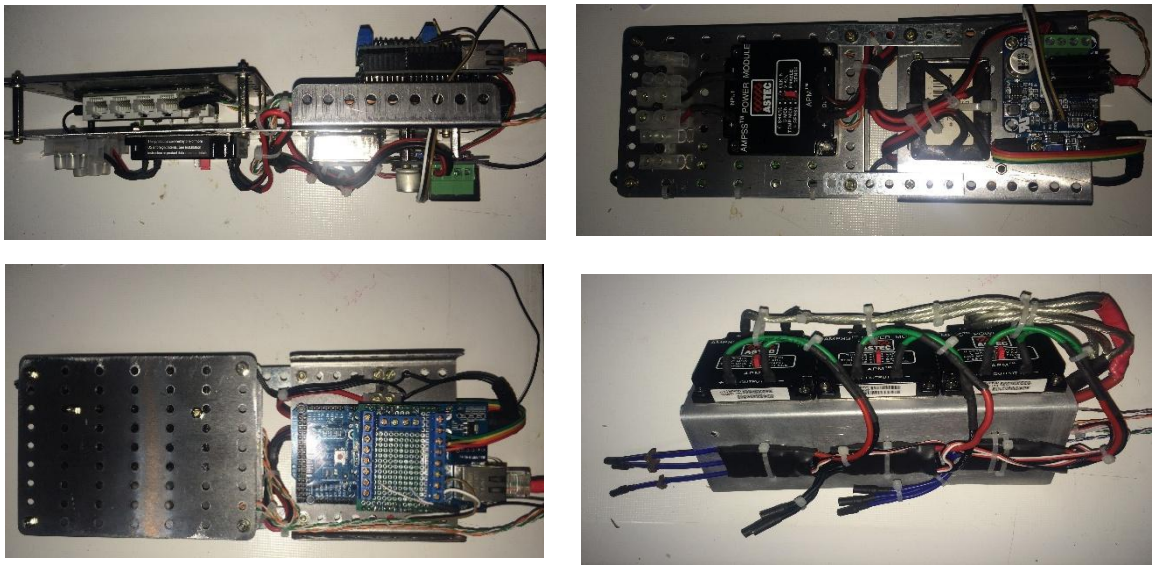
Robot arm has three degrees of freedom, one link for 90 degree movement, one link for 360 degree movement and, one link for opening and closing of the arm jaw.

The arm has three 12 V DC motors and its length is approximately 15 cm and its weight is 1.5 Kg.

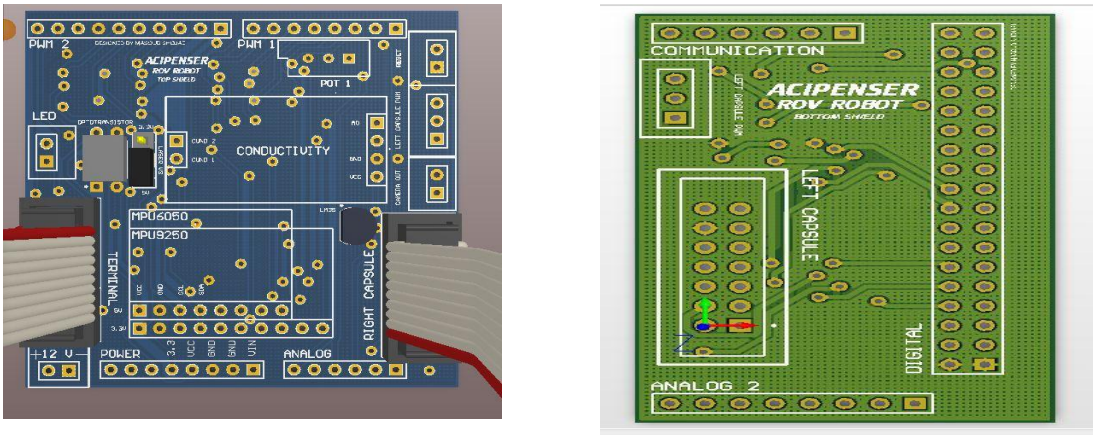
C.Electronics

Electronic part consists of two sections, out of the water and in the water.

Section in the water includes control boards, sensors and other equipment. Section out of the water includes communication part with operator. Electrical drawing of the robot is shown in the following figure



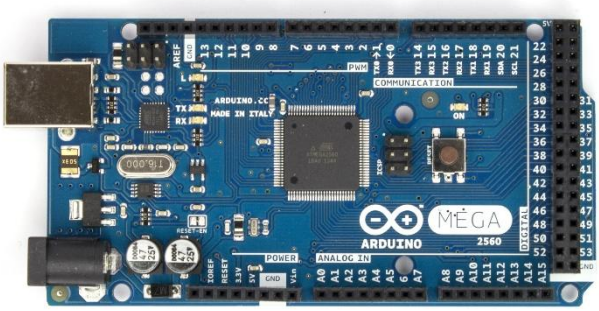
Electronic complete Board



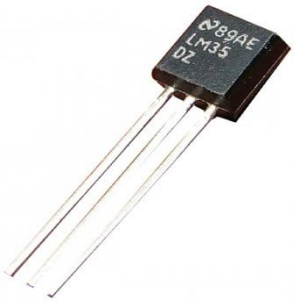
Acipencer Costum Bord

Microcontroller

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input / output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started



Microcontroller



Temperature

Temperature Sensors

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ∞ Kelvin , as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1/4∞C at room temperature and ±3/4∞C over a full -55 to +150∞C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35ís low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1∞C in still air. The LM35 is rated to operate over a –55∞ to +150∞C temperature range, while the LM35C is rated for a -40∞ to +110∞C range (-10∞ with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

Pressure Sensor

pressure Sensor

WIKA ECO-Tronic pressure transmitters are engineered to fit many industrial pressure measurement applications. Typical applications include hydraulics and pneumatics, compressor controls, pump protection, refrigeration and air conditioning systems. The ECO Tronic features an all-we ed stainless steel measuring cell for improved media comp atibility There are no internal soft sealing materials that may react with the media or deteriorate over time. The case is also made of stainless steel and is available with environmental protection ratings up to NEMA 4 / IP 67. Pressure ranges from 0 psi to 2.5psi meet the requirements of most industrial pressure sensing applications. Pressure ranges up to 300psi use a piezoresistive measuring cell. The higher pressure ranges use thin film sensor technology. Standard signal outputs of 4-20 mA and 0-10V allow the ECO-Tronic to be integrated into many existing applications. Excellent RFI and EMI resistance protect the output signal integrity under difficult operating conditions. Each ECO-Tronic undergoes extensive quality control testing and calibration to achieve an accuracy of < 0.50% full scale. The printed circuit boards use state-of-the-art surface mount technology. Each is individually temperature compensated to assure accuracy and long-term stability even when exposed to severe ambient temperature variations.

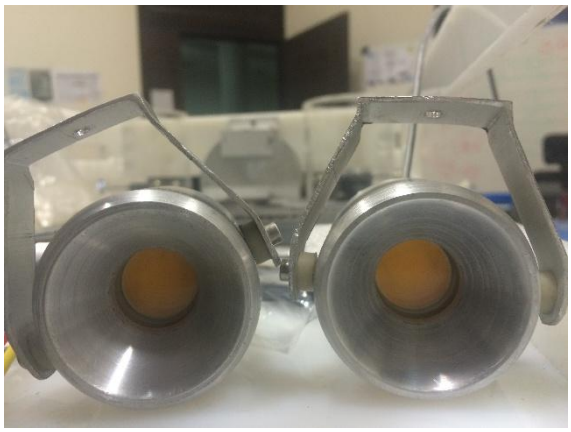
IMU

IMU Sensor

The MPU-9250 is a serious little piece of motion processing tech! By combining a MEMS 3-axis gyroscope and a 3-axis accelerometer on the same silicon die together with an onb oard Digital Motion Processor™ (DMP™) capable of process ing complex 9-axis Motion Fusion algorithms, the MPU-9250 does away with the cross -axis alignment problems that can creep up on discrete parts .Our breakout board for the MPU-9250 makes this tiny QFN package easy to work into your project. Every pin you need to get up and running is broken out to 0.1" headers, including the auxiliary master I2C bus which allows the MPU-9250 to access external magnetometers and other sensors.

Dimer LED Lighte

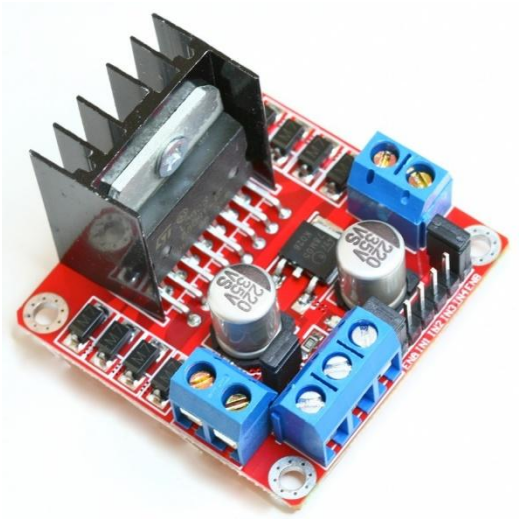
As it can be seen, the robot light is provided by 4 adjustable LEDs which are controlled by PWM, ranging from 0-100% for switching on and off the LEDs.



LED Housing

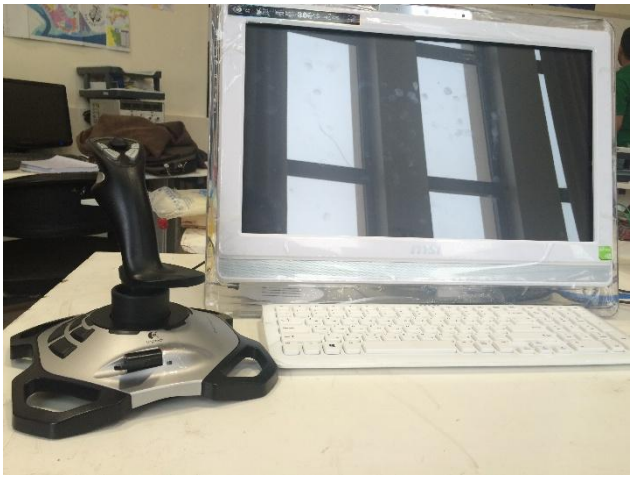
Driver Motor

For motor control of the arm of've l298 motor driver. The LN298 is a high voltage, high current, dual full-bridge motor driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Operating supply voltage of up to 46V,4.5-7VDC logic supply voltage,Total DC current of up to 4Low saturation voltage,Over-temperature protection,Logical ‘0’ input up to 1.5V (high-noise immunity)

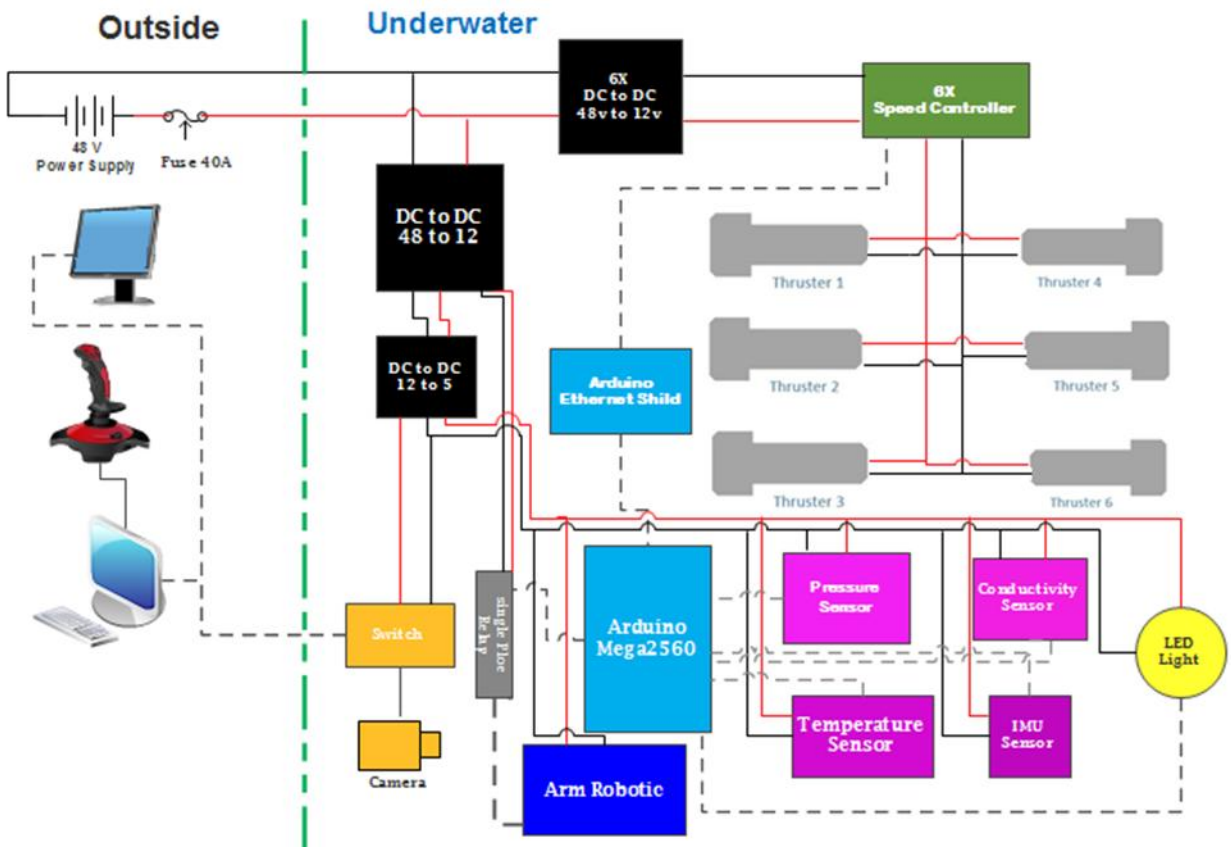


D. Control part

The control part being out of the water includes a Pc and a joystick. All data received from underwater are processed in Pc and required commands are given from the operator to the robot. Joystick has two channels in order to transmit all the commands to the robot. Meanwhile, some of channels are used for the arm control.



Controll Unit



Main ROV System Interconnect Diagram

Power Budget

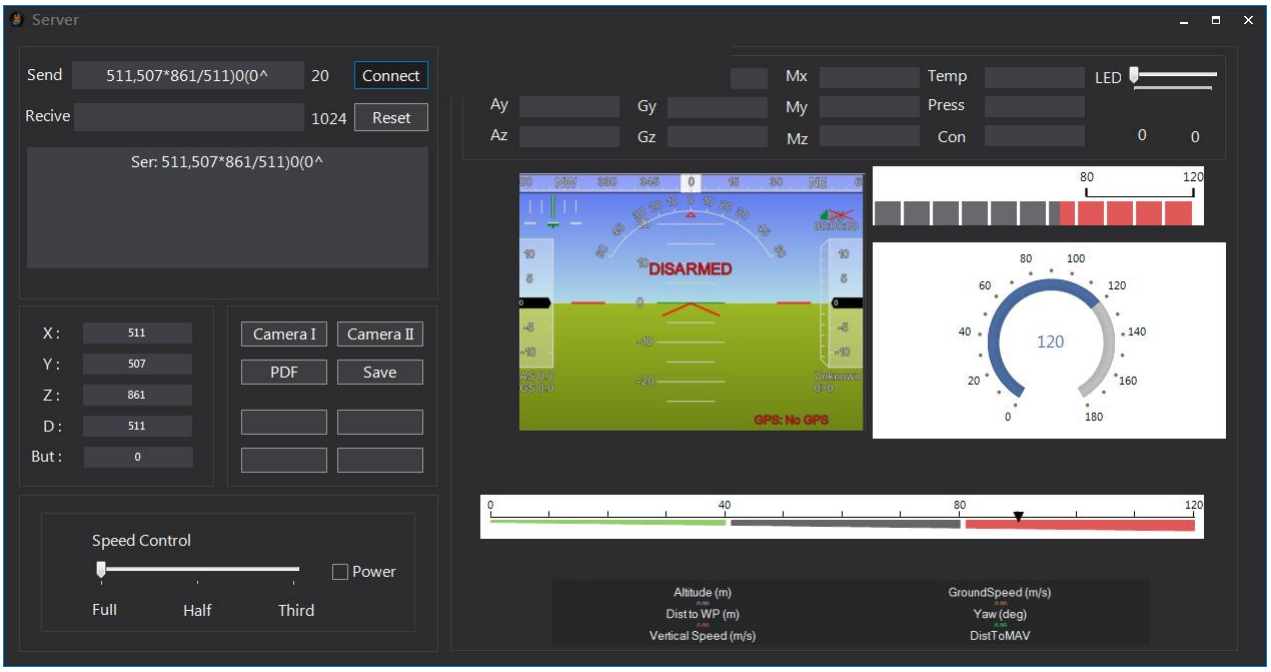
This Chat show the power budget of Acipencer Robot

Acipenser Power Budget			
Unit	Current, A	Volts,V	Max Power ,W
Thrusters	6	12	72
Cameras	0.5	5	2.5
Main bord	1	12	12
Robotic Arm	3	12	36
LEDs	1.5	5	2.5
Total power			125 W

Acipenser Power Budget

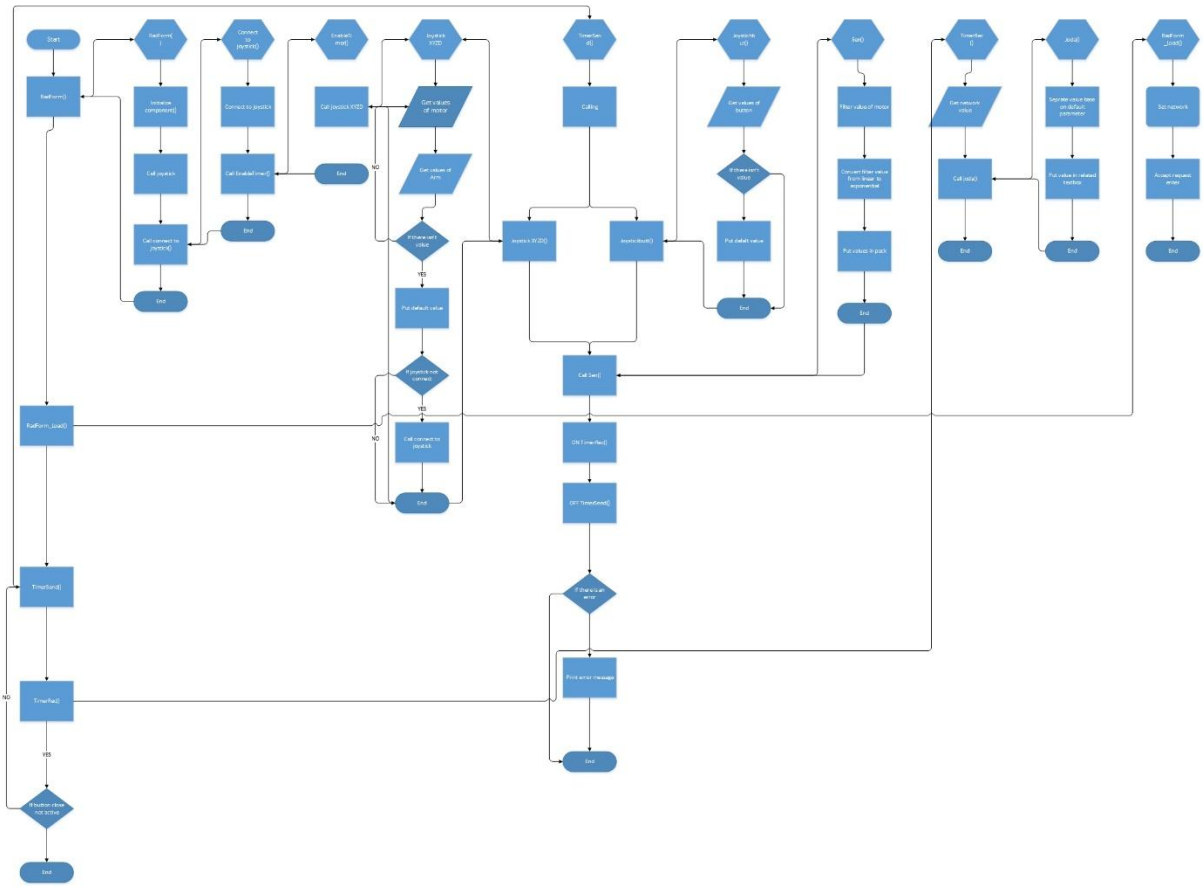
F. Software

Robot control program is written by C#. This program is transferred to robot by network cable and under TCP protocol. Also Visual Studio and Arduino libraries are used for transferring data of robot, camera and control arm. Robot GUI is written by C# language. All the received information from robot is separately represented in this interface. A view of GUI, functions and the method of using data in the control program can be seen in below.

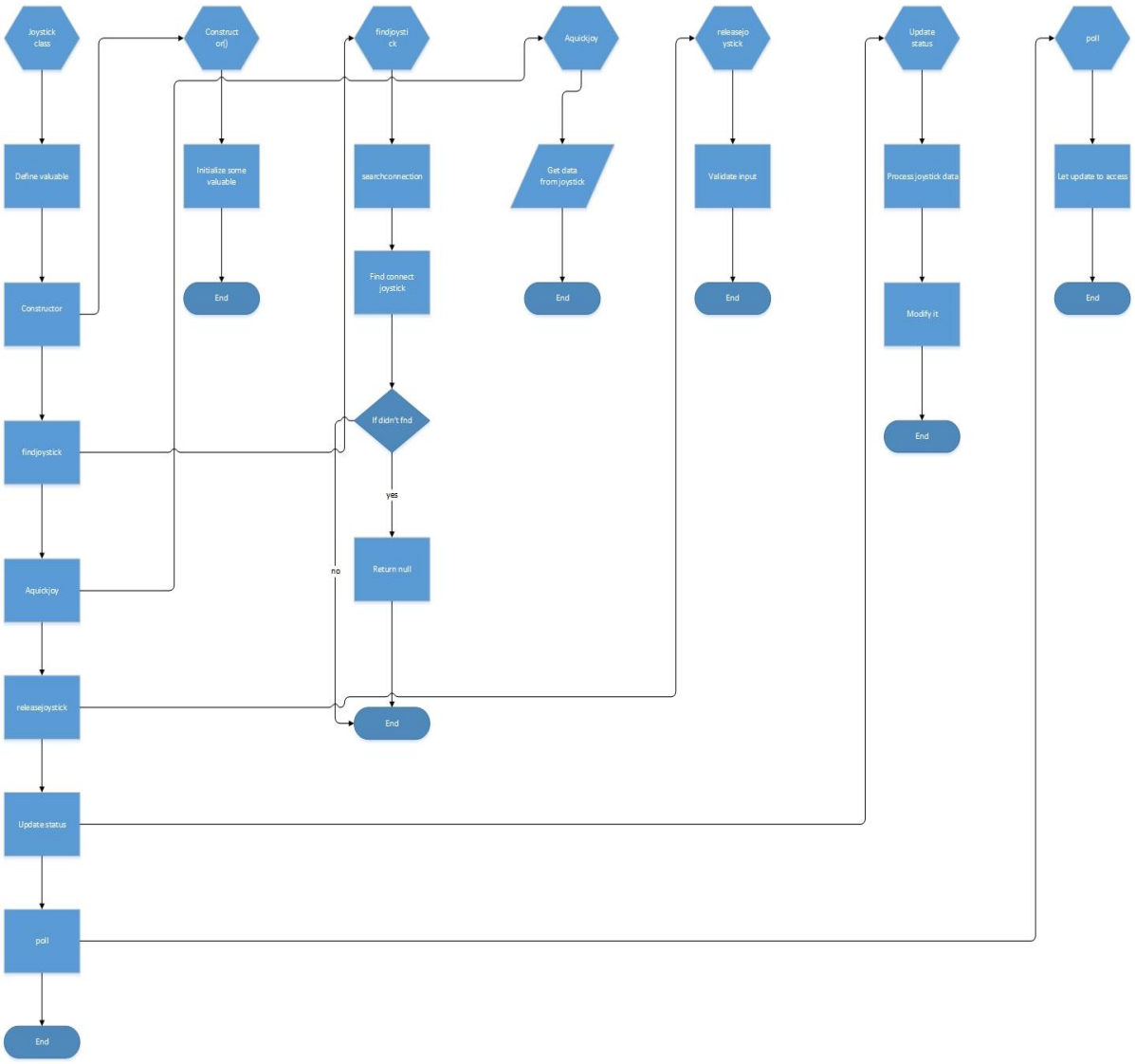


GUI Acipencer

The following figure is the robot software flowchart.



The following figure shows the joystick software flowchart.



G.Gunt chart

The table seen below shows a representation of the duration of the work done by members of the team.

Gunt chart of Team

H. Budget

According to the World competition in the budget we tried to use the lowest cost. Additional costs is the purchase of raw material

	ROV, TCU, Consumables, and Services Cost						
	Expense	Description		#	Amount	Donation	Total
Acipencer ROV	Arduino Ethernet			2	21$		41
	Power Converters	48V to 12V DC to DC Power Converter		1	468$		468
	Interial Measurment Unit (IMU)			1	22$		22
	Motor Controllers			2	11 $		22
	Networking Hub			2	4$		8
	Custom ROV1			1	47$		47
	ROV1 & Descrete Componet	Resistors, Capacitor, LEDs, Connectors (2 sets)			5 $		5$
	Speed Controller			8	21$		162
	Tether Cabling	100 Meter (1212 wire, 1.8" Penumantic Line)2 @ 75 ohm			0.3$		30
	Data Cabling	100 Meter (Cate 6)			0.2$		20
Tether Control Unit	Computer Portable			1	1250$		1250
	Ethernet Hub			1	3.5$		3.5
	Joystick			2	47$		94
	LCD for VGA Camera (Robotic Arm)			1	15$		15
	LCD For Other Camera			1	467$		467
1KW Power Supply	Meanwell Power Supply	220-48V DC		1	468$		468
	Volt Meter			1	80$		80
	Miscellaneous Components	Wire, Terminals, Connectors,			25$		25$
Services	Turney			8	$		
	3D Printer			10	78$		780
Travel	Loading	Team Housing (Students and Teachers)		9	400$		3600
	Team On Location Travel	Travel with AirPlan & Rental Vhecals For Competition		9	1400$		14000
						Total	21607

I.Safety

safety is one of the most important section s. In this section, students are required to follow all safety.use Protective glasses, Safety gloves, Check the cable and wires, Check tanks before work, Safety helmet and etc.

J.Acknowledgments

K.References

www.marinetech.org
www.iranopen.ir
www.mrl.ir