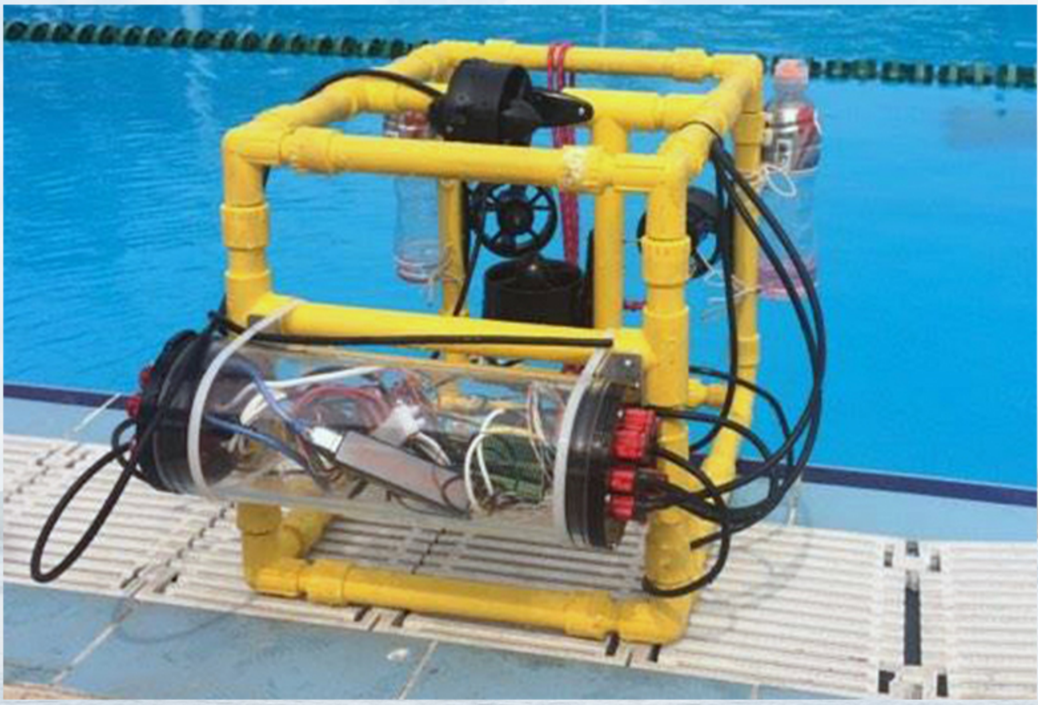
University Veracruzana

Veracruz, México

SeaHawk ROV



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Content

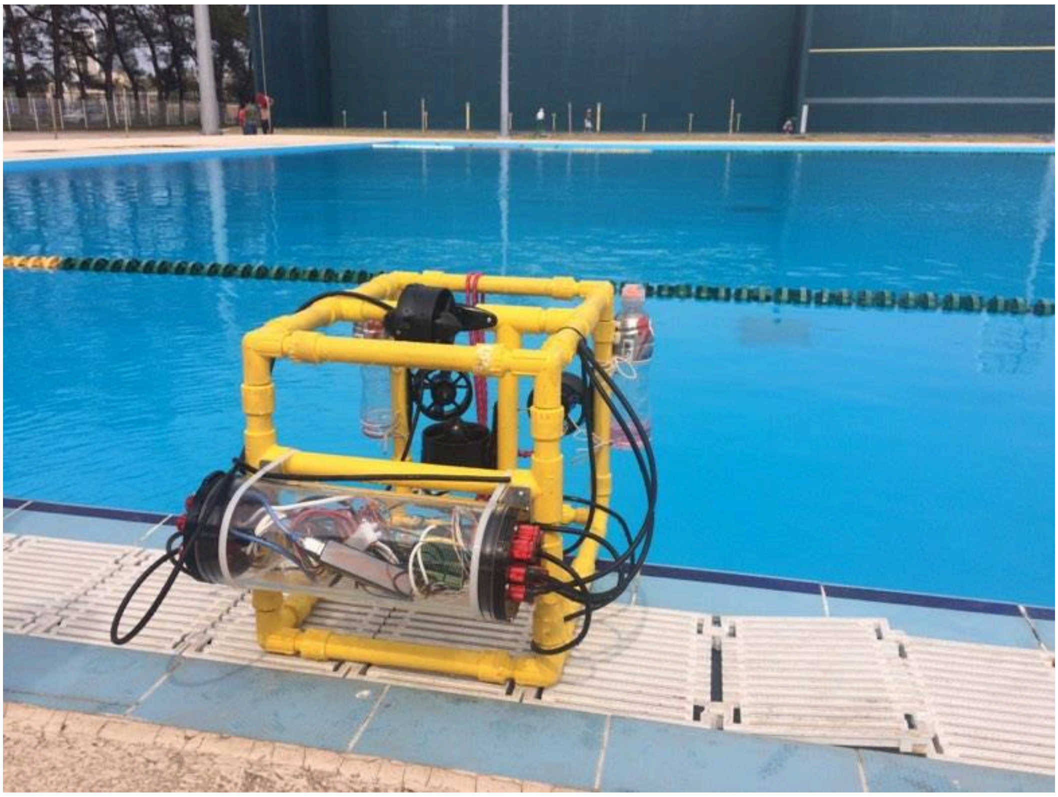
Abstract

Seahawk was built to make the final thesis of three students; Adan Manolo Flores Celis, Rodolfo Arturo Vera Herrera and Angel Alberto Hernandez Gonzales in order to prove his career as a mechanical engineer, then the number of team members was extended to improve the ROV to attend international competition MATE 2016 which 5 members were added more.

This ROV was also built to donate to the Faculty of Engineering of the Universidad Veracruzana in order to make teaching materials for students of the faculty.

The ROV was modified almost entirely with the primary aim of meeting all the standards that marks the MATE 2016 competition.

The vehicle is designed to withstand pressures greater than 50 meters below sea level, has two cameras, temperature sensors, pressure, altitude.



ROV SeaHawk

Budget

Seahawk construction was made possible by generous donations from faculty of the Universidad Veracruzana, both mechanical engineering career as other races. Around a quarter of revenues belong to donations, the rest were own resources students through raffles and parental support was achieved collect the full background.

The initial budget was $ 740 was conceived early last year with the construction began.

Regarding the budget for 6 persons respect to travel, accommodation and logistics was achieved thanks to donations from private companies in the community. It had contemplated traveling 8 students participating in the project, which was difficult to get so many resources so only travel in June.

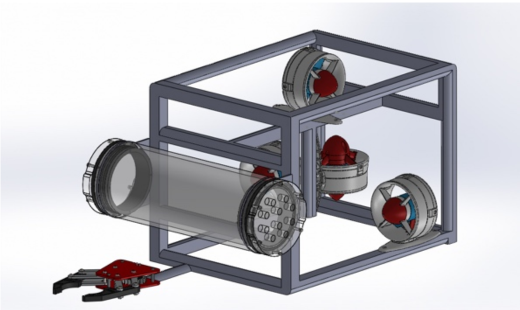
Description	Unit	Cost dls	total
Thruster T100	4	149	596
Temperature sensor	1	56	56
Pressure sensor	1	68	68
Cable penetrator	20	8	160
Aluminum end cap	2	26	52
Cam Gopro HD	2	280	560
Send	1	200	200
Hydraulic tube codo 90	12	1	12
Hydraulic tube TEE	11	1.5	16.5
Hydraulic tube cross	5	1.5	7.5
Pipe PVC 25mm	1	5	5
Pipe PVC 19mm	1	3.5	3.5
Screws	50	0.1	5
Nuts	50	0.1	5
Loctite Marine Epoxy	2	6	12
Potting Kit	1	1	1
Nylon rope	1	10	10
Suction pump	1	83	83
Check valve	1	22	22
Endless clamps	2	1	2
UTP cable	1	27	27
Power cable	1	32	32

Waterproof servo	1	60	60
Basic A30 ESC	4	25	100
Joystick	2	2.5	5
Cable dupont	2	5	10
Monitors	3	75	225
LCD screen	1	20	20
Watertigth enclosure 4"	1	56	56
Battery	1	160	160
Lamp	2	99	198
Accelerometer	1	100	100
IMU	1	40	40
Total Dls			2909.5
Total Pesos			52371

budget table

Design basics

The design was decided after seeing many prototypes on the Internet, I was held to sketch taking ideas from other



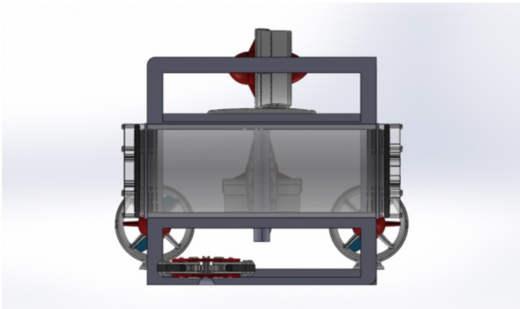
Desing SolidWorks

prototypes to choose the optimum.

Then we proceeded to implement technological aids today such as CAD (Computer Aided Design), where the SolidWorks software was used to make an optimal design and subsequently to carry out the construction according to plan.

Its structure is PVC plastic that is used in hydraulic systems, joints of the same material. It was decided to make a rectangular shape which chose it for its easy construction and shape which helps us to have better stability in water.

Its dimensions are 56 cm long, 35.52 wide and 34.5 cm high.



Desing SolidWorks

Hardware

The hardware is a vital part of the system, we use an Arduino board on which is the motherboard of our system because it is able to control it.

Propellers

To perform the tasks of the MATE 2016 competition, we needed an engine with enough force that favored us. brushless motors bought the brand BlueRobotics model T100, which were purchased in California, U.S
4 motors were used and positioned as follows:

- 2 motors (up / down)
- 2 motors (front / rear)

Manipulator

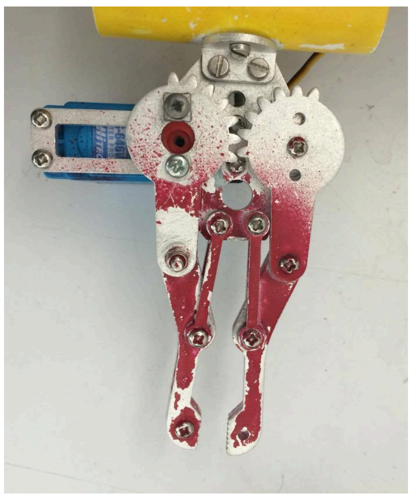
The manipulator is able to manipulate objects under water less than 2 kg. weight, has only one degree of freedom, as this in a fixed position and the front side of ROV.

It is of aluminum material anodized and is driven by a servomotor 17 kg. of torque brand Hi-tec, which allows us to open and close the gripper.

a waterproof case for electronic elements I was used, which consists of an acrylic tube 4 inches in diameter and ½ inch thick.
elements of stainless steel hardware was also used as everything is exposed to corrosion.

T100 BlueRobotics

The T100 propellants are nearly symmetrical on the directional thrust output lbf to 5.2 lbf forward and four rever
I was painted red, as when performing the tests, we presented the problem that the color was lost.



Gripper

Speed Controllers

Controllers for brushless motors T100 are of a capacity of up to 30 amps, which enables us to control the motors through PWM digital signals as well as to control the direction of the engines and meets our need for movement.

The drivers were bought online and imported to our country.

Motor controller

Communication

The communication system in the ROV is designed for a tether up to 45 m, which introduces a number of challenges. 4 motors to control and to transmit two cameras, a lot of bandwidth in our attachment is needed. We had a great difficulty which stopped us for quite some time, you had a voltage drop which only allowed us to work about 5 to 10 minutes ROV underwater, which delayed us greatly, and we thought it was problem programming and a lot of work in the code which was not the solution, after it was cable replacement and a smaller caliber, finally the caliber used was 10 AWG as we used 18 AWG wire.

Our communication consists of 3 elements, two power cables (positive and negative) and an Ethernet cable 8 wires by which the ROV control is performed.

In conjunction with this, a polyester cord was placed to give strength to the strap, so that the burden was on the rope and not the wires. Together these elements form the rope attached communication.


Communication cord

Interconnection System Diagram (SID)

Our company ROVs, you decided to call Halcones UV, was created with the intention of working in harsh environments, as well as other marine habitats. The aim of Halcones UV is to design, develop and test an ROV able to solve different missions and tasks such as navigation, vision and interaction with hostile environments under seawater. To achieve this, the ROV was designed and implemented in a way that possible work in these situations without exceeding budget previously set. The hardware is distributed in three different areas: the system of surface attachment and ROV system underwater.

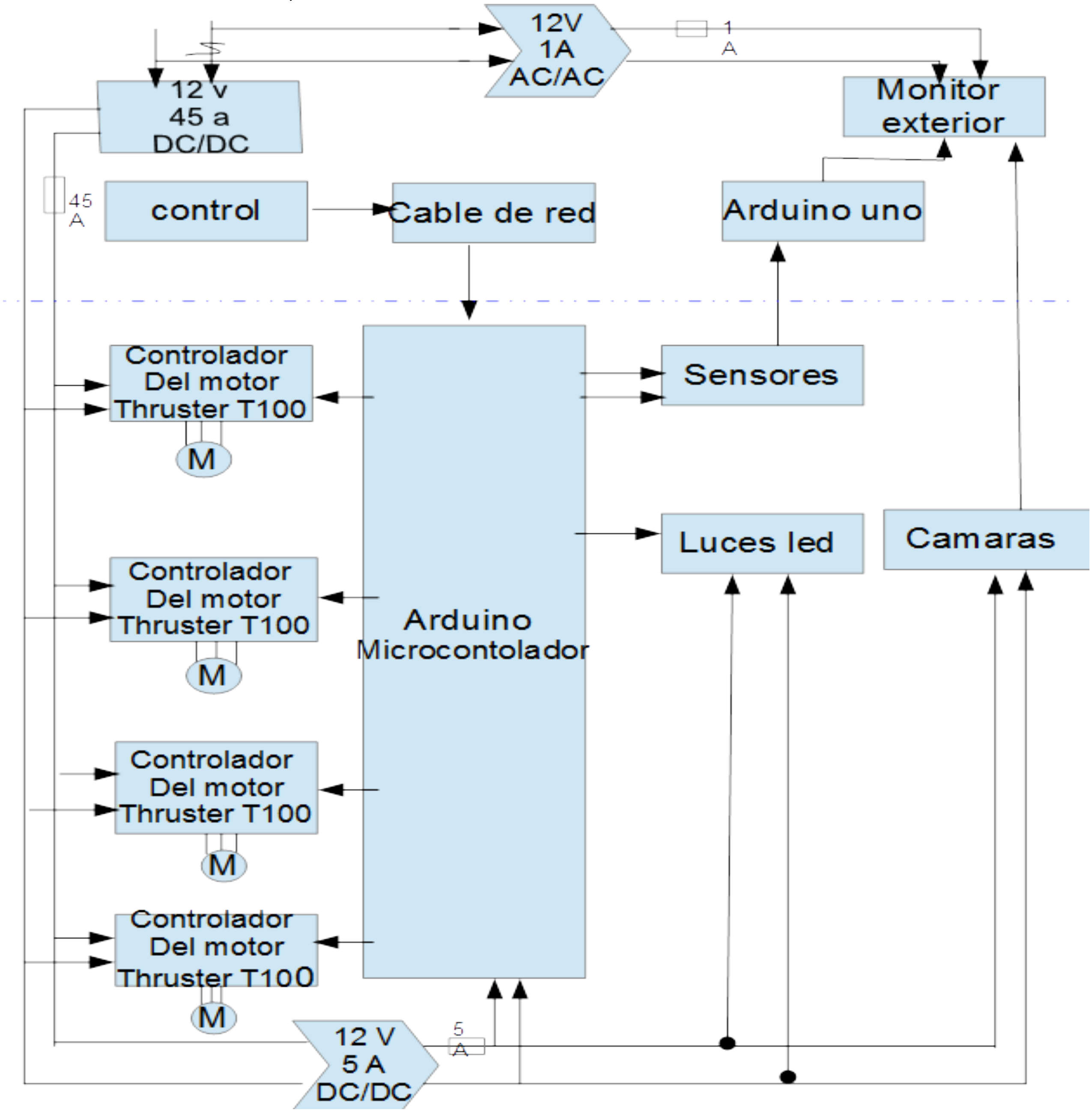


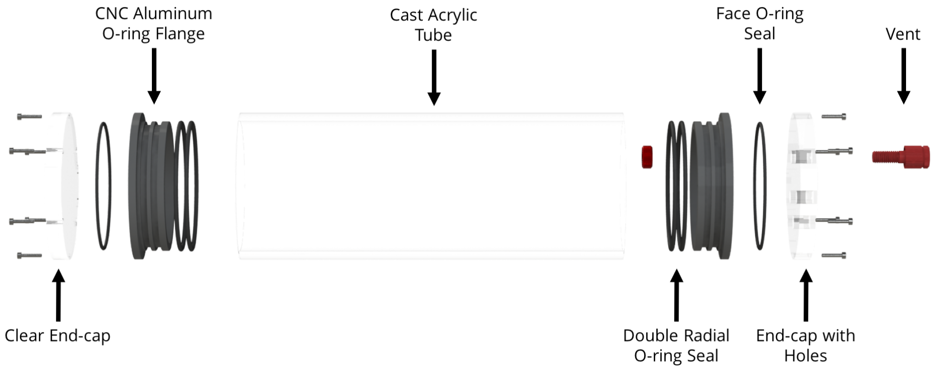
Diagram SID

Waterproof case

Dry to keep all electronic devices is crucial for a good performance of any product that is intended to use in wet environments. Therefore, the electronic control box was completely isolated.

After much research, the first thing we decided to make our own case. The initial design was an acrylic tube in which assemble electronics ROV. But we had a serious problem because it was not completely airtight, so finally decided on a tube made by ... .. Most electronic boards and components used are rectangular or square in shape, which made it easy to accommodate all the case.

We have also had to adapt several connectors tightly with the case of Ethernet and power cables and wires of motors and various sensors. To ensure double protection, each has its own connector O - ring on the inside of the box.



Acrylic waterpoof case

Ethernet communication

Communication between the ROV and the controller (which is conducted the main data processing) is performed through an Ethernet crossover cable 45mm long tipo6 approximate. One of the main reasons for Ethernet was chosen over other means of transmission (including standard) is the great distance that covers the transmission of data as ROV need to travel and explore around 12-30 meters long and about 15 meters underwater. Resulting in an approximate total cable distance of 40 meters.

Another advantage of the transmission over Ethernet is data integrity, since it has high reliability and data loss are at a minimum rate. To reduce this loss we are using an STP (shielded twisted pair), which increases protection against electromagnetic interference (just in case there would be no).

Ethernet also provides the ability to transmit high speed and high transmission capacity (up to 10 Gb and 500 MHz1) reducing latency and ensuring the data frame arrive on time and with all the information is reliable and complete.

Software

To operate the Seahawk we have created a processing program which is a programming language based on open source JAVA (Processing). Among other programming languages and environments we chose because it has some advantages Processing of interest to us than other languages.

Processing is a friendly language. While other programming environments seem complex and require the user to have a great experience in coding and interpretation of the code instructions and their results, production is simple, but no less powerful. Reference is always at hand fans giving programmers a simple structure and skilled ones, a familiar form but less complex than what they're used to doing. It is also an environment object-oriented programming, which allows us to test and observe through different angles what we are trying to achieve with each command.

Processing also has libraries that has Ethernet communication, with instructions in turn, they are also simple. It also has a processing fee, so all operations required for our program in time for transmission so that the performance of our ROV see not affected by latency or any other issue related to the processing and transmission .

Another reason to choose this language was its compatibility with Arduino. As discussed later in this report, Arduino was used to control the functions of Seahawk internally, so the language that was used, it was necessary to connect it to an Arduino program first. Most of the other languages need an intermediary to make the connection and the procedures were complicated in transmission time, so our ROV performance would suffer. In the end, production was the best option, since the connection with Arduino was carried out almost automatically retained and data integrity.

Control

Our ROV uses four engines to generate all the necessary movements also have components such as sensors and grip they need a simple control system for this purpose using joystick, buttons and variable resistors implemented.

We use two interfaces to the movements of the ROV, the first is manual interface that is activated at the beginning of the program, the speed range of the engine is controlled by the joystick, which have speeds of 1100-1900 microsecond, being 1500la steady speed, speeds of 1,100 to 1,500 are reverse speeds and speeds between 1500 to 1900 are forward speeds.

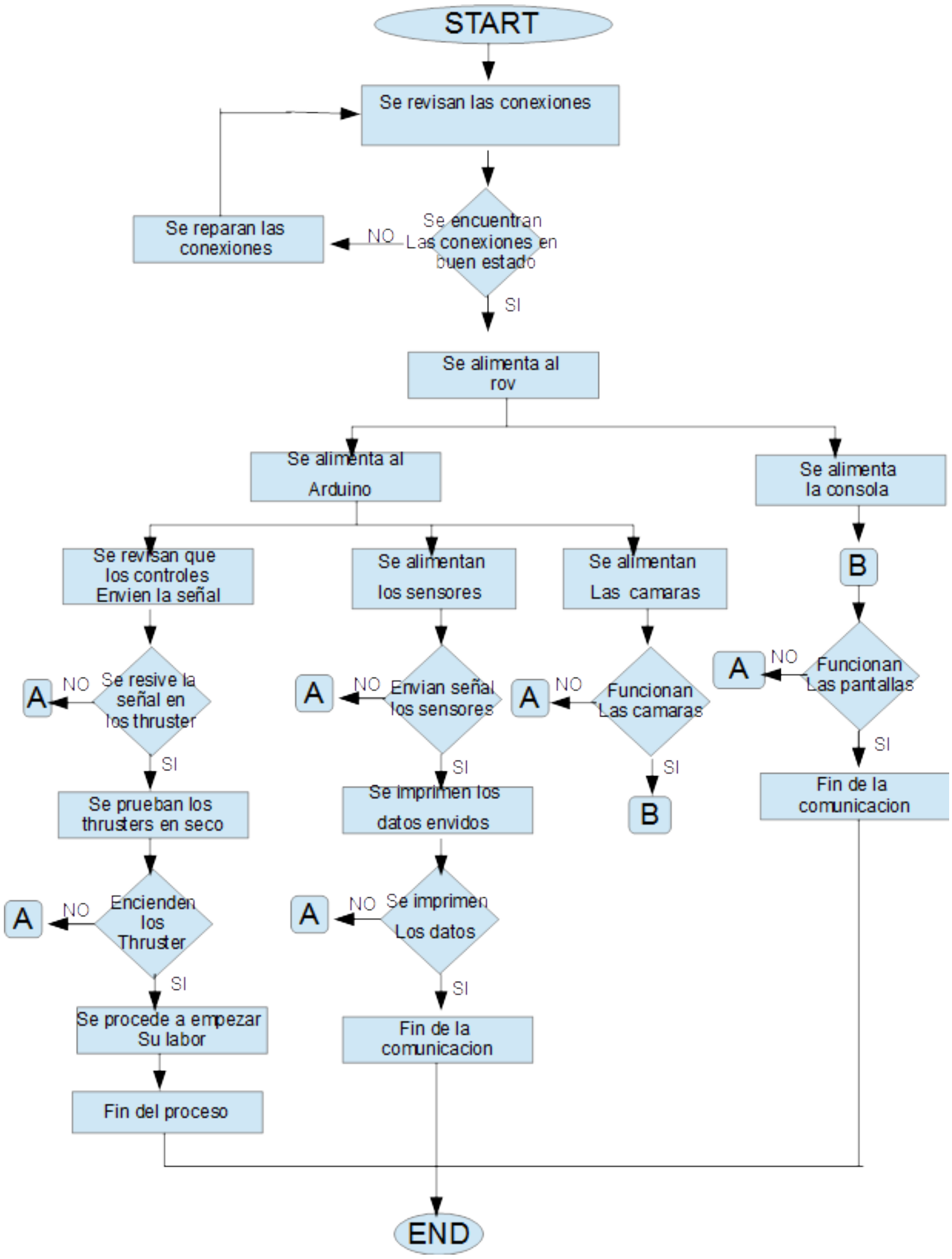
Now, in the first interface, we use the left stick to move the ROV along the axis X and Y, and can also move the ROV at different angles and speeds, according to the angle and movement of the left lever.

The X axis of the right joystick is used for rotational movements of the ROV, in this interface, we can only move a stick when that plane XY movements. The Y axis of the lever on the right is used to tilt movements. In the second interface, we use the left stick to move the ROV on the Y axis and the right stick is used for rotation and immersion.

The ROV is operated by a pilot, leads the ROV with the joystick controller, our control has some characteristics from the fact that each line of code and logic behind the movement of the ROV. In addition, the code was designed to allow the Seahawk movement in every possible way. This was not achieved the cough but in certain cases.

Although our laptop and processing itself have a great ability to "process" that did not want to do unnecessary operations or overburden operations Arduino, so we added a feature that eliminates data and prevents it from being sent over the wire Ethernet. These data are to avoid a strange movement in the thruster.

Flowchart



Electronics

The whole system is controlled by an Arduino Mega ADK, we decided to use this board mainly due to its 15-pin PWM and the fact that we need around 13-pin PWM for our engines and our equipment. At first we were thinking of using a card arduino one, but does not have a lot of this type of pins.

We have also decided to use this card as it is easy to program and has more components and sensors than others.

Pressure sensor

ROVs position is important for pilots, therefore, we chose MS5803--14BA a pressure sensor to calculate the depth position ROVs. This pressure sensor measures the absolute pressure of the fluid around it, including air, water, and anything else that acts as a viscous fluid.

What makes the unique MS5803--14BA is gel membrane and antimagnetic stainless steel cap which protects against water pressure of 30 bar. It is connected to the Arduino Mega, and the data is shown in centimeters for greater accuracy.

Accelerometer

The ADXL335 is a three-axis accelerometer with very low noise and power consumption. The sensor has a range of complete detection of + / - 3g. We use this sensor to measure the distance between the camera and the object of our image processing system.

Temperature and humidity sensor

This sensor includes a resistive - moisture measurement component and a component type of NTC temperature measurement. It is connected to a high-performance 8 - bit microcontroller, which offers excellent quality, fast response, anti - interference ability and cost - effectiveness.

For safety reasons, this sensor is used to determine if there is a water leak through our electronic box or if our system is overheating.

Bomb

To carry out one of the tests that were determined to complete for the test is the fact suctioning liquid for studies of the same, and determine its composition was decided to put a type pump ... also adding a check valve to prevent a backflow of to study this liquid is mounted within the structure of ROV securely fastened to prevent the Seahawk have malfunction.

Mechanical Safety Checklist

1. Ensure that all electronic equipment is in dry and there is no perceptible damage the union.

2. Check the fuse in the connector 25A supply 12 V.

3. ROV out of the water, check that all connectors are tight and vacuum seals are in all cases.

4. Check the o-rings.

5. Safety equipment and personal protective team members.

6. Check that all equipment must be sure: Screws, brackets, ballast suction pump check valve.

7. Ensure that the connection cables in the waterproof case are properly connected.

8. The umbilical cord must be properly stretched and should not be twisted.

9. Verify that the video camera is in the correct position, keep signal and can give image on the screens.

10. Ensure that all penetrators are closed before putting the ROV into the water.

11. Verify that the power cable is securely connected to the battery.

12. Verify that the arm work before surgery and gears are securely installed in place.

13. Overall Rating ROV by two team members.

14. Be sure to follow the guidelines and instructions of competition.

Reflections

As with all projects, there are plenty of experiences in which to reflect. The team started with three students and then there are eight. Fortunately with the increase in the number of team members, we can become more specialized in various fields, which allows us to understand the specialties in more detail. By having students studying mechanical, electrical and mechatronics I helped us learn how little or much each of us can contribute.

Sometimes it is difficult to make a decision when there are too many points of view and different experiences, but teamwork is a virtual large and vital to achieve the same purpose, there are different cultures and ways of thinking that it is often difficult to one mind.

The experience of being able to travel and participate in a competition of international stature is an unforgettable experience, to meet people from around the world were prepared similarly to give the best results in the competition.

Thanks:

I thank the University Veracruzana our highest seat of learning for its support in providing work areas in which we worked to give life to this great project support.

Grateful to our professors; M.I. Alvaro Gabriel Vega De La Garza, M.I. Azzur Mariano Hernandez Contreras, Dr. Rogelio De Jesus Portillo Velez, M.I. Francisco Martinez Ortiz, Dr. Adrian Santo Vidal, Ing. Julio Cesar Amezcua Alcázar, M.I. Jose Juan Fragoso Montalvo, M.I. Armando Campos Dominguez, M.I. Estela Del Carmen Fernandez and Eng. Joshua Dominguez Marquez for all the support provided by its human quality and its economic and intellectual support instruct and guide us to make this project today is already a fact support, keep us confidence at all times.

MATE also thanks to the opportunity they give us to allow ourselves to participate in this great event where we can apply knowledge gained in the race for the confidence that has on students to carry out these types of projects.

A company Tng "Talleres Navales del Golfo" institution that gave us the financial support we needed because without it would not have succeeded this project.

A thank you all are part of this.