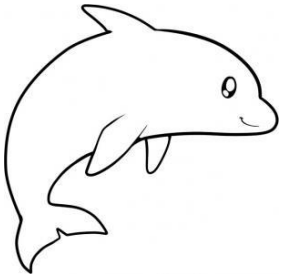
Software Engineering Project Report



The Dolphin

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CS 440 Fall 2017

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Date	Participants	Activities	Notes

I Project Description

1 Project Overview

The product is a diving helmet that provides the wearer with an overhead display projected onto the glass. This display will provide information valuable to divers, such as dive time remaining based on volume of air left in tank, dive depth, sonar map, and alerts to warn the user of perceivable danger. The product will include technology for collecting the various information to be displayed.

2 The Purpose of the Project

2a The User Business or Background of the Project Effort

Safety has become a growing issue in this leisurely activity, and with utilizing our product, we work towards making this activity more enjoyable, as well as safe, to all who participate.

Our product aims to provide scuba divers with a significantly less error-prone technology than compared to what is on today's market. We strive to bring efficiency to all of our users; whether they are just beginning to get into the activity or have had years of experience. Our product achieves this by lessening the amount of responsibility issued to the divers themselves. The diver will no longer be required to manually keep track of their depth below the surface, nor will they have to calculate their own airtime. This will all be done by our product, allowing the consumer to focus on other life-threatening factors that happen in such environments.

The environment that is required for this activity can sometimes be hundreds of meters below the water surface. A diver is essentially isolated to their own wits and intuition. Having so many other distractions and hazards, it would help have certain measurements and calculations completed for the divers instead of them manually keeping track themselves.

2b Goals of the Project

This product came into existence due to our team discovering the high risks involved with modern scuba diving. The lack of attention to this activity has been pushed to its technological limitations and is an issue that needed light shed to it. Many of our underwater counterparts have not yet been explored due to the limited scuba technology available on the market.Our product will bridge this technological gap.

We strive to continue to create a user-friendly product that increases the safety and efficiency associated with this activity.

We want to display a hands-free informational overhead projected onto the glass of the diving helmet. This information screen will output carefully calculated and helpful data directly on the helmet to the user. It will give users calculations made such as their current depth, as well as the amount of air they have remaining in their tanks.

2c Measurement

With the success of our product, we will hopefully see an increase in novice scuba divers, as well as in experienced divers.We will also be looking to measure the effectiveness and reach of our product.This is to say that we want to reach all ranges of divers. Our goal is to determine how and where our product is being used (i.e is it being used by new users attending scuba diving classes or by professionals who partake in this activity as a career). Depending on who purchases our product and for what reason, we will be able to determine if consumers believe it brings efficiency to the activity. We will also measure our customer satisfaction by administering surveys and determining whether our product is in use long-term and for what depths the product is being used for. If the result is having more divers achieving increasingly high depths, we will know that our product has increased efficiency. If we see more novice users buying our products, it will potentially reflect the safety reputation associated with this product.

3 The Scope of the Work

3a The Current Situation

The current world of divers use a basic scuba mask with a bodysuit and air tank. The mask is very basic and only keeps water out while allowing the user to see underwater. The bodysuit is skin tight to reduce water drag when diving and to prevent getting caught on objects underwater. The typical air tanks that are used today are around 80cu.ft. compressed at 3000 psi. This would typically last a diver around 45-60 minutes under water at around a 40 ft dive. Divers will roughly use twice the amount of air at around 33 ft depth compared to at the surface and this increases with more depth. Currently divers use a dive watch, a depth gauge, and how much pressure is left in the air tank to determine how long they have left under water. However this requires them to do the math while diving.

3b The Context of the Work

The diving mask that we are trying to develope is targeted towards divers in general however it can have multiple applications among the divers. For recreational diving it is possible to observe your surrounding using your body mounted sonar so that you will be able to know what is around you. The mask will also display the amount of air remaining along with a clock so that you know when you have to return to the surface. This can also be taken to deep diving or structural diving. The amount of air time remaining will automatically be calculated for you and with the ondisplay clock, they will be able to tell how much time is left of their dive. The body mounted sonar will also help with observing the surrounding as sunlight depreciate as you go deeper but will also help in clustered areas such as in structural diving.

3c Work Partitioning

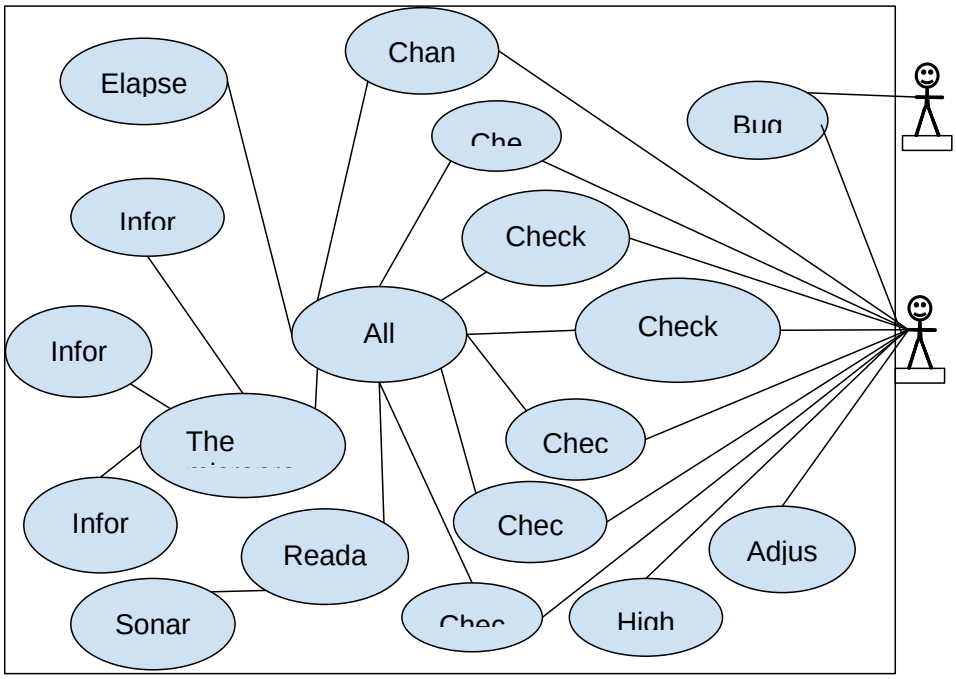
Event	Response	Summary
Air time remaining	Calculate amount of air remaining in air tank	Calculates the air time remaining using current depth, air tank capacity, and current air tank pressure
Dive time elapsed	Displays amount of time spent diving	The time spent underwater diving is projected onto the mask
Surrounding map	Creates a sonar map of the surroundings	The sonar will emit frequencies and create images upon the return of the frequencies
UI display on mask	The mask will display all relevant info	Displays all vital informations onto projection

3d Competing Products

There are only two off the shelf product out there currently that is similar to our product. First is the Aeris Compu Mask HUD, and second is the Oceanic Data Mask HUD. Both of these mask are very similar, they both use a small LCD screen at the bottom of the mask to display information. The information they display are current depth, elapsed dive time, cylinder pressure, and dive time remaining. They also include a feature to allow the diver to replace the battery for the microprocessor.

4 The Scope of the Product

4a Scenario Diagram(s)



4b Product Scenario List

1. Recreational diver Bob:
    a. Bob is in shallow water and does not want to worry about decompression. After putting his mask on, he set the HUD to the proper settings and goes underwater. Everything is working correctly so far. Bob has been underwater for 5 minutes and decides to check his remaining oxygen levels. They are low but fine. Bob, being the adventurer he is, decides to go a little deeper into the water. He eventually finds himself very deep and gets an immediate warning of remaining oxygen levels. He did not plan to be underneath for so long and is glad that the HUD has alerted him of his oxygen levels with ample time to get back to the surface.
2. Deep diver Sally:
    a. Sally is doing marine research on a very rare species residing deep within an underground cave. She is having seconds thoughts upon entering the cave due to its darkness. She immediately raises the light to the HUD display so she can better see her vitals. Sally also adjust her light to see within the cave a little better, however this isn't enough to know where the nest of the species is located. The nest is supposedly very huge and is usually a blockage seen within the cave. Sally uses her sonar mapping to map the cave and locate the nest. The

images returned to her show a huge blockage just a few yards ahead. Sally goes towards this area and is able to locate the harmless rare species' nest. Success for Sally!

3. Structural diving - divers go into small and enclosed areas that are likely to be dark and cluttered

4c Individual Product Scenarios

Users will be able to use the mask without much instruction needed. They will put it on and it will automatically activate once the diver is in the water. It will display the clock, dive time elapsed, dive time remaining, current depth, air tank water pressure, and a sonar map. There will be two physical button on the mask, one that will allow for adjustment of the brightness on the display in case the user wants to make the projections brighter or dimmer. This is optional since the mask will automatically dim the projections depending on the brightness of the surrounding. The other button will switch between imperial and metric units for the convenience of divers.

5 Stakeholders

5a The Client

We plan to work with the American Academy of Underwater Sciences (AAUS) as the client. The AAUS's mission is "to advance and facilitate safe and productive scientific diving." As they set standards for safe diving, we feel it is important to work closely with them to set a standard that ensures our product is as safe as possible for our customers.

5b The Customer

The intended customers are scuba divers. Such a customer would benefit from having such vital information displayed to them in an unobtrusive way. These benefits should be apparent to the customer.

5c Hands-On Users of the Product

Archaeologist Divers:
Role: Research sunk boats and structures
Experience: Master level in archaeologist and diving gear
Technological level: Novice-Journeyman depending on the diver

Deep Divers:
Role: Divers that dive deeper than the commonly accepted limit
Experience: Master in diving (certification is typically required for deep diving)
Technological Level: Novice-Journeyman

Recreational Divers

Role: Dive for fun
Experience: Novices, Journeymen, and Masters
Technological Level: Novice-Journeyman

5d Priorities Assigned to Users

The system is designed with the archaeologist divers and deep divers in mind, but it is still functional for recreational divers.

5e User Participation

We expect archeologist and deep divers to provide usability requirements and help us with prototyping.

5f Maintenance Users and Service Technicians

We will maintain the software embedded in the product. We expect the users to provide maintenance to the product hardware themselves.

5g Other Stakeholders

Scuba instructors should be prepared to teach others how to use our product.
Militaries may also be considered stakeholders, as this product could provide assistance to navy personnel.

6 Mandated Constraints

6a Solution Constraints

Description: The product shall use insulated cables.
Rationale: The product will be used underwater, and will have to be able to work under great pressure and without connection interruptions.
Fit Criterion: The product shall be IP69k certified.

Description: The product shall function without the constant interaction of the diver.
Rationale: The diver will want the information to be displayed while interacting with the surroundings, and will not be able to constantly interact with the device.
Fit Criterion: The product will display the each time the sonar detects something.

Description: The battery shall be able to supply energy to all parts of the product.
Rationale: The product will contain many devices that will be used to display important information to the diver.
Fit Criterion: The battery will have to supply energy to all devices for about 2 to 3 hours.

Description: The product shall have a sonar that can detect objects at a distance.

Rationale: The diver will be using the product to detect if an animal or object is approaching him/her, and the diver has to have time to act.
Fit Criterion: The product shall have a sonar that can at least detect at objects 100 meters away.

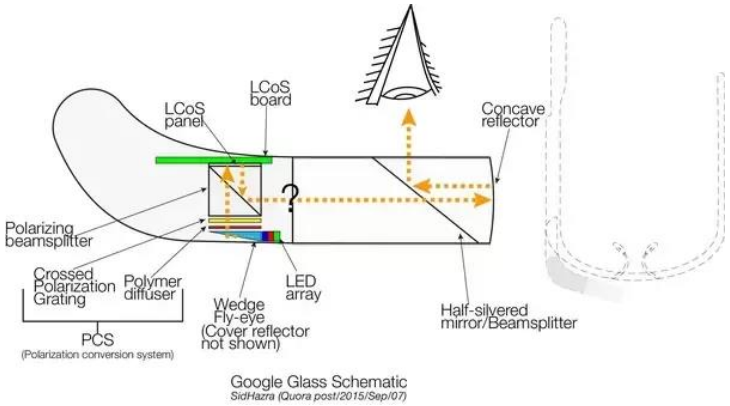
Description: The product shall withstand high pressure.
Rationale: The product will be used underwater and will have to be able to work under great pressure.
Fit Criterion: The product shall be able to withstand distances underwater of 100 meters.

Description: The product shall combine the image of the area around the diver taking into account the divers movement.
Rationale: The product will be used by a diver which will be moving, and the image will be displayed incorrectly if the software does not take into account the movement.
Fit Criterion: The product shall be combine and display the image in real time.

Description: The product shall have a sonar that is small and light enough to be weared on the diver's head and back.
Rationale: The product will be a heavy burden to the diver if the sonar is too heavy.
Fit Criterion: The product shall be about the size of the palm of a hand.

6b Implementation Environment of the Current System

Google Glass Design

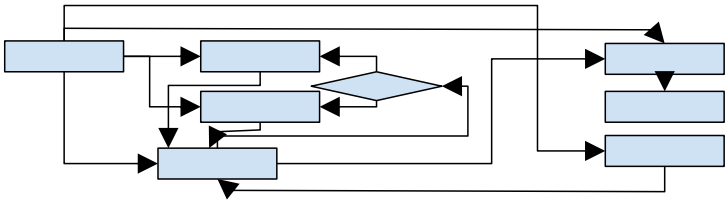


Google Glass Schematic
SidHazra (Quora post/2015/Sep/07)

The system will use an image projection similar to google glass, but the system will use a larger glass. The glass will also have to resist the water pressure and will be the glass that will go on the full face mask.

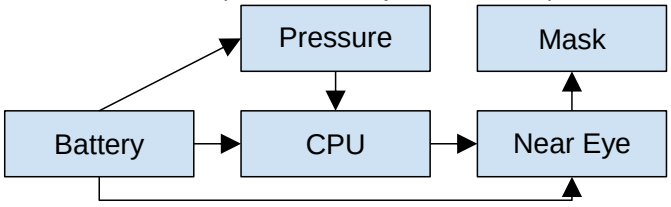
Interaction of the Components in the System for the Sonar

The system will have two rotational



sonar. One of the sonars will go on the diver's head to cover the area around the diver for when in vertical position. The second sonar will be hooked up on the back side of the diver, where the straps that maintain the oxygen tank in place for when in horizontal position. Furthermore, the sonars will communicate with the CPU in the product which will be in charge of telling the sonars to send waves, do calculations to determine the distance and speed of the object, and will then process, combine, and send the image, distance, and speed of the objects to the Near Eye Display which will then project the image to the glass which is located in the diver's mask. In addition, the gyroscope sensor will inform the CPU of what orientation the diver is and then the CPU will turn on and off the correct sonar, and ask for the image that the sonar picked up. Also, the battery will have to supply energy to the CPU, rotational sonars, gyroscope sensor, and the Near Eye Display. Finally, all the components will be connected with insulated cables.

Interaction of the Components in the System for the Depth



The system will also have a pressure sensor which will send information to the CPU which will determine the depth of the diver in the water and send the information to the Near Eye Display. Also, the battery will have to supply energy to the CPU, pressure sensor, and Near Eye Display. Finally, all the components will be connected with insulated cables.

6c Partner or Collaborative Applications

The application that this system will be using will be an application that is based on the current software that is used currently to combine images taken by the sonar, but this application will have to be modified to combine the images in real time and correct the images automatically in the cases where the diver changes direction. The current software can only correct the images after the images are collected, and it takes sometime since it requires some interaction with the user. The current applications also requires the user to manually combine the images and they do not create a complete image of what was around. Therefore, this application will have to be developed or the project will have to be put on hold until it is developed.

6d Off-the-Shelf Software

The system will be using the equipment standard for diving which is mentioned in the equipment regulations for the American Academy of Underwater Sciences, but will be using a modified version of the full mask that uses a Near Eye Display system similar to the one used for the google glasses. The system will also be using a pressure sensor and gyroscope sensor that will have an IP69k certification in order to withstand the high pressures of the water. Furthermore, the system will be using a rotational sonar similar to the sensors that are mounted on the boats, but will have to be a version that is much lighter and smaller so that it can be weared on the diver's head and the back side of the straps that hold the oxygen tank.

Diving equipment standards:
https://www.aaus.org/diving_standards
How Google Glasses Work:
https://www.quora.com/How-does-Google-Glass-project-the-image-onto-the-glass

6e Anticipated Workplace Environment

The product will be running in an underwater environment where it will also have to withstand high pressure. Also, the diver will be swimming in areas ranging from being really shallow to really deep (about 100 meters). The product will also have to withstand long hours since divers can stay many hours enjoying or researching the area underwater. Furthermore, the product will be constantly moving since the diver will be swimming around the water, so the program will have to take this into account when calculating the distance and velocity of the objects around the diver, and when displaying the image of the area around the diver.

6f Schedule Constraints

The sonar portion of the system will be put on hold until the application in charge of combining the images is developed since the system will not be able to display a helpful image of the surroundings without a functioning application.
The Near Eye Display will be the first component that will be implemented to the system since the main function for the system is to display important information to the diver.
The pressure sensor portion will be the second component to be implemented since the hardware is readily available, and will give the client a useful function in the case that the sonar portion is delayed.

The application that will calculates the the diver's depth using the exterior pressure sensor, the oxygen level in the oxygen tank, and the time left before the oxygen tank is empty will be designed after the implementation of the pressure sensor to the suit since this application will be necessary to display this information.
The implementation of the gyroscope sensor will also be delayed until the application in charge of combining the images is developed since the gyroscope sensor will only be used to switch between the top and back rotational sensors.

6g Budget Constraints

The project budget is 2 million dollars.

7 Naming Conventions and Definitions

7a Definitions of Key Terms

Scuba Diving - a form of underwater diving where the diver uses a self-contained underwater breathing apparatus (scuba) which is completely independent of surface supply, to breathe underwater.

Scuba Mask - A diving mask (also half mask or dive mask) is an item of diving equipment that allows underwater divers, including,scuba divers, free-divers, and snorkelers to see clearly underwater.

Air Tank - Used by scuba divers to hold air and other breathing gases at high pressure underwater.

Diver- a person who stays underwater for long periods by having air supplied from the surface or by carrying a supply of compressed air.

Deep Diving - Underwater diving to a depth beyond the norm accepted by the associated community. It is diving in depths that go beyond 30 meters and not exceeding 100 meters.

Rotational Sonar - A sonar system that rotates and creates a circular image of the surrounding area.

7b UML and Other Notation Used in This Document.

N/A

7c Data Dictionary for Any Included Models

N/A

8 Relevant Facts and Assumptions

8a Facts

- The software to combine the images correctly in real time does not exist at the moment.
- The maximum depth that a deep diver can go is 100 meters.
- The maximum depth that a recreational diver can go is 30 meters.
- The time that a diver can be underwater:

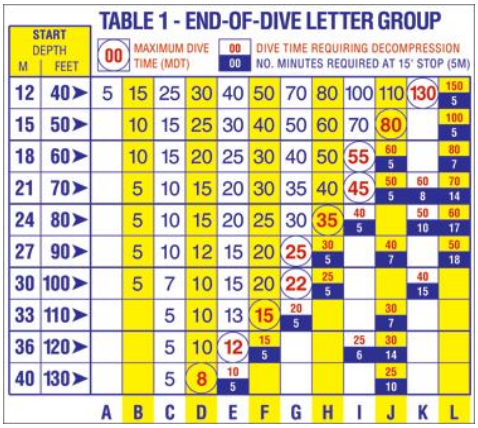


TABLE 1 - END-OF-DIVE LETTER GROUP

START DEPTH M	START DEPTH FEET	A	B	C	D	E	F	G	H	I	J	K	L
12	40	5	15	25	30	40	50	70	80	100	110	130	150 / 5
15	50		10	15	25	30	40	50	60	70	80		100 / 5
18	60		10	15	20	25	30	40	50	55	60 / 5		80 / 7
21	70		5	10	15	20	30	35	40	45	50 / 5	60 / 8	70 / 14
24	80		5	10	15	20	25	30	35	40 / 5		50 / 10	60 / 17
27	90		5	10	12	15	20	25	30 / 5		40 / 7		50 / 18
30	100		5	7	10	15	20	22	25 / 5			40 / 15	
33	110			5	10	13	15	20 / 5			30 / 7		
36	120			5	10	12	15 / 5			25 / 6	30 / 14		
40	130			5	8	10 / 5					25 / 10		

00 = MAXIMUM DIVE TIME (MDT)

00 / 00 = DIVE TIME REQUIRING DECOMPRESSION / NO. MINUTES REQUIRED AT 15' STOP (5M)

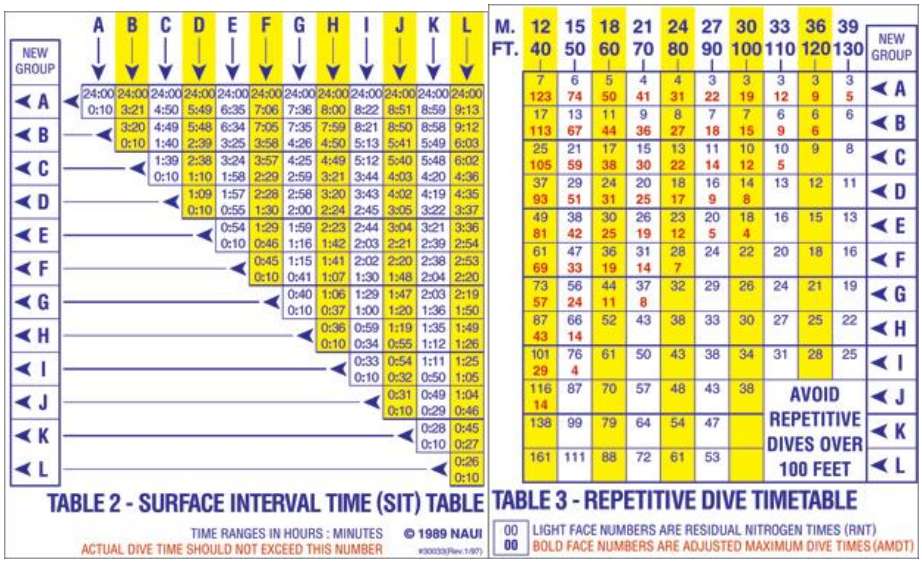


TABLE 2 - SURFACE INTERVAL TIME (SIT) TABLE

NEW GROUP	A	B	C	D	E	F	G	H	I	J	K	L
A	24:00 / 0:10	24:00 / 3:21	24:00 / 4:50	24:00 / 5:49	24:00 / 6:35	24:00 / 7:06	24:00 / 7:36	24:00 / 8:00	24:00 / 8:22	24:00 / 8:51	24:00 / 8:59	24:00 / 9:13
B		3:20 / 0:10	4:49 / 1:40	5:48 / 2:39	6:34 / 3:25	7:05 / 3:58	7:35 / 4:26	7:59 / 4:50	8:21 / 5:13	8:50 / 5:41	8:58 / 5:49	9:12 / 6:03
C			1:39 / 0:10	2:38 / 1:10	3:24 / 1:58	3:57 / 2:29	4:25 / 2:59	4:49 / 3:21	5:12 / 3:44	5:40 / 4:03	5:48 / 4:20	6:02 / 4:36
D				1:09 / 0:10	1:57 / 0:55	2:28 / 1:30	2:58 / 2:00	3:20 / 2:24	3:43 / 2:45	4:02 / 3:05	4:19 / 3:22	4:35 / 3:37
E					0:54 / 0:10	1:29 / 0:46	1:59 / 1:16	2:23 / 1:42	2:44 / 2:03	3:04 / 2:21	3:21 / 2:39	3:36 / 2:54
F						0:45 / 0:10	1:15 / 0:41	1:41 / 1:07	2:02 / 1:30	2:20 / 1:48	2:38 / 2:04	2:53 / 2:20
G							0:40 / 0:10	1:06 / 0:37	1:29 / 1:00	1:47 / 1:20	2:03 / 1:36	2:19 / 1:50
H								0:36 / 0:10	0:59 / 0:34	1:19 / 0:55	1:35 / 1:12	1:49 / 1:26
I									0:33 / 0:10	0:54 / 0:32	1:11 / 0:50	1:25 / 1:05
J										0:31 / 0:10	0:49 / 0:29	1:04 / 0:46
K											0:28 / 0:10	0:45 / 0:27
L												0:26 / 0:10

TIME RANGES IN HOURS : MINUTES

ACTUAL DIVE TIME SHOULD NOT EXCEED THIS NUMBER

TABLE 3 - REPETITIVE DIVE TIMETABLE

NEW GROUP	M. FT. 12 40	15 50	18 60	21 70	24 80	27 90	30 100	33 110	36 120	39 130
A	7 / 123	6 / 74	5 / 50	4 / 41	4 / 31	3 / 22	3 / 19	3 / 12	3 / 9	3 / 5
B	17 / 113	13 / 67	11 / 44	9 / 36	8 / 27	7 / 18	7 / 15	6 / 9	6 / 6	6
C	25 / 105	21 / 59	17 / 38	15 / 30	13 / 22	11 / 14	10 / 12	10 / 5	9	8
D	37 / 93	29 / 51	24 / 31	20 / 25	18 / 17	16 / 9	14 / 8	13	12	11
E	49 / 81	38 / 42	30 / 25	26 / 19	23 / 12	20 / 5	18 / 4	16	15	13
F	61 / 69	47 / 33	36 / 19	31 / 14	28 / 7	24	22	20	18	16
G	73 / 57	56 / 24	44 / 11	37 / 8	32	29	26	24	21	19
H	87 / 43	66 / 14	52	43	38	33	30	27	25	22
I	101 / 29	76 / 4	61	50	43	38	34	31	28	25
J	116 / 14	87	70	57	48	43	38	AVOID REPETITIVE DIVES OVER 100 FEET		
K	138	99	79	64	54	47				
L	161	111	88	72	61	53				

00 = LIGHT FACE NUMBERS ARE RESIDUAL NITROGEN TIMES (RNT)

00 = BOLD FACE NUMBERS ARE ADJUSTED MAXIMUM DIVE TIMES (AMDT)

8b Assumptions

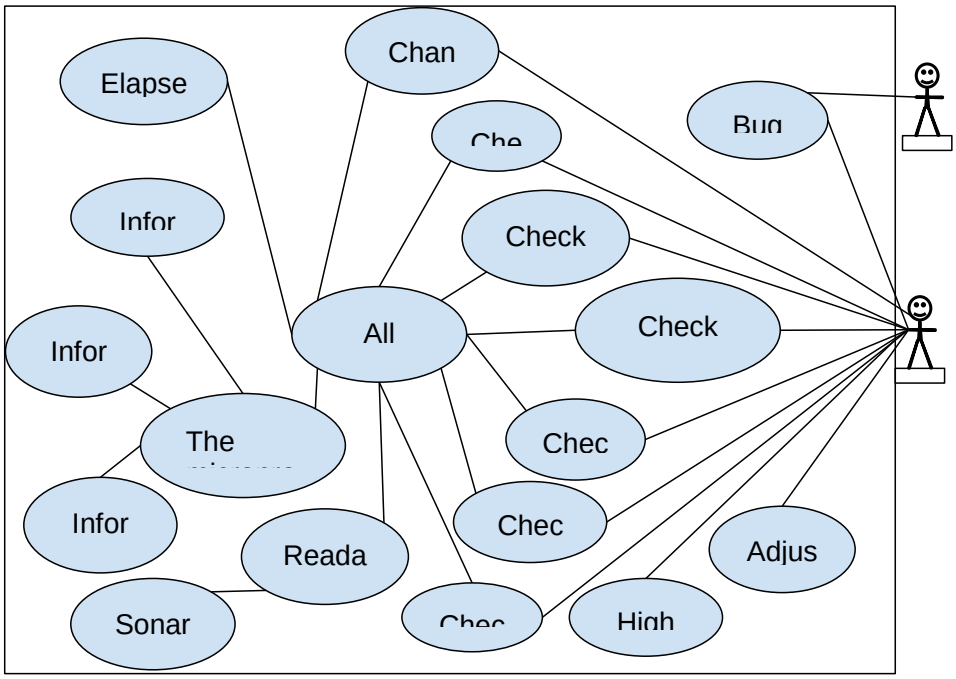
- The software to combine the images in real time will developed in a near future.

- The rotational sonar with a small size and lightweight exists or will be developed in a near future.
- The system will be used for deep diving, so the equipment is expected to work in deep waters.
- The battery is expected to last at least the time that the oxygen tank lasts.
- The system is expected to not shock the diver.
- The mask is expected to be a full face mask.
- The image of the surrounding and the information is expected to not interfere with the divers visibility.
- An image display will be added to the full face scuba mask that already exists.
- The sonars will be placed on the diver's head and on the straps that hold the oxygen tank.
- The system will be have the option of switching between imperial and metric units for the convenience of divers.

II Requirements

9 Product Use Cases

9a Use Case Diagrams



9b Product Use Case List

PUC No	PUC Name	Actor/s	Input & Output
0001	Increase Brightness	Diver	Increase Brightness Button(in) Brightness Increased(out)
0002	Decrease Brightness	Diver	Decrease Brightness Button(in) Brightness Increased(out)
0003	Check Depth	Diver	Depth Level(out)
0004	Check Time Remaining of Oxygen	Diver	Time Left(out)
0005	Check Elapsed Time.	Diver	Elapsed Time(out)
0006	Check Oxygen Tank Level	Diver	Tank Level(out)
0007	Check Sonar Mapping	Diver	Sonar Mapping(out)
0008	Check All Information.	Diver	Sonar Mapping(out) Depth Level(out)

			Time Left(out) Elapsed Time(out) Tank Level(out)
0009	Changing Measurements	Diver	Long pressing brightness Up Button(in) Long Pressing Brightness Down Button(in) Changed Measurements(out)
0010	High Pressure Usage	Diver	HUD Displays Correct Information(out) System Does Not Break(out)
0011	Bug Fixes	User	Report Bug(in) System Updated(out)

9c Individual Product Use Cases

Use case ID: 0001 **Name:** Increase Brightness
pre-conditions: System's HUD is on.
post-conditions: HUD brightness is higher.
Initiated by: Diver
Triggering Event: Diver presses the Increase Brightness Button.
Additional Actors: N/A
Sequence of Events:

1. The diver presses the Increase Brightness Button.
2. The system sends to the HUD the command to increase the brightness.
3. The HUD increases the intensity of the light.
4. The diver perceives the screen as brighter.

Alternatives: PUC #0002, the screen stays in the same brightness since it has reached the maximum brightness.
Exceptions: N/A

Use case ID: 0002 **Name:** Decrease Brightness
pre-conditions: System's HUD is on.
post-conditions: HUD brightness is lower..
Initiated by: Diver
Triggering Event: Diver presses the Decrease Brightness Button.
Additional Actors: N/A
Sequence of Events:

1. The diver presses the Decrease Brightness Button.
2. The system sends to the HUD the command to decrease the brightness.
3. The HUD decreases the intensity of the light.
4. The diver perceives the screen as dimmer.

Alternatives: PUC #0001, the screen stays in the same brightness since it has reached the minimum brightness.
Exceptions: N/A

Use case ID: 0003 **Name:** Check Depth
pre-conditions: Diver is in the water, system's HUD is on.
post-conditions: HUD displays the depth.
Initiated by: Diver
Triggering Event: Turning the system on.
Additional Actors: N/A
Sequence of Events:

1. The diver turns on the system.
2. The system asks the pressure sensor for the pressure level it is detecting.
3. The pressure sends the data to the microprocessor.
4. The microprocessor calculates the depth level.
5. The microprocessor sends the value to the HUD.
6. The HUD displays the depth level.
7. The diver sees the depth level.

Alternatives: N/A
Exceptions: N/A

Use case ID: 0004 **Name:** Check Time Remaining of Oxygen
pre-conditions: System's HUD is on, the oxygen tank is hooked up to the sensors.
post-conditions: HUD displays time remaining before the oxygen runs out.
Initiated by: Diver
Triggering Event: Turning the system on.
Additional Actors: N/A
Sequence of Events:

1. The diver turns on the system.
2. The system asks the pressure sensor on the oxygen tank for the pressure level it is detecting.
3. The pressure sends the data to the microprocessor.
4. The microprocessor calculates the time remaining before the oxygen tank runs out of oxygen.
5. The microprocessor sends the value to the HUD.
6. The HUD displays the time remaining before the oxygen tank runs out of oxygen.
7. The diver sees the time.

Alternatives: N/A
Exceptions: N/A

Use case ID: 0005 **Name:** Check Elapsed Time.
pre-conditions: System's HUD is on.
post-conditions: HUD displays the time that has elapsed since the system turned on.
Initiated by: Diver

Triggering Event: Turning the system on.
Additional Actors: N/A
Sequence of Events:

1. The diver turns on the system.
2. The system asks for the time from the timer program.
3. The timer program sends the time to the HUD.
4. The HUD displays the time.
5. The diver sees the time.

Alternatives: N/A
Exceptions: N/A

Use case ID: 0006 **Name:** Check Oxygen Tank Level.
pre-conditions: System's HUD is on, oxygen tank is hooked up to the sensors.
post-conditions: HUD displays the current oxygen level in the tank.
Initiated by: Diver
Triggering Event: Turning the system on.
Additional Actors: N/A
Sequence of Events:

1. The diver turns on the system.
2. The system asks the pressure sensor on the oxygen tank for the pressure level it is detecting.
3. The pressure sends the data to the microprocessor.
4. The microprocessor calculates the oxygen remaining.
5. The microprocessor sends the value to the HUD.
6. The HUD displays the oxygen level.
7. The diver sees the oxygen level.

Alternatives: N/A
Exceptions: N/A

Use case ID: 0007 **Name:** Check Sonar Mapping.
pre-conditions: System's HUD is on, sonar is hooked up to the system.
post-conditions: HUD displays the sonar mapping.
Initiated by: Diver
Triggering Event: Turning the system on.
Additional Actors: N/A
Sequence of Events:

1. The diver turns on the system.
2. The system asks the sonar for the Images it creates from what it detected.
3. The sonar sends the data to the microprocessor.
4. The microprocessor combines and corrects the images.
5. The microprocessor sends the image to the HUD.
6. The HUD displays the sonar mapping.
7. The diver sees the sonar mapping.

Alternatives: N/A

Exceptions: N/A

Use case ID: 0008 **Name:** Check All Information.
pre-conditions: System's HUD is on, sonar is hooked up to the system, oxygen tank is hooked up to the sensors.
post-conditions: The HUD displays the sonar mapping, depth level, time left before the oxygen runs up, elapsed time since the system was turned on, oxygen level in the tank,
Initiated by: Diver
Triggering Event: Turning the system on.
Additional Actors: N/A
Sequence of Events:

1. The diver turns on the system.
2. The system asks the pressure sensor on the oxygen tank for the pressure level it is detecting.
3. The pressure sends the data to the microprocessor.
4. The microprocessor calculates the oxygen remaining.
5. The microprocessor sends the value to the HUD.
6. The HUD displays the oxygen level.
7. The diver sees the oxygen level.
8. The system asks the sonar for the Images it creates from what it detected.
9. The sonar sends the data to the microprocessor.
10. The microprocessor combines and corrects the images.
11. The microprocessor sends the image to the HUD.
12. The HUD displays the sonar mapping.
13. The diver sees the sonar mapping.
14. The system asks for the time from the timer program.
15. The timer program sends the time to the HUD.
16. The HUD displays the time.
17. The diver sees the time.
18. The system asks the pressure sensor on the oxygen tank for the pressure level it is detecting.
19. The pressure sends the data to the microprocessor.
20. The microprocessor calculates the time remaining before the oxygen tank runs out of oxygen.
21. The microprocessor sends the value to the HUD.
22. The HUD displays the time remaining before the oxygen tank runs out of oxygen.
23. The diver sees the time.
24. The system asks the pressure sensor for the pressure level it is detecting.
25. The pressure sends the data to the microprocessor.
26. The microprocessor calculates the depth level.
27. The microprocessor sends the value to the HUD.
28. The HUD displays the depth level.
29. The diver sees the depth level.

Alternatives: N/A

Exceptions: N/A

Use case ID: 0009 **Name:** Changing Measurements
pre-conditions: System's HUD is on.
post-conditions: HUD displays the correct units.
Initiated by: Diver
Triggering Event: Long pressing brightness up or brightness down buttons.
Additional Actors: N/A
Sequence of Events:

1. The diver turns on the system.
2. The HUD is displayed in metric units.
3. User long presses brightness down button.
4. The system changes the units to imperial.
5. The diver sees imperial units.

Alternatives:

1. The diver turns on the system.
2. The HUD is displayed in imperial units.
3. User long presses brightness up button.
4. The system changes the units to metric.
5. The diver sees metric units.

Exceptions: N/A

Use case ID: 0010 **Name:** High Pressure Usage
pre-conditions: System is on.
post-conditions: HUD displays correct information.
Initiated by: High depth
Triggering Event: Reaching ~100 meters depth
Additional Actors: N/A
Sequence of Events:

1. The system is running.
2. Diver reaches high depth of ~100 meters
3. System calculations are still correct
4. Sonar mapping is still functional
5. HUD displays information like normal

Alternatives:

1. The system is running.
2. Diver reaches high depth of ~100 meters
3. System calculations are incorrect
4. Sonar mapping loses functionality
5. HUD displays abnormal information

Exceptions: N/A

Use case ID: 0011 **Name:** Bug Fixes
pre-conditions: System has a bug

post-conditions: System bug is fixed
Initiated by: Users
Triggering Event: Bug is found
Additional Actors: N/A
Sequence of Events:

1. User finds a bug
2. User reports bug
3. Bug is fixed
4. Patch is released to fix bug
5. Users connects product to computer to download patch
6. Patch is installed and bug is fixed

Alternatives:N/A
Exceptions: N/A

10 Functional Requirements

Scale for Requirements:
1 = Highest 10 = Lowest

Requirement #: 0002 **Requirement Type:** Sonar **Event / BUC / PUC #:** 0007
Originator: Luis Hernandez **Origination Date:** 10/19/17 **Latest Update:** 10/19/17
Description: The product shall change the rotational sensor being used based on the position that the diver is in.
Rationale: The images produced by the sonars should be free from the interference of the diver and the equipment.
Fit criterion: The system will use the head rotational sonar when the diver is swimming vertically in the water. The sonar will use the back rotational sonar when the diver is swimming horizontally.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 3
Conflicts: N/A **Supporting Materials:** N/A

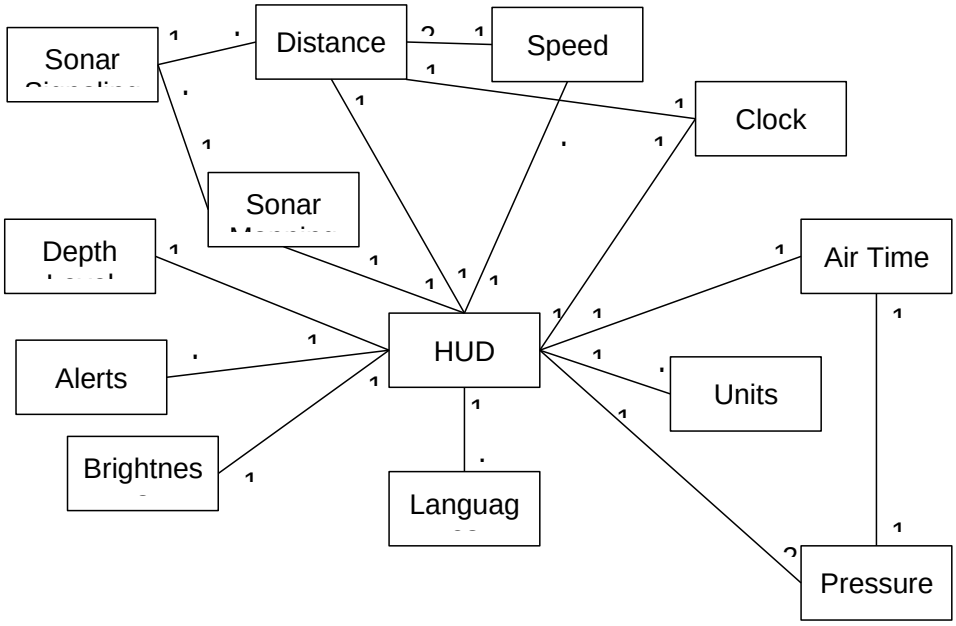
Requirement #: 0007 **Requirement Type:** HUD **Event / BUC / PUC #:**0001/0002
Originator: Luis Hernandez **Origination Date:** 10/20/17 **Latest Update:** 10/20/17
Description: The system will allow the diver to adjust the brightness of the screen.
Rationale: The environment that the diver is in will affect how clear the screen is.
Fit criterion: The HUD will be visible to the diver in pitch black and completely lighted environments.
Customer Satisfaction: 3 **Customer Dissatisfaction:** 3 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0015 **Requirement Type:** Units **Event / BUC / PUC #:** 0009

Originator: Kandyce Burks **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The system will display the data in different unit systems.
Rationale: Not all divers use the same unit system.
Fit criterion: The product will be able to switch between imperial and metric units for the convenience of divers.
Customer Satisfaction: 8 **Customer Dissatisfaction:** 8 **Priority:** 8
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0016 **Requirement Type:** HUD **Event / BUC / PUC #:** 0008
Originator: Kandyce Burks **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The system will display vitals of user onto the HUD.
Rationale: The main function of the system is to display through the HUD to the user vital information.
Fit criterion: The system will display the sonar map, air time remaining, dive depth, and air level through the HUD.
Customer Satisfaction: 3 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

11 Data Requirements



12 Performance Requirements

12a Speed and Latency Requirements

Requirement #: 0003 **Requirement Type:** Speed **Event / BUC / PUC #:** 0007
Originator: Luis Hernandez **Origination Date:** 10/19/17 **Latest Update:** 10/19/17
Description: The system will retrieve the data that the sonar picked up in real time.
Rationale: The sonar will be used to display to the diver the velocity, distance, and image of objects around the diver.
Fit criterion: The system shall retrieve the data at most every half a second.
Customer Satisfaction: 4 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0004 **Requirement Type:** Speed **Event / BUC / PUC #:** 0004
Originator: Luis Hernandez **Origination Date:** 10/20/17 **Latest Update:** 10/20/17
Description: The system will alert the diver about low oxygen with enough time for the diver to act.
Rationale: The diver will be displayed important information throughout the dive.
Fit criterion: The system shall alert the diver 20 minutes before the oxygen fully runs out.
Customer Satisfaction: 4 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0005 **Requirement Type:** Speed
Event / BUC / PUC #: 0003/ 0004/ 0005/ 0006
Originator: Luis Hernandez **Origination Date:** 10/19/17 **Latest Update:** 10/19/17
Description: The system should do all the calculations in real time.
Rationale: The diver will be in harsh conditions and will need to have the information at all times to reduce the amount of concerns.
Fit criterion: The system shall complete the calculations in at most half a second.
Customer Satisfaction: 4 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0008 **Requirement Type:** Speed **Event / BUC / PUC #:** 0007
Originator: Luis Hernandez **Origination Date:** 10/20/17 **Latest Update:** 10/20/17
Description: The system should correct and combine the images in real time.
Rationale: The diver should be able to know what is around at all times.
Fit criterion: The system shall combine and correct the images in at most a half a second.
Customer Satisfaction: 4 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0017 **Requirement Type:** Speed **Event / BUC / PUC #:** N/A
Originator: Kandyce Burks **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The response time between the user and the system should be short.
Rationale: The user will be getting important information from the system that can determine the user's safety.
Fit criterion: Maximum response time between user and system shall be at most 1.5 seconds.

Customer Satisfaction: 4 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0018 **Requirement Type:** Speed **Event / BUC / PUC #:** 0007
Originator: Kandyce Burks **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The system will do a recalibration of the sonar for proper transmission of frequency range and image creation without interruption to dependents.
Rationale: The system will have to always create accurate images and each part of the system should run without the interruption of the other parts to insure real time data.
Fit criterion: The system will do a recalibration of the sonar for proper transmission of frequency range and image creation without interruption to dependents (main system data retrieval) every 60 seconds.
Customer Satisfaction: 3 **Customer Dissatisfaction:** 1 **Priority:** 2
Conflicts: N/A **Supporting Materials:** N/A

12b Precision or Accuracy Requirements

Requirement #:0014 **Requirement Type:**Precision **Event / BUC / PUC #:**0004
Originator: Dieu Do **Origination Date:**10/31/17 **Latest Update:**11/3/17
Description: Remaining oxygen left in tank must be calculated precisely.
Rationale: Calculating the amount of air left in the tank has to be very precise every time as a miscalculation may cause the death of the diver.
Fit criterion: Remaining oxygen left in tank must be calculated to be $\pm$1 minute.
Customer Satisfaction: 3 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #:0019 **Requirement Type:**Precision **Event / BUC / PUC #:**0005
Originator: Kandyce Burks **Origination Date:**10/31/17 **Latest Update:**11/3/17
Description: Synchronized time server will be used to display the current time to user.
Rationale: Ensures accuracy and time management for user.
Fit criterion: Must be within $\pm$.1 seconds accuracy of actual time.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 5
Conflicts: N/A **Supporting Materials:** N/A

Requirement #:0020 **Requirement Type:**Precision **Event / BUC / PUC #:** 0003
Originator: Kandyce Burks **Origination Date:**10/31/17 **Latest Update:**11/3/17
Description: Calculations for depth will be at the user's choice of unit system(ft, km,mi).
Rationale: User's come from different backgrounds with different metric systems. System must reflect this.
Fit criterion: The system will give the user the choice of selecting the units for displaying depth.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 5
Conflicts: N/A **Supporting Materials:** N/A

12c Capacity Requirements

Requirement #:0031 **Requirement Type:**Capacity **Event / BUC / PUC #:** N/A
Originator: Dieu Do **Origination Date:**11/04/17 **Latest Update:**11/04/17
Description: Product should have enough memory storage to store information from sonar inputs while it process the data to be turned into a readable map.
Rationale: Converting sonar data to the map will require storing the data while processing it at the same time. This requires that there be a storage space to temporarily keep the data before it is converted.
Fit criterion: The product should have 32gb of flash storage. It is small, fast and will be enough for the data to be stored in with a little bit to spare.
Customer Satisfaction: 10 **Customer Dissatisfaction:**10 **Priority:**3
Conflicts:N/A **Supporting Materials:**Flash memory

13 Dependability Requirements

13a Reliability Requirements

Requirement #: 0029 **Requirement Type:** Reliability **Event / BUC / PUC #:**0008
Originator: Dieu Do **Origination Date:** 11/04/17 **Latest Update:**11/04/17
Description: The product should not fail, or not fail frequently.
Rationale: If product fail during use it could put users in a very dangerous situation so the fail rate for it should be extremely low.
Fit criterion: Product should fail at most once a month or it will be deemed defective.
Customer Satisfaction:8 **Customer Dissatisfaction:**1 **Priority:** 1
Conflicts:N/A **Supporting Materials:** N/A

13b Availability Requirements

Requirement #:0030 **Requirement Type:** Availability **Event / BUC / PUC #:**0008
Originator: Dieu Do **Origination Date:** 11/04/17 **Latest Update:** 11/04/17
Description: Product will be available for use whenever users dive.
Rationale: Users will only need it when they are diving and would not require it to work outside of that.
Fit criterion: Product will activate when a dive begins.
Customer Satisfaction: 10 **Customer Dissatisfaction:** 10 **Priority:**10
Conflicts:N/A **Supporting Materials:** N/A

13c Robustness or Fault-Tolerance Requirements

Requirement #:0035 **Requirement Type:**Fault-Tolerance **Event / BUC / PUC #:**0010
Originator: Dieu Do **Origination Date:**11/04/17 **Latest Update:**11/04/17
Description: Product is meant to be used up to 100 meters depth however it should be able to withstand several meters deeper than 100 meters.

Rationale: If it can withstand pressure higher than that at 100 meters depth then it should be able to withstand recommended conditions better.
Fit criterion: Product should be able to withstand of up to 130 meters depth to leave headroom for the product to operate under abnormal conditions.
Customer Satisfaction:10 **Customer Dissatisfaction:**10 **Priority:**5
Conflicts:N/A **Supporting Materials:**N/A

13d Safety-Critical Requirements

Requirement #: 0006 **Requirement Type:** Safety **Event / BUC / PUC #:** 0004
Originator: Luis Hernandez **Origination Date:** 10/20/17 **Latest Update:** 10/20/17
Description: The system should alert the diver about low oxygen with enough time for the diver to act.
Rationale: The diver needs enough time to reach the surface.
Fit criterion: The system shall alert the diver 20 minutes before the oxygen fully runs out.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0009 **Requirement Type:** Safety **Event / BUC / PUC #:** 0008
Originator: Luis Hernandez **Origination Date:** 10/20/17 **Latest Update:** 10/20/17
Description: The HUD should not block the view of the diver.
Rationale: The diver should be able to see the area in front.
Fit criterion: The HUD will not block more than 25% of the mask.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 2
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0010 **Requirement Type:** Safety **Event / BUC / PUC #:** 0010
Originator: Luis Hernandez **Origination Date:** 10/19/17 **Latest Update:** 10/19/17
Description: The system will have to withstand high pressures.
Rationale: The system will be providing information that will increase the safety of the diver. The system can also damage the user if it can't withstand the pressure.
Fit criterion: The system will have to withstand waters that are 100 meters deep.
Customer Satisfaction: 7 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0012 **Requirement Type:** Safety **Event / BUC / PUC #:** N/A
Originator: Luis Hernandez **Origination Date:** 10/20/17 **Latest Update:** 10/20/17
Description: The system will have to be waterproof.
Rationale: The system will be used underwater and will short-circuit and/or damage the diver if the water makes contact with the system.
Fit criterion: The system will have to be IP69k certified.
Customer Satisfaction: 1 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0028 **Requirement Type:** Safety **Event / BUC / PUC #:** N/A
Originator: Kandyce Burks **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The materials used to create the system must all be non-hazardous when exposed for long periods of time.
Rationale: The system will be used underwater and could cause any reactions (allergic or otherwise) to the user.
Fit criterion: Known allergenic materials must be notified to all user's before purchase.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 3 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0021 **Requirement Type:** Safety **Event / BUC / PUC #:** N/A
Originator: Kandyce Burks **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The HUD shall be offered in various size adjustments to individual users if necessary.
Rationale: If the system is too big or tight it could possible interfere with the user's ability to breath and other medical related criteria.
Fit criterion: The HUD will be offered in the sizes that scuba masks are offered.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 4
Conflicts: N/A **Supporting Materials:** N/A

14 Maintainability and Supportability Requirements

14a Maintenance Requirements

Requirement #:0025 **Requirement Type:**Maintenance **Event / BUC / PUC #:**
Originator: Dieu Do **Origination Date:**11/03/17 **Latest Update:**11/03/17
Description: Product will have a replaceable battery.
Rationale: Batteries wear down or time or sometimes are defective and we want users to have the ability to replace it themselves.
Fit criterion: A normal battery should last about a year before replacement is needed. Battery should also be able to be replaced via a simple screwdriver.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 4 **Priority:** 10
Conflicts: Waterproofness under high pressure **Supporting Materials:** O-ring, screws

14b Supportability Requirements

Requirement #: 0022 **Requirement Type:** Supportability **Event / BUC / PUC #:** N/A
Originator: Dieu Do **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The product will come with a way to know how to use and what to avoid.
Rationale: Users should have a way to figure out how to use the product and what they should avoid.
Fit criterion: The product will come shipped with a manual to explain how to use the mask as well as hazard warnings for proper usage of mask.
Customer Satisfaction: 8 **Customer Dissatisfaction:** 5 **Priority:** 5
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0023 **Requirement Type:** Supportability **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The software will have updates provided by the contracted company.
Rationale: The software is likely to have unfound bugs or new features that will not be available at release date.
Fit criterion: The contracted company will release updates when a new bug is found.
Customer Satisfaction: 3 **Customer Dissatisfaction:** 3 **Priority:** 3
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0024 **Requirement Type:** Supportability **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: The system will automatically check for updates.
Rationale: Updates are required in order to solve the bugs that appear in the software, and the user does not always remember to update the system.
Fit criterion: The mask will automatically check for updates when it is plugged into a computer.
Customer Satisfaction: 3 **Customer Dissatisfaction:** 3 **Priority:** 3
Conflicts: N/A **Supporting Materials:** N/A

14c Adaptability Requirements

Requirement #:0026 **Requirement Type:** Adaptability **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: Mask must be able to search for updates.
Rationale: Mask must be able to recognize OS to be able to search for the updates.
Fit criterion: Must work on windows 7(minimum), Mac OSX, Linux
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 3
Conflicts: N/A **Supporting Materials:** A computer

14d Scalability or Extensibility Requirements

Requirement #: 0027 **Requirement Type:** Extensibility **Event / BUC / PUC #:** N/A
Originator: Dieu Do **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: Product has no plans for scalability as it is going to be uniform across all devices.
Rationale: Product will be the same for everyone.
Fit criterion: Product will have no difference between 1 and 100,000 customers.
Customer Satisfaction: N/A **Customer Dissatisfaction:**N/A **Priority:**N/A
Conflicts:N/A **Supporting Materials:** N/A

14e Longevity Requirements

Requirement #:0032 **Requirement Type:** Longevity **Event / BUC / PUC #:**N/A
Originator: Dieu Do **Origination Date:** 11/04/17 **Latest Update:** 11/04/17
Description: Product should last an ample amount of time under normal usage.
Rationale: Product should be able to withstand normal wear and tear and still be functional for a couple years.

Fit criterion: Under normal wear and tear product should last around 5 years. There should also be no issues within the first year of usage.
Customer Satisfaction: 1 **Customer Dissatisfaction:** 3 **Priority:** 6
Conflicts: N/A **Supporting Materials:** N/A

15 Security Requirements

15a Access Requirements

Requirement #:0033 **Requirement Type:** Access **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:** 11/04/17 **Latest Update:** 11/04/17
Description: Users should be able to access all user interface functionalities of the product.
Rationale: Users should only be able to access the part that they will use and not be able to access parts that can compromise the system.
Fit criterion: Users cannot have developer level access into the product.
Customer Satisfaction: N/A **Customer Dissatisfaction:** 4 **Priority:** 3
Conflicts: Users may want to implement their own software **Supporting Materials:** N/A

Requirement #:0034 **Requirement Type:**Access **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:** 11/04/17 **Latest Update:** 11/04/17
Description: Developers must have access to all levels of permissions into product.
Rationale: Developers need to make changes to the software to fix bugs and would need all permission levels.
Fit criterion: Developers will have Developer level permissions which is the highest level and allows full access to software.
Customer Satisfaction:N/A **Customer Dissatisfaction:**N/A **Priority:** 3
Conflicts: N/A **Supporting Materials:** N/A

15b Integrity Requirements

Requirement #:0037 **Requirement Type:**Integrity **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:**11/05/17
Description: The product will only allow changes from the developers specifically for the product. They will only be able to access the code via an authentication code or key.
Rationale: Reducing the amount of people able to access the code will reduce the chances of attack.
Fit criterion: A unique authentication key is needed to make any changes to the software.
Customer Satisfaction:N/A **Customer Dissatisfaction:**N/A **Priority:**4
Conflicts:N/A **Supporting Materials:**N/A

15c Privacy Requirements

Requirement #: 0049 **Requirement Type:** Privacy **Event / BUC / PUC #:**N/A
Originator: Kandyce Burks **Origination Date:** 11/05/17 **Latest Update:**

Description: Product shall secure location data remain private except when in extreme cases.
Rationale: If diver gets lost, hurt, or any other damage putting them in a hazardous environment, emergency services can be notified quicker.
Fit criterion: Emergency precautions must be written within the Handbook.
Customer Satisfaction: 1 **Customer Dissatisfaction:** 6 **Priority:** 4
Conflicts: N/A **Supporting Materials:** N/A

15d Audit Requirements

Requirement #:0052 **Requirement Type:**Audit **Event / BUC / PUC #:**N/A
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:**11/05/17
Description: There are currently no Audit Requirements
Rationale: N/A
Fit criterion: N/A
Customer Satisfaction: N/A **Customer Dissatisfaction:**N/A **Priority:**10
Conflicts:N/A **Supporting Materials:**N/A

15e Immunity Requirements

Requirement #: 0036 **Requirement Type:** Immunity **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:** 11/05/17
Description: Product will not contact with other devices except through computers to receive updates from provider. This helps prevent the risk of being compromised.
Rationale: There is no need for the product to interact with other devices except for the periodic bug fix updates.
Fit criterion: The only time the product communicates with another device is through a computer for an update, otherwise there is no communication.
Customer Satisfaction: N/A **Customer Dissatisfaction:**N/A **Priority:**10
Conflicts:N/A **Supporting Materials:**N/A

16 Usability and Humanity Requirements

16a Ease of Use Requirements

Requirement #: 0013 **Requirement Type:** Ease of Use **Event / BUC / PUC #:**N/A
Originator: Luis Hernandez **Origination Date:** 10/24/17 **Latest Update:** 10/24/17
Description: The system shall be as easy to understand.
Rationale: The system will be used underwater and if it is easy for a beginner, an experienced will be able to use it without thinking.
Fit criterion: The system shall be as easy to understand that a beginning diver will know how to use it.
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 5
Conflicts: N/A **Supporting Materials:** N/A

16b Personalization and Internationalization Requirements

Requirement #:0038 **Requirement Type:** Personalization **Event / BUC / PUC #:** 0009
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:**11/05/17
Description: Users can swap their preferred metrics for the information that is displayed.
Rationale: Our user base could be used to using either metric or imperial systems and they should be able to see the information in the units they are most familiar with.
Fit criterion: Information will be displayed in metric(m, kPa) or imperial(ft, Psi) units.
Customer Satisfaction: 2 **Customer Dissatisfaction:** 8 **Priority:**8
Conflicts:N/A **Supporting Materials:** N/A

16c Learning Requirements

Requirement #:0039 **Requirement Type:** Learning **Event / BUC / PUC #:** N/A
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:** 11/05/17
Description: The product should be easy to pick up and learn. Users should understand how to use it after 15 minutes to an hour of training.
Rationale: Most of the product functions are automatically done so the learning curve is low. Users will only need to change their preference and be able to read and understand the data.
Fit criterion: Users choose their preferred metrics and be able to understand all the information that is displayed such as dive time remaining and understanding the sonar map.
Customer Satisfaction: 2 **Customer Dissatisfaction:** 7 **Priority:**10
Conflicts:N/A **Supporting Materials:**N/A

16d Understandability and Politeness Requirements

Requirement #:0043 **Requirement Type:**Understandability **Event / BUC / PUC #:**0008
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:**11/05/17
Description: Product should display information that is relevant and important to divers.
Rationale: Product should be intuitive and provide necessary information that will be useful and helpful to users.
Fit criterion: The information displayed must be calculated correctly and placed in a manner that is helpful.
Customer Satisfaction: 1 **Customer Dissatisfaction:** 3 **Priority:**10
Conflicts:N/A **Supporting Materials:** N/A

16e Accessibility Requirements

Requirement #:0051 **Requirement Type:**Accessibility **Event / BUC / PUC #:** N/A
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:** 11/05/17
Description: Users with hearing disabilities would still be able to use the product as hearing is not required for using the product.
Rationale: All HUD informations would still be relevant to the user.
Fit criterion: User with hearing disabilities would still be able to use the product as all functionality are still usable except for warning sounds.
Customer Satisfaction:1 **Customer Dissatisfaction:**10 **Priority:**10
Conflicts:N/A **Supporting Materials:**N/A

16f User Documentation Requirements

16g Training Requirements

Requirement #: 0040 **Requirement Type:** Training **Event / BUC / PUC #:**N/A
Originator: Kandyce Burks **Origination Date:**11/05/17 **Latest Update:**11/05/17
Description: User Knowledge
Rationale: Users do not have to have extensive knowledge outside of this product's Handbook.
Fit criterion: User are advised to read entire Handbook because using this product. Additional learning resources are advised, but not necessary.
Customer Satisfaction: **Customer Dissatisfaction:** **Priority:** 1
Conflicts:N/A **Supporting Materials:** Handbook

17 Look and Feel Requirements

17a Appearance Requirements.

Requirement #:0041 **Requirement Type:** Appearance **Event / BUC / PUC #:**N/A
Originator: Kandyce Burks **Origination Date:** 11/05/17 **Latest Update:**11/05/17
Description: The product shall include company's logo
Rationale: The company's logo is a symbol of safety and comfort, which is our main marketing approach.
Fit criterion: All packaging should come with a company logo located in two visible places.
Customer Satisfaction: 7 **Customer Dissatisfaction:** 0 **Priority:** 6
Conflicts: **Supporting Materials:**

17b Style Requirements

Requirement #: 0042 **Requirement Type:** Style **Event / BUC / PUC #:**N/A
Originator: Kandyce Burks **Origination Date** 11/05/17**: Latest Update:**
Description: This product shall appear safe.
Rationale: This product is used in hazardous areas.
Fit criterion: The product is tested frequently and efficiently. This data is known to the consumers.
Customer Satisfaction:6 **Customer Dissatisfaction:**0 **Priority:** 5
Conflicts: **Supporting Materials:**

18 Operational and Environmental Requirements

18a Expected Physical Environment

Requirement #: 0001 **Requirement Type:** Environment **Event / BUC / PUC #:**0010
Originator: Luis Hernandez **Origination Date:** 10/19/17 **Latest Update:** 10/19/17

Description: The system will have to withstand high pressures.
Rationale: The system is directed to deep divers, and deep divers will be swimming in waters that are deeper than what ordinary people will be swimming.
Fit criterion: The system will have to withstand waters that are 100 meters deep.
Customer Satisfaction: 7 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

Requirement #: 0011 **Requirement Type:** Environment **Event / BUC / PUC #:**0010
Originator: Luis Hernandez **Origination Date:** 10/20/17 **Latest Update:** 10/20/17
Description: The system will have to be waterproof.
Rationale: The system will be used underwater and in a high pressure environment.
Fit criterion: The system will have to be IP69k certified.
Customer Satisfaction: 1 **Customer Dissatisfaction:** 1 **Priority:** 1
Conflicts: N/A **Supporting Materials:** N/A

18b Requirements for Interfacing with Adjacent Systems

Requirement #:0026 **Requirement Type:** Adaptability **Event / BUC / PUC #:**0011
Originator: Dieu Do **Origination Date:** 11/03/17 **Latest Update:** 11/03/17
Description: Mask must be able to search for updates.
Rationale: Mask must be able to recognize OS to be able to search for the updates.
Fit criterion: Must work on windows 7(minimum), Mac OSX, Linux
Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 3
Conflicts: N/A **Supporting Materials:** A computer

18c Productization Requirements

Requirement #:0045 **Requirement Type:**Productization **Event / BUC / PUC #:**N/A
Originator: Dieu Do **Origination Date:**11/05/17 **Latest Update:**11/05/17
Description: Users will have access to the software once they purchase the product as a whole.
Rationale: The software and hardware are designed together and will be sold/bought together.
Fit criterion: There is no distribution of the standalone software, it will be together with the physical device.
Customer Satisfaction: N/A **Customer Dissatisfaction:** N/A **Priority:**10
Conflicts: N/A **Supporting Materials:** N/A

18d Release Requirements

Requirement #:0047 **Requirement Type:** Release **Event / BUC / PUC #:** 0011
Originator: Dieu Do **Origination Date:** 1/05/17 **Latest Update:** 11/05/17
Description: The product will have new releases after bugs have been found and reported.
Rationale: There is little need for constant releases unless there are bugs to be corrected.
Fit criterion: After a bug is found and the solution there is a solution, there will be a release to fix the bug.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5 **Priority:** 5
Conflicts: N/A **Supporting Materials:** N/A

19 Cultural and Political Requirements

19a Cultural Requirements

Requirement #:0044 **Requirement Type:**Cultural **Event / BUC / PUC #:**N/A
Originator: Kandyce Burks **Origination Date:**11/05/17 **Latest Update:**11/05/17
Description: The product shall be able to compensate for all languages displayed with Handbook and on the HUD.
Rationale: All readers must be able to learn any vital information given within and handbook or receive from the HUD regardless of background.
Fit criterion: Include dictionary for HUD and product Handbook is English, French, Mandarin, Spanish, Japanese, German, as base languages and disperse accordingly. Provide any additional language at user's request.
Customer Satisfaction:6 **Customer Dissatisfaction:** **Priority:** 7
Conflicts: Marketing demographic areas often vary.. **Supporting Materials:**N/A

19b Political Requirements

Requirement #: 0046 **Requirement Type:** Political **Event / BUC / PUC #:**N/A
Originator: Kandyce Burks **Origination Date:** **Latest Update:**
Description: This product shall be manufactured in the US only. It will be dispersed worldwide.
Rationale: Main focus for initial release will be geared towards marketing to the US with majority of our resources.
Fit criterion:
Customer Satisfaction: 4 **Customer Dissatisfaction:** **Priority: 6**
Conflicts: **Supporting Materials:**

20 Legal Requirements

20a Compliance Requirements

Requirement #: 0050 **Requirement Type:** Compliance **Event / BUC / PUC #:**N/A
Originator: Brent Yurek **Origination Date:** 11/05/17 **Latest Update:** 11/05/17
Description: Comply with national laws in every county we deal with.
Rationale: To sell this product internationally we must comply with local national laws per country we do business it.
Fit criterion: Product passes all national laws in a country before selling to it.
Customer Satisfaction: 4 **Customer Dissatisfaction:** 4 **Priority:** 5
Conflicts: N/A **Supporting Materials:** N/A

20b Standards Requirements

Requirement #: 0048 **Requirement Type:** Standards **Event / BUC / PUC #:**N/A
Originator: Brent Yurek **Origination Date:** 11/05/17 **Latest Update:** 11/05/17
Description: Product must meet all safety standards adhered by the American Academy of Underwater Sciences (AAUS)
Rationale: Product is focused on the field of underwater science and safety when using the product must be highly ensured.
Fit criterion: AAUS certifies that our product follows all safety standards and regulations adhered by them.
Customer Satisfaction: 6 **Customer Dissatisfaction: 6** **Priority: 6**
Conflicts: N/A **Supporting Materials:** N/A

III Design

21 System Design

21a Design goals

Sonar mapping should be computed and displayed as fast as possible. The faster the mapping is done the closer the software will be to real time. Faster calculations may require more computing power which requires more battery usage.

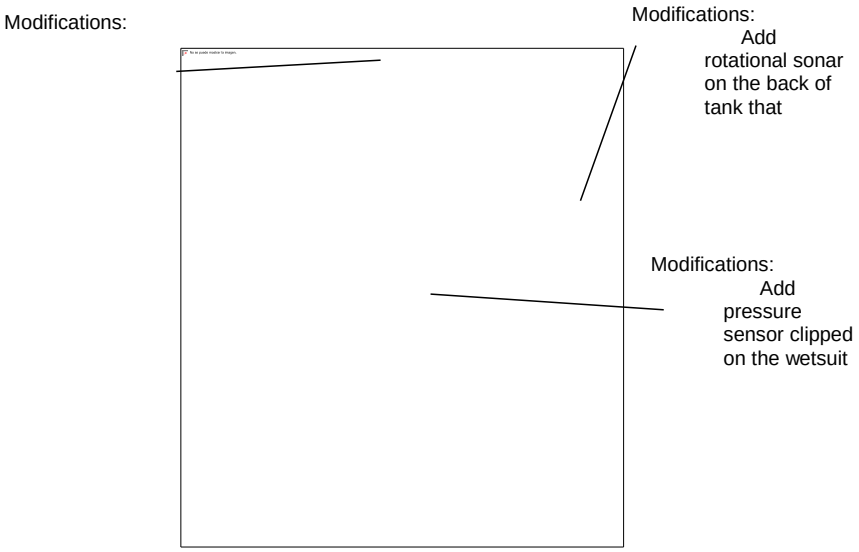
Vital calculations should be computed and displayed as fast as possible.Slower calculations can create misinformation for users.Faster calculations may require more computing power which requires more battery usage.

The battery should be able to sustain the mask for a longer duration that an average dive. Having extra battery after a dive is better than having one that runs out immediately when a dive is complete. This is a safety measure just in case of a situation where users remain underwater longer than usual.

Software should have no bugs. This is a major goal however it is a little unrealistic. A more realistic goal of this would be that there is no major bugs such as miscalculations and improper mapping.

System should be able to continuously take in input from all peripherals along with computing calculations at the same time. This would give the best results however this is very computing intensive and is a reach goal

22 Current Software Architecture



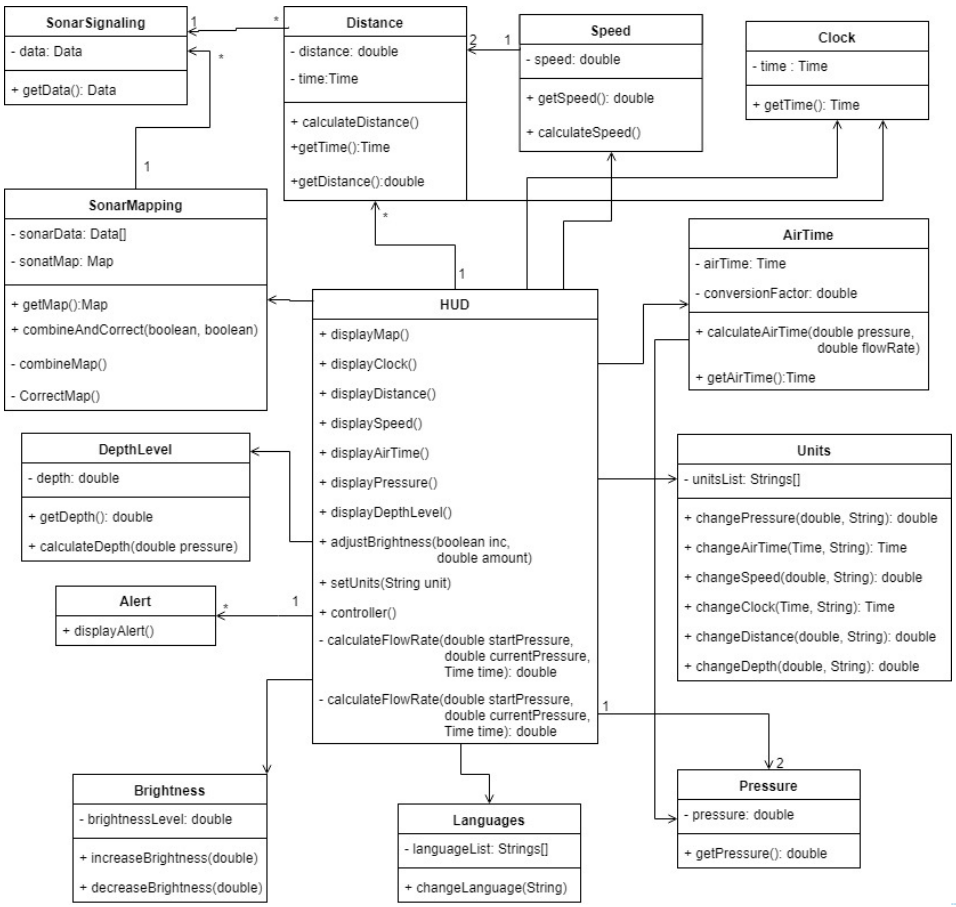
23 Proposed Software Architecture

23a Overview

The system will have multiple classes interacting and communicating with each other to create a proper task flow. Each class will have its own distinct functionality and is responsible for performing the required actions needed by the system. The system will have the following classes:

- HUD
- SonarMapping
- SonarSignaling
- Distance
- Clock
- DepthLevel
- Alerts
- Brightness
- Languages
- Pressure
- Units
- AirTime
- Speed

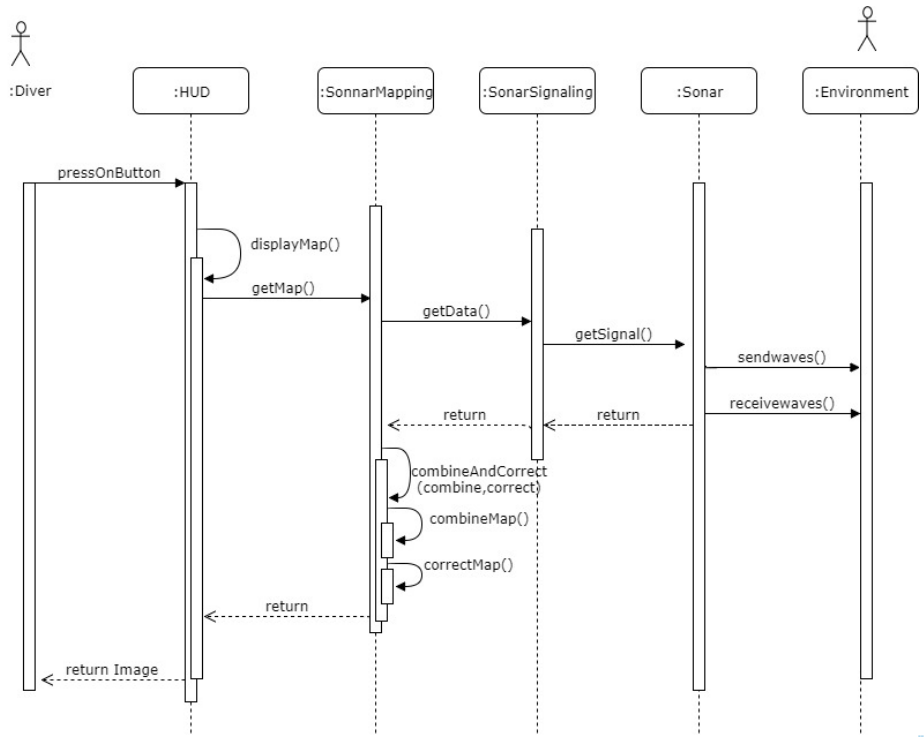
23b Class Diagrams



Comentado [1]: Here's the link to the uml document: https://drive.google.com/a/uic.edu/file/d/1d0mgDxdQuulizqAB1kstVDjeKNcf-SS8/view?usp=sharing

23c Dynamic Model

Use case ID: 0007



Comentado [2]: Link to diagram: https://drive.google.com/a/uic.edu/file/d/11wbVtX3tFMcNcTWstXLF3MG3X1BU8wSP/view?usp=sharing

23d Subsystem Decomposition

Application

- Core functionality of the system

User Interface

- Interface that users sees and interact with via HUD display

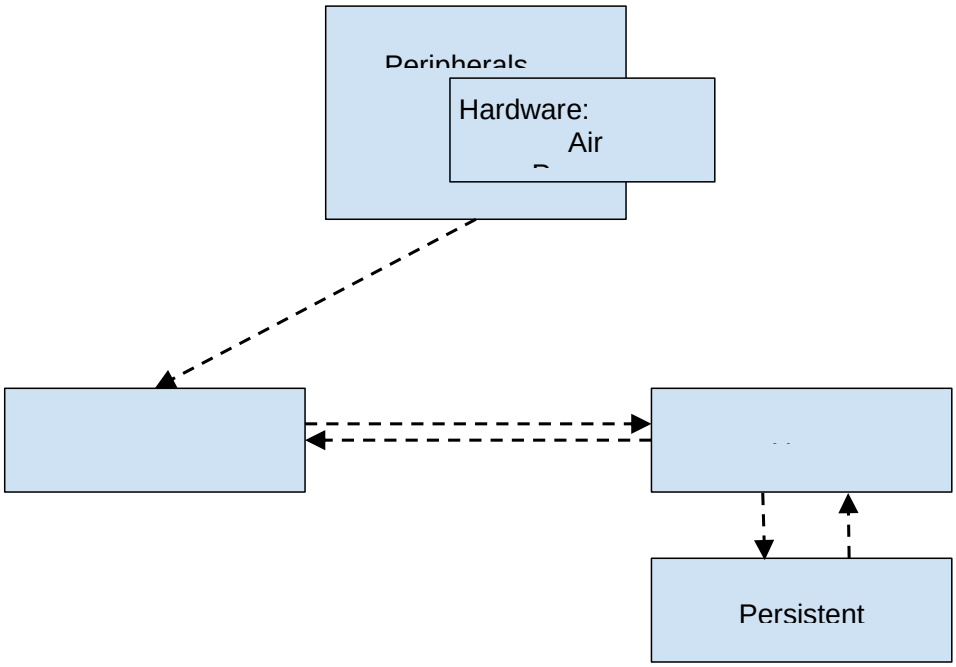
Persistent Data Storage

- Provides data storage

Peripherals

- Takes in data to provide to Application

23e Hardware / software mapping



23f Data Dictionary

Data Name	Description	Definition	Data Type
SonarSignaling	Signal's data obtained by sonar.	Data	Class
Data	Data obtained by sonar.	Format depends on sonar.	Data Element
SonarMapping	Map of the surrounding area based on sonar data.	Data[] + Map	Class
Map	Map of the surrounding area.	Format depends on sonar.	Data Element
Distance	Distance of an object from the user.	Distance+Time	Class
Time	A point of time as measured in hours and minutes and	Hours + Minutes + Seconds	Class

	seconds.		
Speed	Speed is distance traveled per unit of time.	Distance + Time	Class
Clock	Actual time in the day.	Time	Class
AirTime	Amount of time before the air in the oxygen tank runs out.	Time + Conversion Factor	Class
Conversion Factor	Factor with which the air time is multiplied to change psi to liters.		Constant
Units	Units of measurements.	unitsList[]	Class
unitsList	List of units.		Data Element
Pressure	Exertion of force upon the sensor calculated by the sensor.	Pressure	Class
Language	The language with which the system will display the information.	languageList[]	Class
languageList	List of languages with which the system will be able to display information.		Data Element
Brightness	The amount of light that the screen will emit.	brightnessLevel	Class
brightnessLevel	Level of brightness of the screen.		Data Element
Alert	Flashing light and text that is displayed to alert the user of an important message or event.	Alert	Class

DepthLevel	Distance from the surface of the water to the user.	Depth	Class
Depth	Distance from the surface of the water to the user.		Data Element

23g Persistent Data management

The persistent data for our system will be stored as flat files as there is no database used. The persistent data stored are the settings that the user last set before turning the device off. Settings such as brightness, preferred units, and language.

23h Access control and security

Object Actors	Parts	Functionality
Diver	Buttons	adjustBrightness() setUnits() changeLanguage()
Air tank sensor	Air Tank Pressure sensor	calculateAirTime() getAirTime() unitsList[]
Depth Gauge	Depth Gauge	getDepth() unitsList[]
Sonar	Frequency emitters	getData(): Data sonarData: Data[] getMap() combineMap() correctMap()

23i Global software control

Software will be updated or patched periodically. This can be done on a global scale as the update only require a download and install. The language and units option allow for international usage. Other than this there is no global presence for the software.

23j Boundary conditions

1.Initial Start-up out of box:

Product will be useable directly out of box as long as battery is charged.
Defaults:

- English
- Metric Units
- Brightness: 50%

Users will be able to adjust the settings to their preference once it is turned on

2.Normal Start-up

Product turns on and previous settings will be imported from Persisted Data Storage and information displayed in that format. Any preference changes can be done.

3.ShutDown

Product saves the current settings to Persistent Data Storage

24 Subsystem services

Application

- Takes in data from the peripherals
  - getPressure()
  - getDepth()
  - getData()
  - getAirTime()

- Computes all the calculations
  - calculateAirTime()
  - getMap()
  - combineMap()
  - correctMap()
  - calculateDistance()
  - calculateSpeed()
  - calculateAirTime()

- Sends computed data to the User Interface to be displayed

User Interface

- Displays all the necessary information for users from Application and Peripherals
    - displayMap()
    - displayClock()
    - displayDistance()
    - displaySpeed()
    - displayAirTime()
    - displayPressure()
    - displayDepthLevel()
    - displayAlerts()

- Certain aspects will be customizable for users preference
    - Units
    - Brightness
    - Language

- Sends user commands to Application for customization via buttons
    - changeLanguage()
    - increaseBrightness()
    - decreaseBrightness()
    - setUnits()

Persistent Data Storage

- Saves user settings

Peripherals

- Air pressure sensor
- DepthGauge
- Sonar frequency emitters and receivers
- Buttons
- Takes in data from hardware and commands from buttons

25 User Interface

The user interface will be the HUD displayed inside the diving mask. It will display information on the sides while leaving the center clear for the user to see where they are diving. Users will also be able to interact with the User Interface via the buttons on the mask to change certain elements to their preference. This includes unit system, language, and brightness. Last used settings before shutting off the product will be saved to Persistent Data Storage and be

applied again once the product is next turned on. All information displayed will be obtained from the Application after calculations.

All necessary information will be retrieved from Application via:

- displayMap()
- displayClock()
- displayDistance()
- displaySpeed()
- displayAirTime()
- displayPressure()
- displayDepthLevel()

Using buttons will send commands to Application to change formats via:

- changeLanguage()
- increaseBrightness()
- decreaseBrightness()
- setUnits()

26 Object Design

26a Object Design trade-offs

1. Cost vs. Durability - Since our product embodies safety in an underwater setting, the use of highly durable materials are needed. These are usually a little costly.
2. Response Time vs Memory Management - Our product will only store User Preferences, so we will not use a database. This allows a faster response time with our Applications computations.

26b Interface Documentation guidelines

1. The user interface must have two buttons for user preference adjustments.
2. The interface must display dive information.
3. The interface must display sonar mapping.
4. The user interface must display obvious alerts at the top of the HUD.
5. The interface must update automatically.
6. The interface must communicate with the Application.
7. The application must make computations based on information received from the interface and return results to interface.
8. The interface is customizable.

26c Packages

At the moment we have no packages to report.

26d Class Interfaces

- HUD
- SonarMapping
- SonarSignaling
- Distance
- Clock
- DepthLevel
- Alerts
- Brightness
- Languages
- Pressure
- Units
- AirTime
- Speed

IV Test Plans

27 Features to be tested / not to be tested

ID:#1
HUD projection
To see if there is a proper projection on the screen with all the required data areas. Data must be displayed in the correct areas so that information will be relevant and not misunderstood. If the projection onto the mask is not functional, the data will not be seen.

ID:#2
Vital calculations
The vitals calculations must be precise and have a small error margin to keep the data relevant. Error margins should be within 2% as it can cause dangerous circumstances for divers outside

of that margin. Information for air tank calculated is off by 1 minute. Diver may run out of breath surfacing if air tank ends 1 minute sooner than calculated time and diver drowns or suffocates.

ID:#3
Sonar Mapping
Sonar is used for creating images to alert user of surroundings. Calculations and image creation must remain accurate at all times with a .1 percent predicted error. If any. If sonar mapping is not within its accuracy margin, diver can encounter various obstacles that can be deemed hazardous in use case environment.

ID:#4
Water Pressure
The system will be used in depths of about 100 meters where the water pressure will be large. The system will have to meet the IP69k standards and will not result in short circuit, the system damaged, or with water inside the electrical system of the product.

28 Pass/Fail Criteria

ID Correspondence:#1
Projection displays correct data and Response <1.5 seconds with button interactions. To make sure the buttons can be used with no hesitation or cause any unnecessary waiting time to the user. If user needs to adjust display very quickly to check vitals, system should respond accordingly.

ID Correspondence:#2
Device has no overall system malfunctions any less than 100 meters depth.

ID Correspondence:#3
Sonar maps surroundings correctly and outputs accurate images.

ID Correspondence:#4
The system will be free from water inside the electrical system of the product, without physical damage, and will meet the IP69k standards.

29 Approach

ID Correspondence :#1 #2 #3 #4
Test mask functionality in approximate water pressure level at 100 meters depth. This will have to be conducted for all test in order to pass.

30 Suspension and resumption

Suspension: When >=70% of device functionality begins to malfunction
Resumption: When <40% of device is malfunctioning

31 Testing materials (hardware / software requirements)

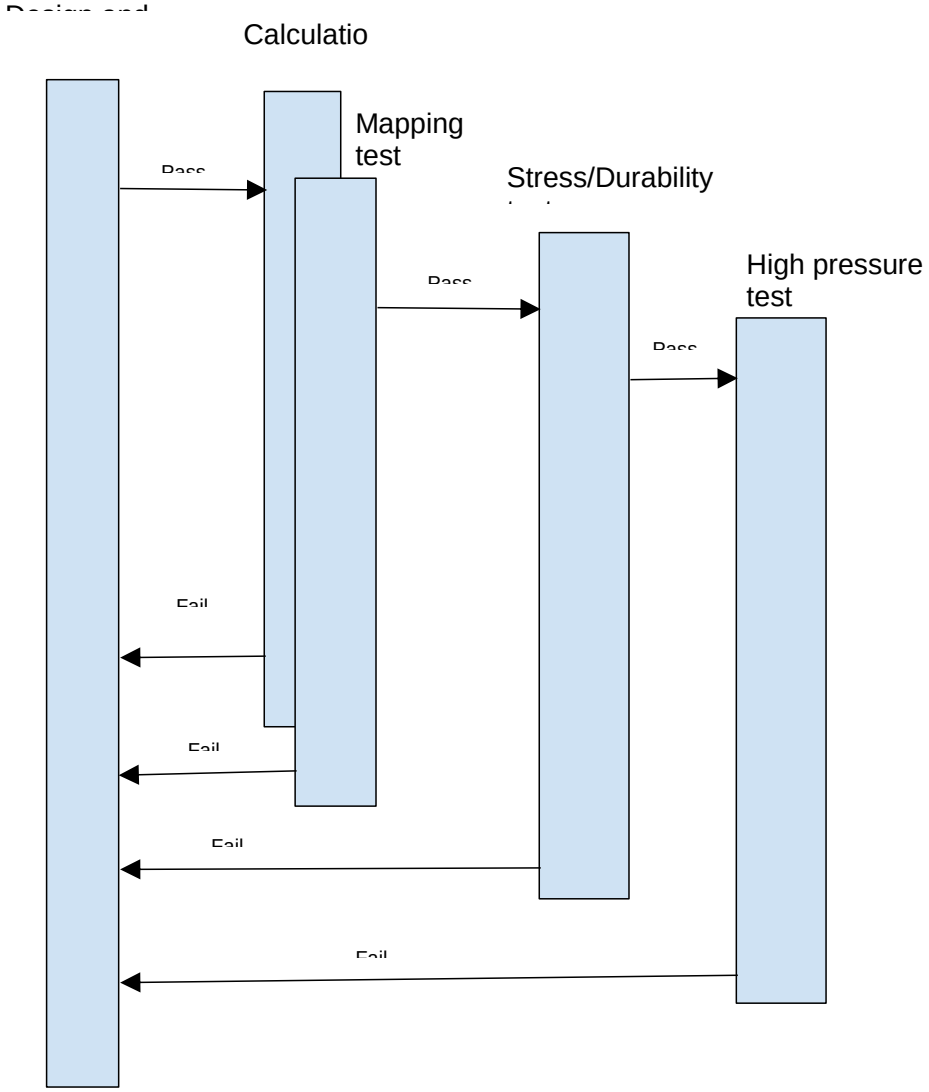
Materials: Completed System, Body of water >=100 meters depth

32 Test cases

Case 1: Device sonar shall produce accurate images up to ~100+ meters depth.
Case 2: HUD shall be respond accordingly to button presses.
Case 3: Device shall accurately detect user's vitals up to ~100+ meters depth.

33 Testing schedule

Testing will be conducted once a functionality is completed. It will first be tested under normal conditions before it can pass onto the extraneous test. If any test were to fail, the design must be rechecked before going through the process again.



V Project Issues

34 Open Issues

1. Hardware Support: There is currently no hardware to support our product.
    a. A full face scuba mask that has a microprocessor built in is not available and would have to be developed for this project.
    b. Body mounted sonar devices are not yet available. This device would require a lot of research and development to achieve. This is the biggest issue that the project faces. The product requires two sonar devices that is small enough to be bodymounted but still effective enough to pick up objects in 100m radius. There is currently nothing that comes close to this.

2. Efficient software: The calculations that are required by the product is very intensive
    a. The software must be designed to be optimized well. If the software is poorly optimized it can cause two major issues.
        i. Slow Performance: would cause inaccurate information to be displayed
        ii. Power Consumption: unoptimized software could drain more power than needed from the battery. Since the power capacity is very limited due to the battery, using as little power as possible during usaged is preferred for a longer usage duration.

3. Weight: product weight being too great
    a. Due to having so many parts attached to the product for it to function to it greatest potential, the overall weight from all the gear could be too heavy for users to move freely. While we want the product to be as lightweight as possible, the initial product will likely be heavy due to all the equipment and the size of current hardware. This issue can be resolved with more compact devices but will take time for overall optimization on software and hardware to occur.

4. Standard changes: IP69k and other diving standards
    a. The product was designed around IP69k and the current diving standards. However the standard could change in the future and our product may not fulfill the criterias.

35 Off-the-Shelf Solutions

35a Ready-Made Products

There are several ready made products that are already available on the current market. They can be divided into three categories: Full Dive Mask, Console Dive Computer, Wrist Dive Computer. The Dolphin would fall under a Full Dive Mask and the products that fall into that category would be the closest solution. Even though there are similar features, The Dolphin has certain features that do not exist on currently available products. Console Dive Computers and

Wrist Dive Computers can accomplish some of the features that the Dolphin can, however they are different in usability and is not as close of a comparison.

1. Full Dive Masks: Diving mask with a dive computer attached. The dive computer does the calculations and is displayed to the diver using a small LCD/OLED display. Everything is handsfree and the user does not have to mess with it after the initial setup. It is larger than a Wrist Dive Computer so it can be more powerful and versatile like a Console Dive Computer while retaining the handsfree benefits.

- Oceanic Data Mask HUD
- Aeris Compu Mask HUD

2. Console Dive Computer: Handheld dive computer. Console dive computer can be more sophisticated than dive watches. It will be able to provide more information for divers than dive watches can. However the drawback is that it is not handsfree, divers will have to hold it with one hand while they are diving.

- Oceanic Proplus X
- Sherwood Scuba Sage

3.Wrist Dive computer: A small dive computer that is wearable on the wrist. Due to the smaller size it will not be as strong as a console dive computer or a full dive mask. However it is hands free which gives it an advantage over the console dive computers.

- Aqua Lung I200
- Cressi GOA
- DEEPBLU COSMIQ+
- Mares Quad
- Scubapro Aladin Sport (Matrix)
- Seac Jack
- Aqua Lung I750TC
- Shearwater Perdix AI
- Scubapro G2

35b Reusable Components

1. Microprocessor: Computes all the necessary calculations and runs software. The microprocessor should be:
    a. Small enough to fit in mask
    b. Low power consumption
    c. Powerful enough to complete all calculations

2. Full face Diving mask: A Dive mask that is:
    a. Able to withstand high pressure levels in deep waters
    b. Waterproof
    c. Reflective enough to display projections of the UI. (Glass front)
    d. Able to allow airflow from air tank and exhaust
    e. Able to mount microprocessor and projector
3. Air pressure sensor: Sends information on the pressure level of the air tank for the computer to calculate remaining air time
4. Wetsuit: To keep diver dry and allow for easier diving
5. Depth gauge: Determines the current depth of user. This information is sent to mask for display and calculations
6. Air tank: Stores air for divers while they are underwater
7. HUD projector: Projects a UI onto the glass of the dive mask

35c Products That Can Be Copied

The Oceanic Data Mask HUD and Aeris Compu Mask HUD are currently the only two dive masks that are available on the market. While they are not exactly the same as our current product, there are certain features that are similar to what our product offers. They both offer calculations for dive time remaining, current depth, and dive time elapse. These are features that The Dolphin has as part of it's primary features.

While The Dolphin has more features in it, we can take the Oceanic Data Mask HUD and Compu Mask HUD as a base for the features that overlap. Copying the entire software would not be ethically correct nor will it provide us with major benefits. Using some of the algorithms that the Oceanic and Aeris masks uses for their calculation could save developmental time by a margin of about 40%. Having a base for the algorithm and then improving upon it would be much more beneficial to the development process. Rather than creating a new algorithm and then thoroughly testing It would be very time consuming and resource draining to achieve this.

Although thorough testing on the algorithms would still be required, improving upon something that already works would be much better and beneficial for the developmental process.

36 New Problems

36a Effects on the Current Environment

Introducing this product to the current environment should not have any negative effects. It does not affect any of the current systems that divers are using as each product has its own system. It is only adding additional equipment for divers to use and produce more options within the market creating competition between the products. This is a benefits to users as they will have more options to choose from for their needs and a wider range of tools at their disposal. Having a sonar map feature as part of the product will help revolutionize the diving industry as it is a concept that has not been implemented yet. It allows users to be more aware of their surroundings with less effort.

36b Effects on the Installed Systems

The product will be integrated with most of the current diving gear available today. The product would only change the headgear that divers would use but the body gear are going to be relatively the same. Users will still use an air tank, wetsuit, and fins. The need for a dive watch and depth gauge would be optional as the product will already have both of those built into it. The addition of the sonar devices is designed around the current setup of a diver and their equipment so that there is little to no interference. The overall design of the system is to integrate new gear with old gear with as little conflicts and high integration as possible.

*Red markers indicates the sonar devices mounting location

36c Potential User Problems

Experienced divers could already be used to making their own calculations instead of relying on a system to compute the calculations for them. The system may confuse them as it is different from the method that they have adapted and has a multitude of additional features. However, this should be a short term problem as they will become accustomed to the system if they continue to use it. New divers may also be overwhelmed by using such a complex system at first, but they will be able to use it after some time. This is not a major concern as it is only a issue presented by a learning curve for new users. It is recommended that users undergo proper training before using the product as well reducing this issue even further.

36d Limitations in the Anticipated Implementation Environment That May Inhibit the New Product

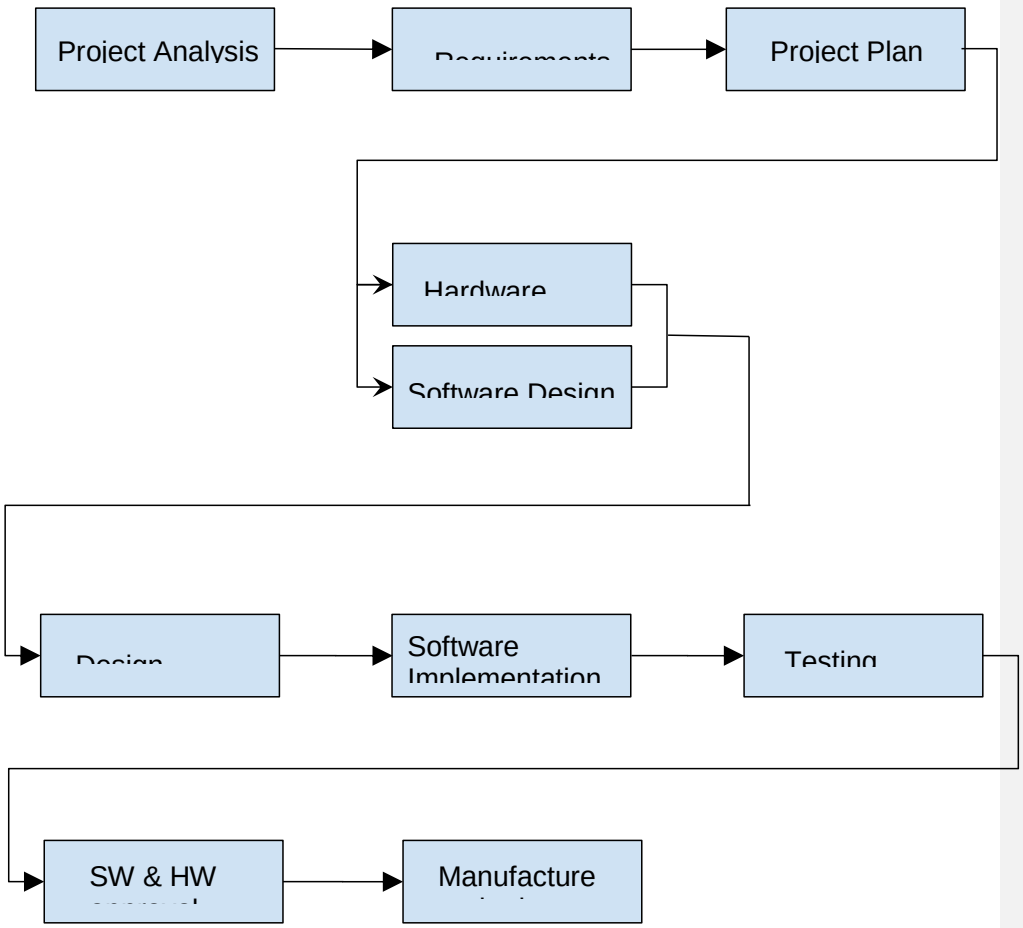
All the equipment that will be required for the system to run may end up being too heavy for divers to carry. Currently, a full set of equipment that divers use for a deep dive is already relatively heavy, mostly due to the air tank. Depth gauges and dive clocks should be relatively light and is not much of a concern in the weight issue. However the finalized dive mask and sonar attachments would add a significant sum to the overall weight. Since the dive mask will be made of glass, rubber and plastic with a depth gauge, microprocessor, and HUD projector attached to it, the final weight will be much heavier than a current standard dive mask. Current sonar devices are giant and are significantly heavy. Even after research and development to create smaller body-mountable devices they will still initially be relatively large and heavy. Once all the components are added the overall weight could be too much for an average diver to carry. This requires advancements in technology for the hardware before the issue will be fully resolved. Further research and development for the hardware could be done or wait for others to fully develop the hardware. It is better to further the research and development as this is a very niche field and there is likely not many willing to conduct research and development in this specific item.

36e Follow-Up Problems

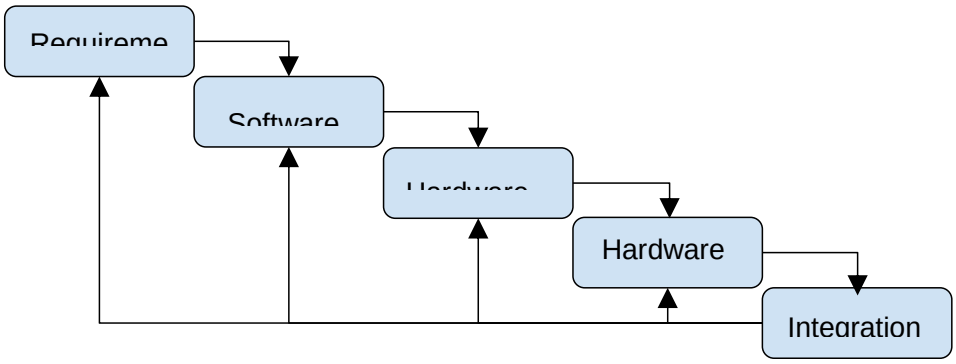
1. Final product may be too heavy for users to wear. All the equipment attached will sum up to a large amount and may cause some smaller users to struggle carrying the weight around until they are in the water.
2. Existing hardware cannot be applied to this project. Creating new hardware could pose new risk that are not currently present.

37 Tasks

37a Project Planning



37b Planning of the Development Phases



38 Migration to the New Product

38a Requirements for Migration to the New Product

N/A. The system is a standalone system that is developed along with the hardware. There is no old system in place and development will be continued step by step. There will be version control on the system while in development for backup.

38b Data That Has to Be Modified or Translated for the New System

N/A. The system is a standalone system that is developed along with the hardware. There is no old system in place and development will be continued step by step. There will be version control on the system while in development for backup.

39 Risks

- Inaccurate metrics
  - Check computational algorithms and sensors
- Slow computations
  - Redesign algorithms
- High power consumption
  - Redesign software structure for more optimal energy usage
  - Use less power consuming components
- Inaccurate mapping
  - Change to different type of sensors
  - Redesign mapping algorithm
  - Change mapping approach to 3D instead of 2D

- Inaccurate sensor readings
    - Check sensor accuracy through testing
    - Check communication between devices
- Silver Bullet Syndrome
    - Change in hardware will not always solve a problem and the software will have to be redesigned with new hardware used
- Inaccurate Cost estimate
    - Research and development for a body mounted sonar is high. Request for more investors or donations for research.

40 Costs

1. Requirements and use cases: 81 FP
    a. 11 product use cases
    b. 48 functional requirements
    c. 4 nonfunctional requirements
    d. 18 use cases

2. Project design: 27 FP
    a. 4 people worked on project
    b. Each supplying ~100hours over 15 weeks
    c. Each person worth $40/man-hour

3. Project Development
    a. 1 requirement hour to 20 development hour per person(1,620 FP)
    b. Assume team of 10 working on project
    c. Each person worth $40/man-hour
    d. $200/FP for development cost(without per person cost)
    e. .5 FP/hour(1,620 / .5 = 3,240)

4. Hardware R&D
    a. $2 million in R&D to develop hardware suitable for project

Type	Cost

Requirements and use cases	$16,200
Project Design	$16,000
Project Development FP cost	$648,000
Project Development man-hour	$1,296,000
Hardware R&D	$2,000,000
Total	$3,976,200

41 Waiting Room

Requirement #:0053 **Requirement Type:**Waiting Room **Event / BUC / PUC #:**N/A
Originator: Dieu Do **Origination Date:**12/09/17 **Latest Update:**12/09/17
Description: Reduce overall weight and clunkiness of system.
Rationale: The less weight the diver has to carry the better it will be for them to move.
Fit criterion: The overall weight of equipment that divers carry should be under 100 pounds.
Customer Satisfaction: N/A **Customer Dissatisfaction:**N/A **Priority:**N/A
Conflicts:N/A **Supporting Materials:**N/A

42 Ideas for Solutions

- Updates be distributed and applied without use of a computer
- More languages added for user preferences
- Larger batteries for the mask be developed for longer diving time
- Smaller equipment developed for lighter overall weight on divers

43 Project Retrospective

The project was designed with waterfall and an agile methodology in mind and worked well throughout the design process. With the nature of the project there needs to be a clear flow of where the project is headed. This is for software development and hardware research and development. The waterfall method allows for a clear scope of the project and the direction that it should heads towards, however since the hardware is not available and the outcome from the finished hardware is unpredictable. Designing the software around a agile methodology works out better. Designing the project along the way with the hardware coming in when it is complete allows for developers to prepare for the hardware instead of having to completely redesigning once the hardware comes in. This methodology should be adopted later on as well for the benefits of being able to change and adapt when the hardware becomes available.

VI Glossary

- Peripherals - In context with The Dolphin, peripherals are categorized as any hardware located on our product that is able to detect something about the user's current external environment.
- Application - The application is a subsystem within our product that communicates between the peripherals and the user interface. It does all of the products calculations.
- Flat Files - Files that do not need to be stored in a database.
- HUD - Heads Up Display; A transparent display that presents data without requiring users to look away from their usual viewpoints
- Sonar - a technique that uses sound propagation to navigate, communicate with, or detect objects on or under the surface of the water.

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