ROBO-TECH
The Kraken

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1-Abstract:

The port of Long Beach in California is in need of a remotely operated vehicle (ROV), which can do missions under deep water, ROBOTECH is a marine company dedicated to development and manufacturing of ROVs to tackle multiple challenges environments see (Fig(1)).

Furthermore, to be more organized and in order to speed the development and fabrication of our product, we were split into four teams (Administrative, Electrical, Software and Mechanical). The design was based on leaving free space to facilitate handling errors Moreover; the ROV's flexible design enables adding or removing any extra hardware or required software. We took into consideration the size and weight to ease our mission under water.

Software was developed and coded from scratch via arduino allowing the user swift correction of any error. Electronics were assembled, modified and tested extensively to ensure the system stability. The safety for environment and people is a priority in our product so we made sure that safety labels have been added and electronics system is protected from any unexpected increasing in current by adding a safety fuse.

This report will show the technical information about the mechanical design, software and electronics as well as the safety considerations and the future improvements.

(fig(1))

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2- Table of content :

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2-Design Rationale:

2.1- Frame:

Definition : starting with some simple ideas in our minds , drawings , researches and some imagination we eventually reached our aim to design such a simple , fixed , stable and affordable design stress analysis on the frame was done to see points of maximum stress and ensure safety

Design: Design: it contains two parallel main plates attached to each other by one horizontal pillar and some horizontal rods ,there is also one horizontal pillar works as a slider and the arm is fixed on it so we can move it towards and backwards as we want to save our chance in targeting(decrease) the dimensions' (and get the) bonus and finally it contains one camera that allows the pilot to know what's happening under the water

Material Selection: polyethylene

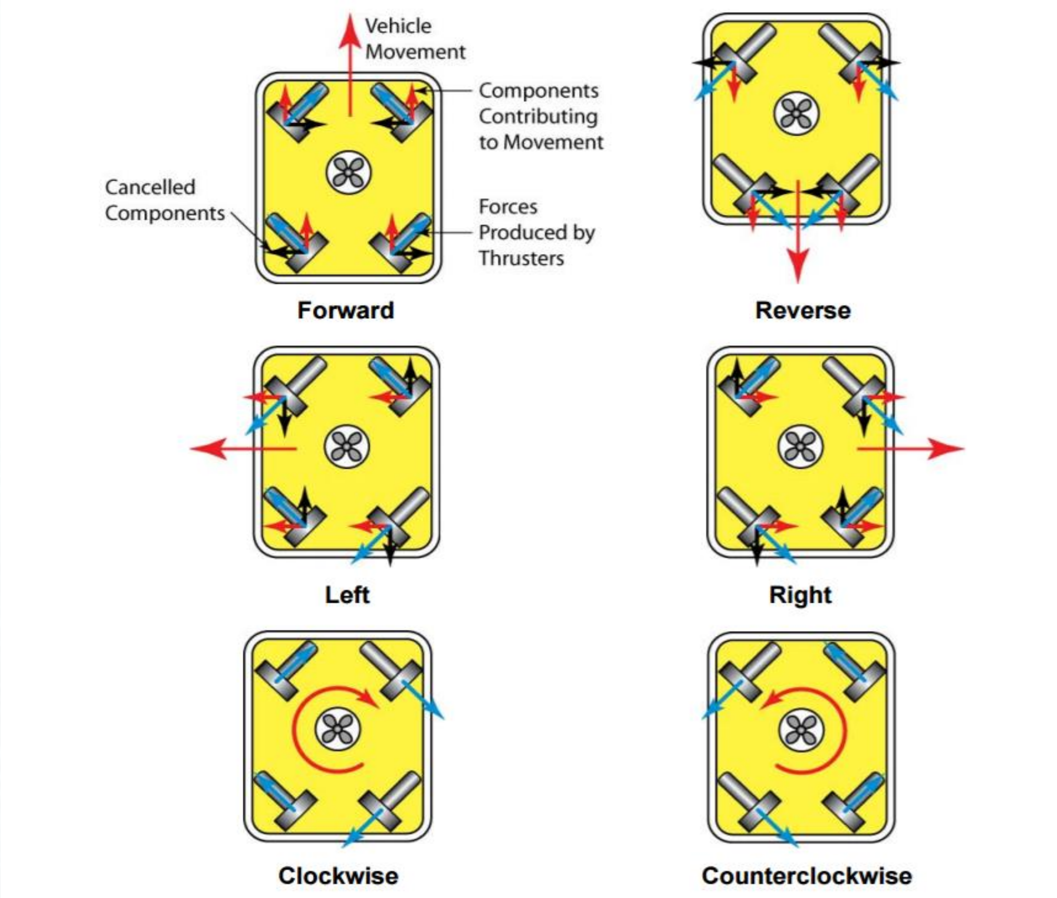
We chose this material for:

1-Low cost
2-Readily available
3-High Corrosion resistance
4-Easily Machined
5-Wear resistant
6- High Toughness

Moreover, This design was executed on computer-aided Design programs including SolidWorks®, AutoCAD individual parts of the frame are connected with a male/female type connection and two bolts securing both parts together, adding to the strength and integrity of The Kraken

2.2 – Propulsion :

Our Company utilizes a 6-thruster propelling system , 4 of them are mounted in a 30-60 degree configuration on the edges of the middle(bottom) plate ; To have the ability to move flexibly whether horizontally or laterally , while the other two motors are mounted vertically on the two vertical plates to control the movement of the Kraken vertically see fig(2)



fig(2)

Motors are controlled via 3 motor drivers (H-Bridges).

These features provided an easy and stable maneuvering which is required in performing the missions.

In order to save time and effort ; our crew chose to buy factory sealed thrusters (Bilge Pumps)as they are cheap , efficient , and as they are fast and strong enough to make our **ROV move easily.**

Issues to consider when placing thrusters:

♣ Clear water flow pathways in front and behind the thrusters. Steamline the motor housing to minimize thrust loss.

♣ Be aware that each thruster that acts along a line that does not go through the center of the vehicle results in a turning moment. See fig(2)

♣ Thrusters normally produce more thrust in one direction than in the opposite direction. For example, if your vehicle buoyancy is slightly positive, the most robust vertical thruster should be pointed downward to overpower the positive buoyancy.

♣ Incorporate counter-rotating propellers whenever possible to avoid prop walk.

♣ Adding more or larger thrusters for more power can shorten run times or require larger batteries.

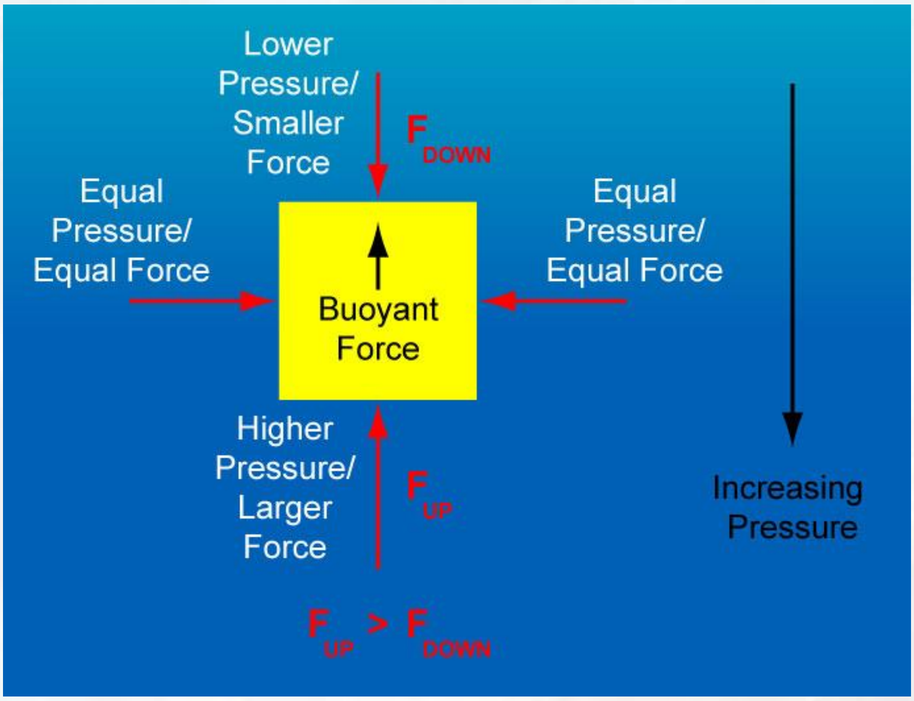
♣ Placing thrusters at the bottom of the vehicle increases stability, but it also increases the possibility of damaging contact with hard objects and stirring up sand or silt which can reduce visibility. We were concerned more by the safety of ROV so vertical motion motors are placed at the top of The Kraken.

♣ The farther a thruster is placed from the center of rotation of the vehicle, the faster the speed of rotation.

♣ Keep electronic sensors away from the electromagnetic fields generated by thrusters.

2.3 — Buoyancy:

Buoyancy is defined as the upward force exerted by the fluid on a body that is immersed in it and according to Archimedes' principle ; the magnitude of this force - buoyant force- is equal to the magnitude of the weight of fluid displaced by this body.



fig(3)

depending on the net force of both the weight and the buoyant force generated by the ROV body, this net force may result in one of these **three Conditions:**

Positive: buoyant force > weight: the ROV floats. See fig(3)

Neutral: buoyant force = weight: the ROV neither floats nor sinks.

Negative: buoyant force < weight: the ROV sinks

One of Our Kraken's special features is that it is slightly positive Buoyant so ROV can ascend up gradually with no thrust applied. This ensures safety for the system if any Electrical problems happened. Once the issue of the ROV's buoyancy was solved the buoyancy of the custom in-house tether was tackled. All submerged objects are subject to an upward buoyant force. Even objects that sink undergo this upward force and therefore weigh less in

2.4 –Stability

Our mechanical team designed a symmetric ROV to ensure stability and equal distribution of forces We mounted two thrusters vertically on the middle of the edges responsible for vertical motion to avoid tilting when moving up or down. and we managed to make the center of gravity under the center of Buoyancy so our rov would never overturn under the water as if it was about to title it would avoid overturning and it would take it's really position again so it would ensure high stability and avoid any moment under the water by some calculations by computer-aided Design programs like solidworks and also by placing some floats above the ROV

2.5 – Grippers :

The arm works as the main assistant underwater.

Therefore , The Kraken possesses a manipulator fixed in the middle of it ; It's controlled by a DC motor which we chose to seal by our selves to decrease it's cost .

The end effector was manufactured using polyethylene ; As it's cheap , easily machined , available , tough , flexible , and it has high corrosion resistance .

It was cut using CNC laser in order to be accurate.

The end effector of the manipulator are 2 fingers like parts designed to hold any shape tightly ;

To increase friction between the parts of the gripper are covered by rubber sheets. We chose lead screw mechanism for our design as it is easily and rapidly calibrated by loosening and tightening just two screws , yet stable and reliable

Fig(5)

Fig(6)

the manipulator has 2 degrees of freedom the 1st one is the DC motor connected with the nut rotating around the spiral rod which allows the gripper to be opened and closed easily, and the 2nd one is the DC motor connected to two gears which allow the arm to rotate 360-degrees ,so it would be useful it rotating the valve in light and water show maintenance .

2.6 –Sealing:

Sealing is preventing any leakage in our system (in our case water) from penetrating our control box by closing all the openings using different methods and materials thus protecting al the circuitry inside from any kind of short wiring in order to preserve a proper system with no problems or malfunctions with the highest degree of safety available.

Our technical team has researched several methods of sealing of electronic components with various techniques and have determined the most efficient and guaranteed method with minimum effort, time and highest quality available allowing the company to have enough time to experiment with its electronic configuration and provide a creative and safe way to enhance our product quality and compete with other companies.

2.6.1- Acrylic tube (Control Box) sealing

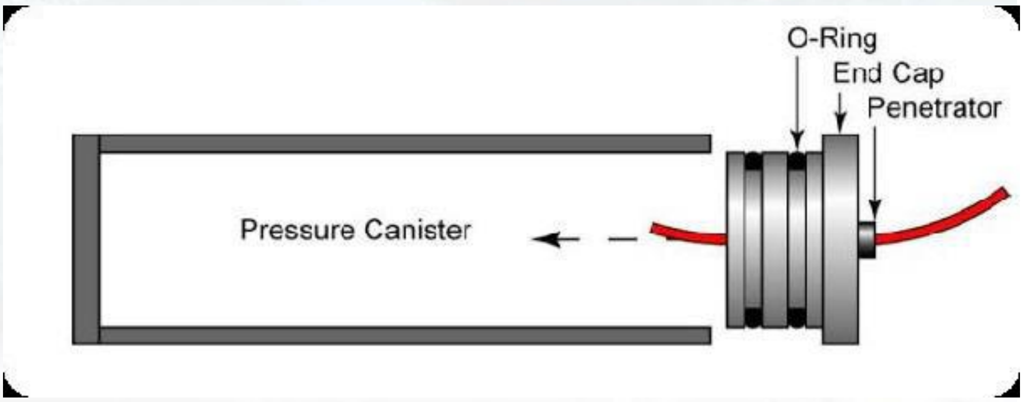
Design:

Putting every board or circuit or motor inside an acrylic tube with two end caps were designed to fit perfectly inside that tube preventing any kind of water leakge . And for more sealing we used a carfully chosen set of orings .

Material Selection

- Polyethylene (Artelon) for the endcapes
- Transparent Acrylic
- EPDM Rubber Orings See fig(6)

_(see the figure above . Endcaps design and position of O-rings)



Fig(6) Fabrication :

- A bench driller was used to drill the Endcap holes to ensure no holes will be skewed

A center lathe machine was used to synthesize the endcaps

2.6.2- Arm Sealing :

Design:

We used the same technic we used in the control box.

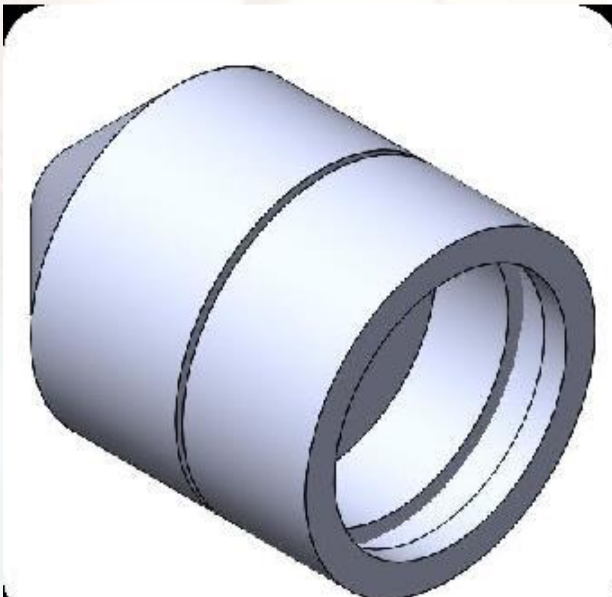
Material Selection :

- PVC Pipes as the motor housing
- Polyethylene (Artelon) for the endcapes
- EPDM Rubber Orings

Fabrication :

The same operation and steps in the sealing of the control box

See fig(7)_



Fig(7)

2.6.3- Cameras Sealing :

Design:

Our designers' objective was to design the housing to be easily installed/uninstalled. And hence, the *Artelon* casing with a threaded end with its cap that replaced the actua lhousing of the camera for sealing purposes. (See the figure above Camera housing and final product.)

Material Selection :

- Polyethylene (Artelon) for the endcaps
- Transparent Acrylic
- EPDM Rubber Oil Seals
- Epoxy

Fabrication :

A center-lathe machine was used to manufacture the Artelon Housing.

See fig(8)

Fig,(8)

3– Electrical and controlling system

3.1 – Power Distribution :

The DC-DC 7V Output Buck converter was used in our product since we needed to distribute voltage to our electrical components with either 7 or 12 volts such as our product's micro controller which is operated by 7 volts. see fig(9)

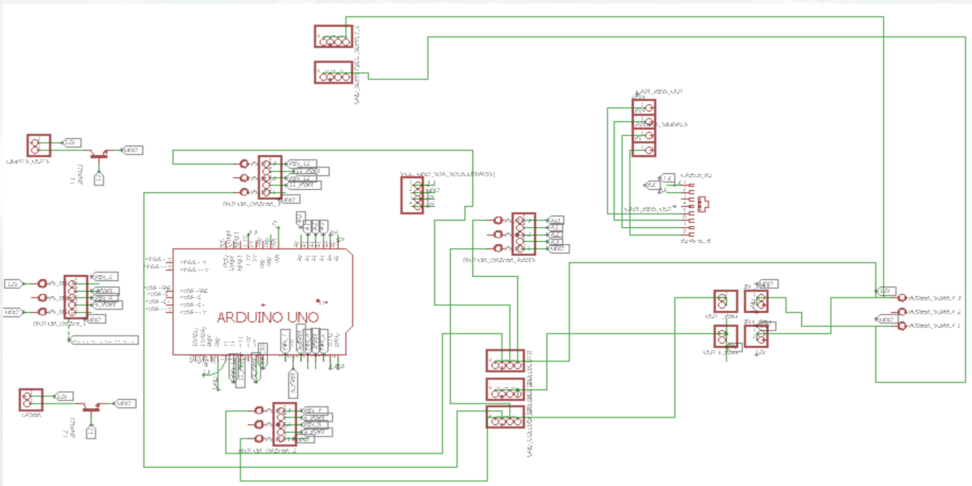
fig(9)

3.2 – Mother Board :

The kraken has an all-new innovative electrical system and boards that can be easily diagnosed in case of problems. This year, the electric team's aim when designing the PCB boards was to reduce the cost, time and effort spent. Thus, our company came up with a design which can adapt to the required missions and the customer's need.

Our company's mechanical team decided to use a transparent acrylic cylindrical shape to cope with high pressure. Inside that cylindrical shape is the one printed circuit board that we used to control our system.

The control board contains one Arduino UNO, Four motor drivers, Two MOSFET transistors to control ROV's lights under deep-water ,one compass sensor and two analog cameras



Fig(11): company's control board schematic

Fig(10)

3,3)Controller Board (ArduinoUNO) :

Our electrical team chose to use an Arduino UNO which is supplied by 7v as it was mentioned because it is relatively cheap, User friendly and it is dead-simple to setup and use (Compared to other development boards).Thus, this controller fulfilled all our requirements. Our electrical team used the arduino's PWM to control the motor's speed and the analog input to get readings from the compass sensor as required in the mission.See fig(12)

fig(12)

3,4)Motor drivers

Our company is using four motor drivers (Two channels each) that use 12V_10A each for operating; three are used for controlling our 6 bilge pump motors (Thrusters) and the last motor driver was used in the arm's DC motors. See fig(13)

fig(13)

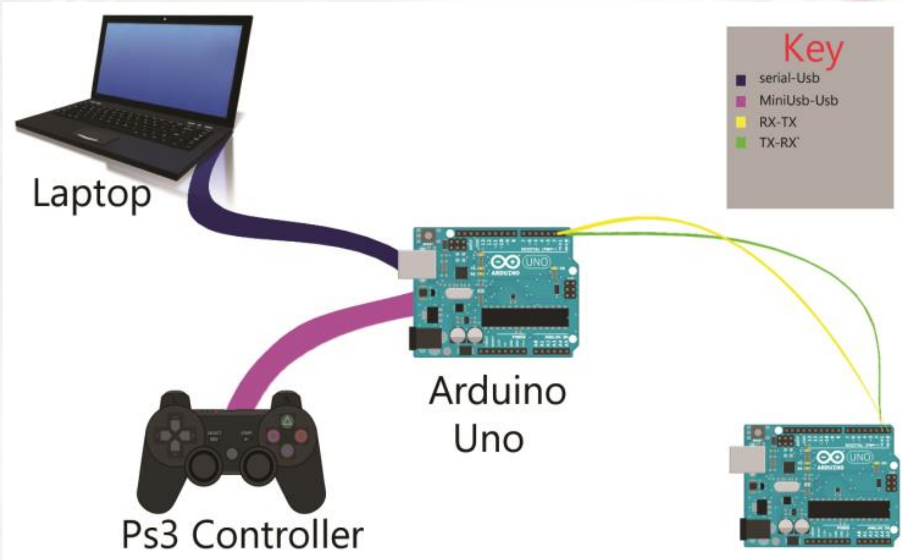
fig(14)

MOSFET Transistors: MOSFET Transistors were used in our company's product. They are semiconductor devices which are widely used for switching and amplifying electronic signals in the electronic devices. The MOSFET is a core of integrated circuit and it can be designed and fabricated in a single chip because of these very small sizes. The MOSFET is a four terminal device with source(S), gate (G), drain (D) and body (B) terminals. The body of the MOSFET is frequently connected to the source terminal so making it a three terminal device like field effect transistor. It is also the most common transistor and can be used in both analog and digital circuits. We use the MOSFET to drive High Power LEDS in order to light The Kraken's way through the ocean. See fig(14) and fig(15)

fig(15)

4-Communication

Our target is to control The Kraken's movement and thrusters remotely using a joystick. This is through communication between Two microcontroller boards(Arduino) using the UART protocol , one on Our station as a master connected to the laptop and the other



fig(16)

The main idea is to send and receive DATA via 2 wires; TX and RX as follows:- fig(16)

- Our Master Arduino is connected to the laptop and Serial Monitor is opened.
- Joystick is connected to shielded master Arduino Board.
- TX of the Master is connected to the slave's RX to transfer data between the station and the ROV using UART protocol and control The Kraken's movements.

, Also the Slave's TX is connected to Master's RX to receive sensor readings and Motors' speed to be shown on Serial Monitor and LCD 16*2 as a feedback for the pilot to ensure efficient movement and best performance in every single mission through the ocean.

5 - Camera / Vision system :

Vision system:
Our vision system is one of the most important parts in our product as it helps us to see, observe and explore the underwater clearly. We have two cameras which are; first the Pilot’s camera that see all over the space in front the ROV which helps the customer to move the ROV, second the gripper camera that sees the gripper and what it holds. We used analog cameras with IR and with a DVR to process the captured live stream and images by camera to be shown on our monitor. Camera signals are also amplified to prevent noise from ruining our System see fig (17). Features below; Check Photos

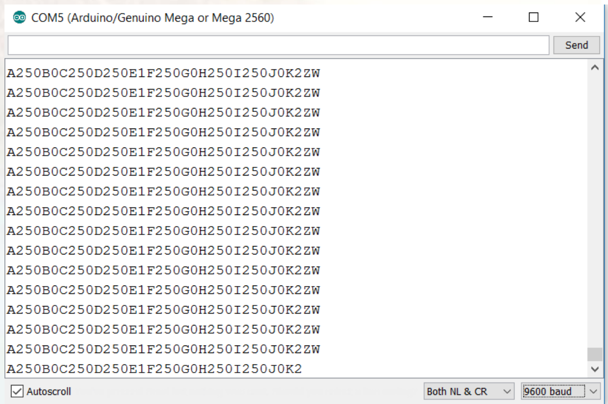
Features

- 1/3" HDIS
- High resolution of 720TVL
- Day/Night(ICR), AWB, AGC, BLC
- 3.6mm fixed lens (2.8mm, 6mm, 8mm optional)
- Max. IR LEDs length 20m, Smart IR
- IP66, DC12V

DVR:- Main aim in ROV is to process the video live streams and images on your Monitor to give the pilot clear vision to control ROV deep underwater used by customers to record their videos or captured images to any storage devices. It suited our requirements for Mission 4 safety to capture images for contaminated area (containers)

6 – Programming

The Kraken is controlled using a master arduino UNO hooked up to a laptop and a joystick (Ps3 controller), the Master takes the input from the joystick, concatenates it into one string to be sent through Our communication system(See Communication) The goal during development was to give the pilot and co-pilot complete and intuitive control over the Kraken. The kraken has a GUI to display information from the ROV‟s communication network and perform operations on.



The GUI consists of:

Serial monitor:

is to know the feedbacks from (Motors, data from sensors, servos, directions & sending data)

LCD:

Is used to display the reading of various sensors (Water sensor & Compass sensor).see fig(17)

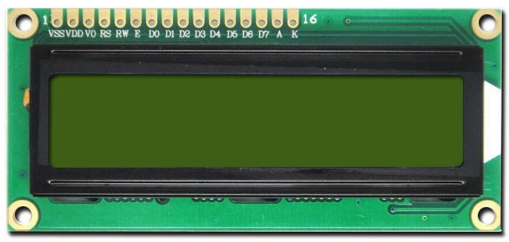


Figure ‹-17

c# image processing software:

Used for Mission 4 Safety & Risk migration to determine the distance between the highest risk container to the rest of containers and represent it on the laptop. It measures distances through a single camera using image processing techniques and algorithms. Using the AForge.net framework to access the camera through the C# software.

7- Sensors :

7.1)Water sensor:

Is attached to the control box near end cap in order to indicate any water leaked inside the control box as one of our safety procedures.

. One of our Kraken's special features is an emergency button to turn off the system with once you are alerted by a water leakage

Specifications:

- Operating voltage: 5V
- Operating current: less than 20mA
- Sensor Type: Analog
- Detection Area: 40mmx16mm
- Dimensions: 62mmx20mmx8mm

7.2)Compass Sensor:

fig(18)

The LSM303DLH is a triple axis magnetometer (Compass) See fig(18)
Combine with a triple axis accelerometer. This breakout board uses the LSM303DLH to give us the data we need to feed into our Arduino and calculate Compass tilt-compensated and more accurate output.

Why do we use tilt compensation for compass?

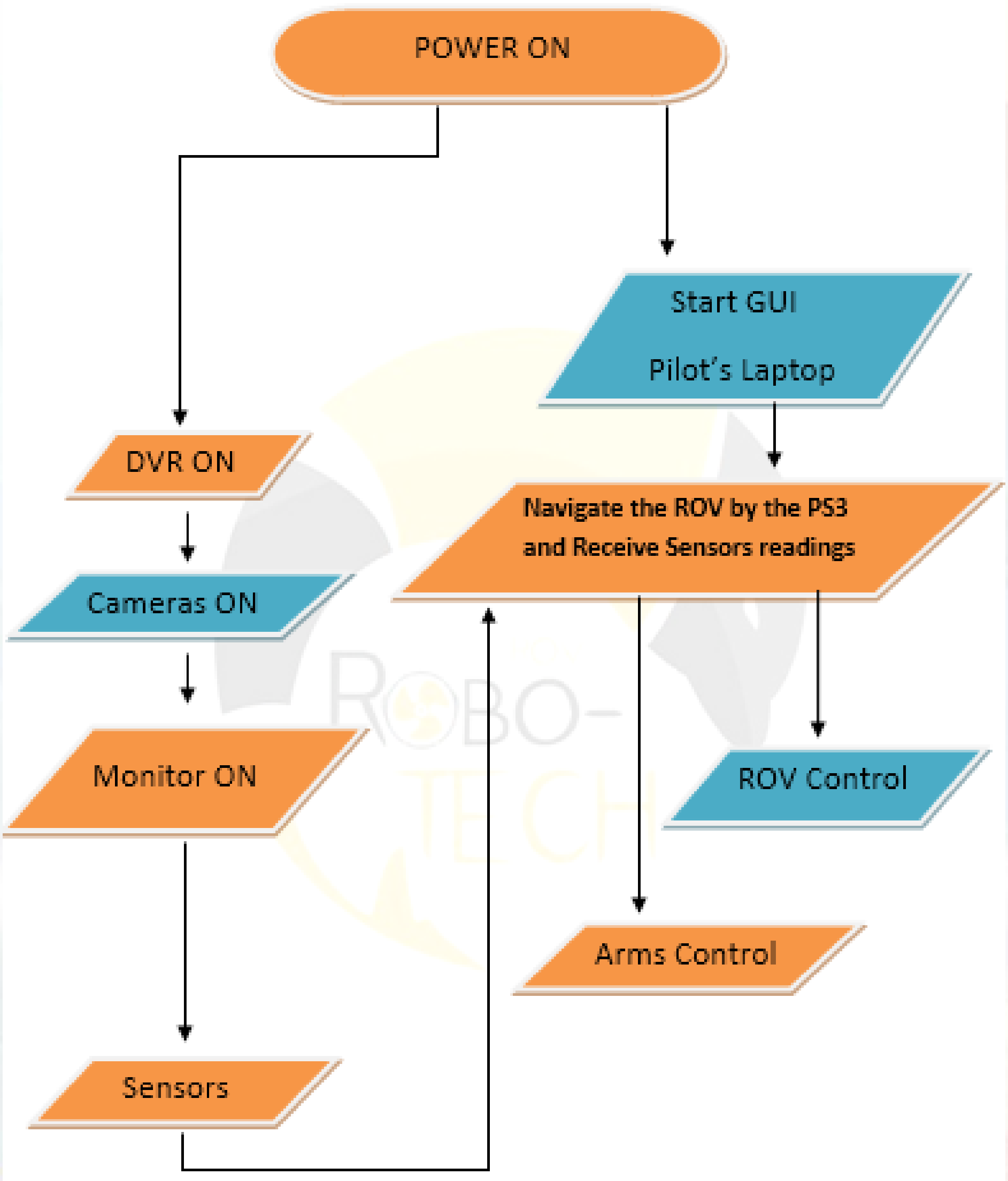
A problem that traditional compasses have is that they need to be held flat (in horizontal plane) to make correct measurements. For example, if you tilt the compass in vertical plan to 45 degrees the reading will be more inaccurate.

This problem occurs because the compass is only using the X and Y axis of the earth's magnetic field. When the compass is not parallel to these axis the amount of magnetism will change based on how out of alignment the compass is to these axis.
If however we want to be able to compensate our compass for tilt up, we will need a way to include in our calculations the third axis, Z, which (when tilted) now collects the magnetic field lost by X and Y when they are tilted out of alignment.
For that, the 3 Axis accelerometer is used. As accelerometer can measure the tilt to the earth through measuring the gravity component G.

Features

- +- 2/4/8 g dynamically selectable full-scale
- 16-bit data out
- I2C interface
- Embedded self-test capability.

8- Flow Chart :

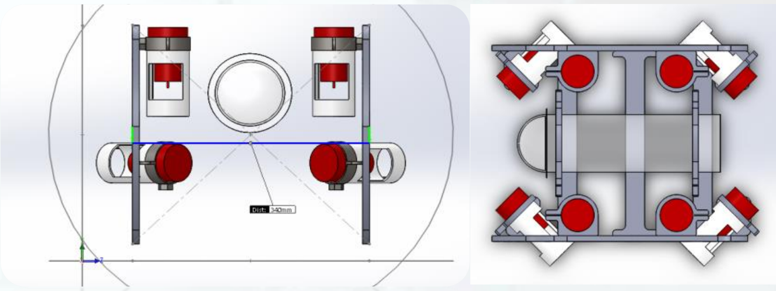

POWER ON
Start GUI
Pilot's Laptop
DVR ON
Navigate the ROV by the PS3
and Receive Sensors readings
Cameras ON
Monitor ON
ROV Control
Arms Control
Sensors

9- Thrusters:

To make our kraken looks hygiene , We use 6 motors for our ROV a Bilge pump 1100 GPH type .

Which is divided in sequence for 2 motors responsible for the vertical motion located at the edges of the ROV which is responsible for UP and Down motion

the other 4 motors are located at the edge of the ROV which are responsible for the horizontal motion and for rotation and rolling see fig (21).



fig(21)

Bilge pump 1100 GPH thrusters properties

fig(22)

Features:
1.Small size,
2. High efficiency,
3.Low current (low cost switching power supply supporting)

Description :
1.This submersible bilge pumps are tough enough for any bilge.
2.High Flow: for use from 22-234L / Min (1.32-14.04 cubic meters / hour)
3.Small size, high efficiency, low current (low cost switching power supply supporting); to achieve a small size perfect combination of high flow
4.Unique automatic “discharge” function can bear the long-term continuous operation under nearly congestion condition
Impact resistant ABS housing.
5.Heavy duty motors with stainless steel shafts and tough. thermoplastic bodies
6.Totally submersible and ignition protected.
7.To all existing safety standards.
8.Water cooled motors for long life, with anti airlock design and moisture tight seals.
9.Snap-lock strainer base for easy installation and removal and silent vibration free running.
10.No burn out if runs dry. It operates on 12V 3A see fig(22)

10- Tether

Our kraken supply is from a 12v power cable connected from the station ,Which transmit the main source of power to the entire ROV , as it deliver the power tracks all over the control box to make our little beast move around and round , it is also folded with an Ethernet cable which contain the full communication for the ROV , the Ethernet cable consists of 3 wires which are the TX ,RX ,GND, as they involve in the protocol communication between the mother board and the controller , in addition of 4 wires which involve the camera power signals and the communication signals , which are :

ETHERNET CABLE (cat 6) :

fig(23)

Wire 1 :TX

Wire 2 : RX

Wire 3 : GND

Wire 5: camera 1 +Ve supply

Wire 6 : camera 1 -Ve supply

Wire 7 : camera 2 +Ve supply

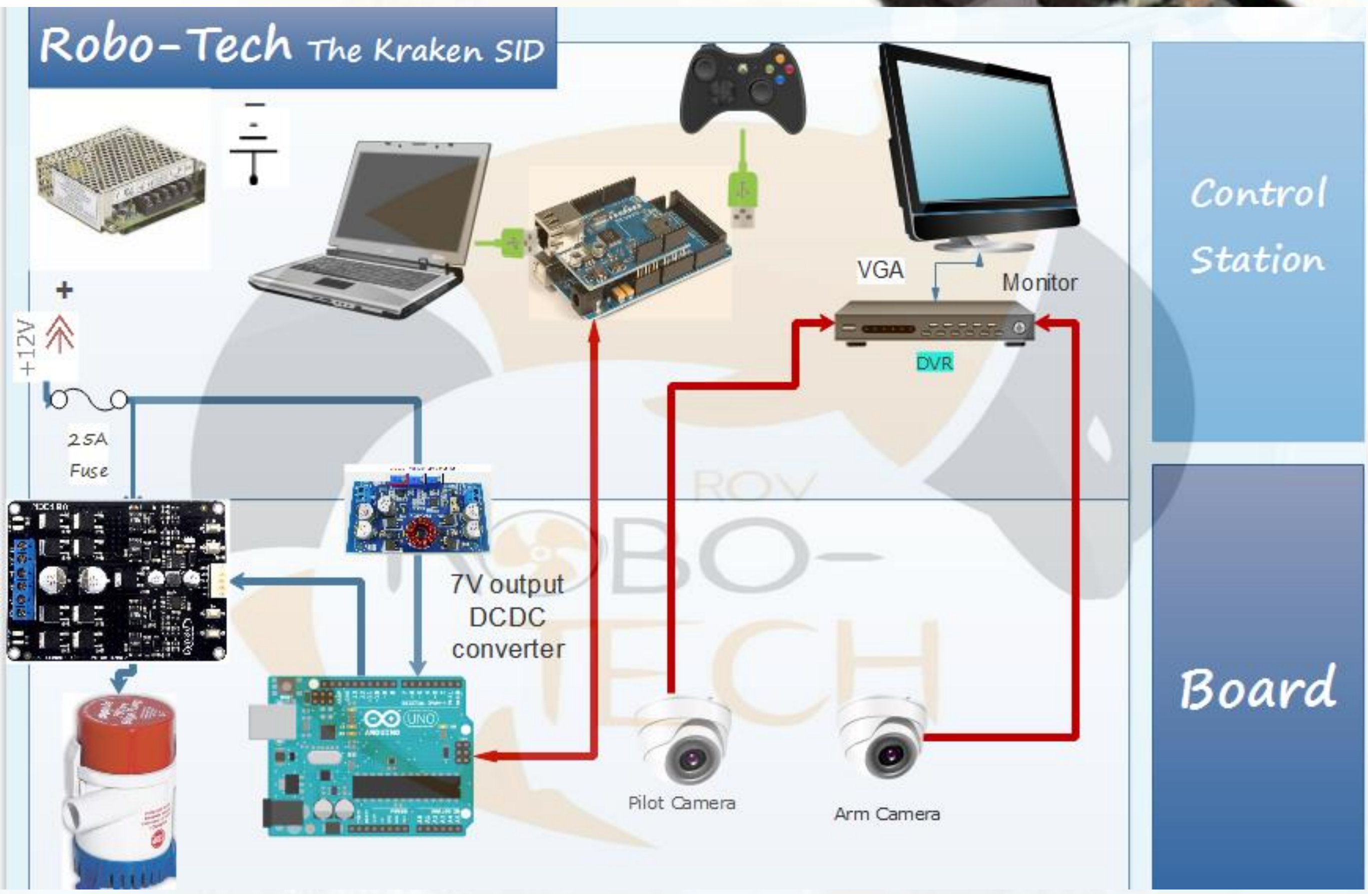
fig(24)

Wire 8 : camera 2 -Ve supply

Power supply cable :Wire 1 : 12

Wire 2 : GND see figures(23 and 24)

11- System Interconnect Diagram (SID) :see fig(25)



Fig(25)

12 – Safety :

Safety is a crucial aspect in Robo-Tech Company; mentors have trained members to deal with tools and machinery safely. In the beginning, there were minimal bruises and soldering iron first degree burns which were treated immediately using our first aid kit which is always in reach in the workspace. Later on, members got used to using them and thank God none of the company members was seriously injured. Based upon the knowledge mentors have provided, members have built these set of rules and regulation while working.

12.1 Workshop :

Providing a safe and well organized workspace helps ensure physical safety and also maximize productivity. Always making sure that there aren't any trailing cables that would cause anyone to trip and none of the tools or any object is placed on the ground; at all times our components and tools are placed orderly in the storage area. Also, if any tools were worn out or damaged -such as cutting blades or drilling bits or cutters- they are immediately replaced with newer and safer models.

12.2 Company staff

To eliminate all sources of accidents company members were committed to always have neither loose nor extremely short clothing on in addition to close toed shoes. While operating heavy machinery safety gloves and safety goggles must be worn, if the machine is loud ear protection is also a must. For instance, while using the cutting chop saw, these saws create dust, sparks, and debris, so eye protection is obliged in addition to wearing thick gloves and hearing protection

12.3 Vehicle safety

Mechanical wise Kraken's design already lacks sharp edges which helped a whole lot. Thrusters are securely attached to the frame and caution stickers are present on each propeller opening as a warning when the vehicle is on. The tether is always neatly coiled, only during the mission the tether is fully untangled to ease The Kraken's maneuverability.

Before enclosing the isolation tube we ensure that all wires are sealed and secured. A water detector sensor is installed inside the tube which automatically stops The Kraken if any leakage occurs in control box. An emergency button is placed in the driving station to shut down the system in case of any emergencies.

12.4 Fuse Calculations :

fig(26)

In worst case:
4 Bilge pump motors ON , 3 amps each 3*4 = 12 amps
2 DC motors for arm , 1 ampere for each 1*2 = 2 amps
One/two camera = 0.5 amps(Each)
Lights = 0.2 amps
Total amps = 15.2 amps X 150% = 22.8 Amps.

Then we are going to use a 25 amps Fuse
The fuse will be installed in the positive power supply line within 30 cm of the power supply attachment point.

13 -Challenges :

Non-technical:

As a corporation of 11 school student , it was hard for us to have fixed days during the week to work on, as each one of us has other responsibilities . This affected negatively the development of the company; And in order to solve this challenge , we started meeting according to the departments : electrical and mechanical. Our CEO started to discuss every department plan to finish their work as soon as possible . Yet ,this wasn't the only challenge we had ;As we were restricted by the deadlines. Thus, we had to meet nearly everyday during our mid-year holiday to finish our work and sometimes we even had to work till late night hours. One of the challenges that we also faced was the high cost of the materials used in manufacturing the vehicle , as we didn't find any financial sponsors , so we afforded everything by ourselves and by the help of our parents.

Technical:

Our company was restricted by the size and the weight of the ROV during designing it , to make it fit the 48 cm diameter circle and at the same time weigh less than 14 kg , putting in consideration the stability and buoyancy laws . To overcome this challenge, we tried our best to study every single specification in the missions and tried our best to design the ROV to be convenient to them , we also made a slider at the bottom of the vehicle to fix the arm on in order to reduce the dimensions of the vehicle . We wanted our ROV to be slightly positive buoyant , but when we tried our ROV in water it was sinking ,so we started adding blocks of foam on the top of the ROV to balance it until we have achieved our aim.

14 – Future Improvements :

The kraken is still seeking perfection and we are going to meet this through our strategy of future improvements as follows:-

Mechanical:

1)Building a manipulator with more degrees of freedom, allowing the pilot to have a more flexible control for the objects underwater.

2)Building the camera with 2 degrees of freedom , horizontally and vertically to provide the pilot with clear vision of ROV motion under water and ease his piloting as he could control the camera and what it is looking at using joystick

3)Provide the ROV with More Movements Such as Peach and Roll to perform various missions underwater.

4.Use 4 Thrusters only instead of 6 and By Using a Gear Box the 4 Horizontal thrusters are turned into 4 Vertical ones , and by this method , we would decrease number of motors , increase propulsion efficiency decrease the current consumption of our system and turn it into a more safer environment . The 4 motors will have multiple degrees of freedom in that case. This is a very good idea we got by brainstorming between the company's members and we are planning to achieve by the next year.

Electrical and Programming :
1)Decrease the diameter of our motherboard to avoid space wasting in our Kraken
2)Use I2C Protocol as it is more faster and sends data in more organized way than The UART.
3).Use C# or Python as our GUI that motors' speed and sensor readings are shown on.
4)Use Current Sensor for each thruster as one of the Safety Procedures.
5)Use Brushless motors instead of Bilge pumps acquired by ESC controllers (Electronic Speed controller circuit) to provide more powerful thrust to the entire ROV System.

15.lessons learned:

Technical:

1) We learned how to use SolidWorks for designing different Mechanical Systems.
2) As well as Eagle Software to design electrical circuit
3) Understanding the programming skills was extremely interesting and learning how to deal with microcontrollers like arduino was great.
4) We had our technical writing skills improved while writing this technical documentation.
5) We learned Adobe Photoshop to design our poster.
6) Mate competition encouraged and elaborated our creative and critical thinking, and we learned how to implement and apply our ideas in real world.

Non-Technical(Interpersonal Skills):

During this amazing journey, the Kraken's team members have learnt a lot of valuable lessons. We learned how to share our ideas and co-operate to come up with the best output without leaving anyone behind "we learned how to work in a team". We had also learned that time is an important factor that shouldn't be ignored .Thus; we learned how to improve our time management skills by balancing between school and working on our product.

ROBO-TECH

16-Budget

The Kraken

Category	Expense	Source/Note	Unit price	Quantity	Total
Mechanics	Acrylic tube	Putting every electric component Inside it	19.5$	1	**19.5$**
	Sheet Polyethylene	Used for making the vehicle frame	60$	---	**60$**
	Frame cutting	(CNC) laser cutter	40$	---	**40$**
	court nozzle	Used as a guard for safety precautions	0.5$	6	**3$**
	propellers	Used for vehicle movement	3$	6	**18$**
	O-Ring	Used for sealing	0.5$	20	**10$**
	Acrylic tube sealing	Sealing electric components by two caps	14$	2	**28$**
	Sealing system	Sealing everything by putting caps and penetrator	2.5$	10	**25$**
	Balance system	Used: foam and payloads	1.5$	2	**3$**
	Bolts and nuts	Used for holding the arm and frame	0.5$	20	**10$**
	Station box		10$	1	**10$**
Electric	Mother board	Used for handling the ROV's system : micro controller – power distribution – motors	5.5$	1	**5.5$**
	Motor drivers	Used for controlling the speed and directions of the motors	27.5$	4	**110$**
	Arduinos : Uno and Mega 2560	Used for sending and receiving and transmitting data from the station and to the ROV	30$	2	**60$**
	Bilge pump	Responsible for the Energy given to the thrusters	35$	6	**210$**
	Dc motor	Responsible for the Gripper movement	10$	2	**20$**
	Dc Buck converter	Convert 12V to 7v for the microcontrollers	3$	1	**3$**
	Joy stick	Responsible for the ROV movement from the station	10$	1	**10$**
	DVR	The connection device between cameras and the screen	30$	1	**30$**
sensors	Analog Dahua camera	Responsible for the Visual view	15$	1	**15$**
Total cost			**690$**		

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Category	Expense	Source/Note	Unit price	Quantity	Total
General	Local competition fees	the entry fees for the competition and for the transportation costs	150$	1	**150$**
	Regional competition	the entry fees for the competition and for the transportation costs	200$	1	**200$**
	International Travel fees	The reservation costs and the accommodation	850$	11	**9350$**
	The ROV total cost	The cost of the all components inside the ROV	960$	1	**960$**
Total budget			**10660$**		

17 - Timeline :

DATE		Activities done during this period
6th October	10th Nov.	Training sessions
10th Nov.	25th Dec.	Researching: 1- Mechanical and Electrical Tools 2-Workshops , cutting workplaces
25th Dec.	27th Jan.	EXAM PERIOD
27TH Jan.	10th Feb.	1-Mechanical design finished 2-Mechanical parts fixed 3-The Mechanical Frame is finished 4-make and develop code
10th Feb.	14th Feb.	1-Video preparations and settings 2- Test and find problems
15th Feb.	20th Feb.	Fix problems and Development our rov
20th Feb.	27th Feb.	**Preparation to local Competition** 1-test our rov 2-pilot and co-pilot Training 3-fixed code problems
27th Feb.		**local Competition**
27th Feb.	10thMar.	Find problems in local competition Fix design problems
10thMar.	20thMar.	**Preparation to Regional Competition** 1-test our rov 2-fixed code problems 3- design the poster 4-making report and space sheet
20thMar.	6thApril.	1-pilot and co-pilot Training 2- fix problems
6thApril.		**Regional Competition**

References:

1) "The ROV Manual : A User Guide For Observation-Class Remotely

Operated Vehicles " , Robert D.Christ and Robert L. Wernli Sr. , 2nd Ed.

2) ROV competition
Marine Advance Technology Education .see fig(27)

http://marinetech.org/rov-competition

fig(27)

19–Acknowledgments:

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