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February 20th, 2006

Dr. Andrew Rawicz
School of Engineering Science
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Re: ENSC 440 Functional Specifications for the GeoPreserver™

Dear Dr. Rawicz,

The attached document, *Functional Specifications for the GeoPreserver™*, goes over the features of the GeoPreserver™, a new and innovative approach to saving the lives of commercial fishermen. It is based on establishing a virtual boundary around a ship that will detect Man Overboard incidents.

This document provides a high-level functional view of both the prototype and the final product. It will prove invaluable to both the design engineers and project leaders to determine the best methods to create a superior product.

Our project team consists of five talented and innovative engineers with solid industrial experience. The team members include Jason Lee, Bryan Friesen, Jason Cho, Will Chan and Jeffrey Huang. Adam Smith of Innovative Technologies will work as a Senior Advisor and Consultant with our project. If you have any questions, please feel free to contact us at ensc440-onjin@sfu.ca.

Sincerely,

Jason Lee
Chief Executive Officer
OnJin Engineering

Enclosure: Functional Specifications for the GeoPreserver™

Functional Specifications for the GeoPreserver

Classification: CONFIDENTIAL

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Submitted To: Dr. Andrew Rawicz
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Executive Summary

The commercial fishing industry is one of the most hazardous industries in North America. The Alaskan crab fisheries alone exhibit estimated fatality rates of 111/100,000 workers per year. According to the Alaska Department of Labour, more than 80 percent of these fatalities are due to drowning either from falling overboard or as a result of a boat accident.

The GeoPreserver™ provides a viable tool for combating this fatal problem in the fishing industry. The purpose of the project is to develop a system that monitors and tracks all of the crew on a fishing vessel. The basis of the system is a geofence, which involves defining a boundary that encompasses the boat using GPS navigation. As long as the boat's crew remains within this boundary, they are in the "safe" zone, but once they exit, the system will be alerted.

The development of the project will consist of a prototype and a final version. The prototype's main purpose is to show the functionality of our project. This document outlines the functionality of our project defining both the prototype and final version. The prototype version will focus on the following features:

1. One or Two personal units with the capabilities of tracking an individual and interfacing with the base station
2. The capabilities to show the functionality of our project such as tracking, alarming when the personnel exits the boundary
3. A base station with an external interface such as a PC
4. An easy to use interface through a PC

The final version will focus on the following features:

1. The capabilities of supporting multiple personal units in the system
2. A standalone embedded device that requires no connection to an external PC
3. Waterproofed enclosure to meet all physical requirements
4. Be a fully usable, reliable, and ready to commercialize product

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Glossary

Geofence A virtual fence or geographical boundary used to trigger events once the fence boundary is crossed.

GPS GPS stands for Global Positioning System. It consists of 24 satellites controlled by the United States Department of Defense for the purpose of navigation and positioning [2].

MOB MOB stands for 'man overboard', signifying that a person has fallen off the ship into the water.

IPX7 An IPX7 designation means the GPS case can withstand accidental immersion in one meter of water for up to 30 minutes [1].

Revision History

Revision	Status	Publication/Revision Date	By:
1.0	• Created	Monday, February 20, 2006	Jeff Huang

1. Introduction

The GeoPreserver™ is a system that monitors and tracks all crew members onboard a fishing vessel. The system consists of a base station, and a personal unit assigned to each crew member. When a crew member falls overboard, the base-station will alert the other crew members that someone has fallen into the water. The system also tracks the fallen crew member so it is more effective at locating the crew member.

To reduce high fatality rates in the fishing industry, the GeoPreserver™ will provide a more efficient and effective method of saving lives. The development of this project will consist of multiple stages, including the completion of the prototype to illustrate its functionality by April 2006

This document will serve as a guide in the design of our prototype. It illustrates the physical and functional requirements for both our device and the final product. The specifications were designed, in part, for consumer safety and product reliability.

2. System Overview

The GeoPreserver™ will consist of two distinct modules, a Base station, and Personal Units. The Base Station will be mounted inside the bridge of the boat and will serve as the reference point for establishing the geofence and determining when personnel are in the water. The Personal Units will be worn by everyone on the boat at all times. These units will wirelessly transmit their geographical location back to the base station. The base station will then determine if the person is on the boat or over. If over, the system will be alerted thus indicating a man overboard.

This project is limited by funding and time. As outlined in our functional specifications there are certain goals that we will meet in our prototype. The basic functionality of the project will be shown in our prototype but the final manufacturing and physical aspects of the project will be left for final revisions. The theory and functionality of the project will not be lost due to the simpler prototype.

In the future, with additional funding and time, we will be able to implement much more functionality in our project. The specific prototype versus final version changes will be indicated in detail in a later section.

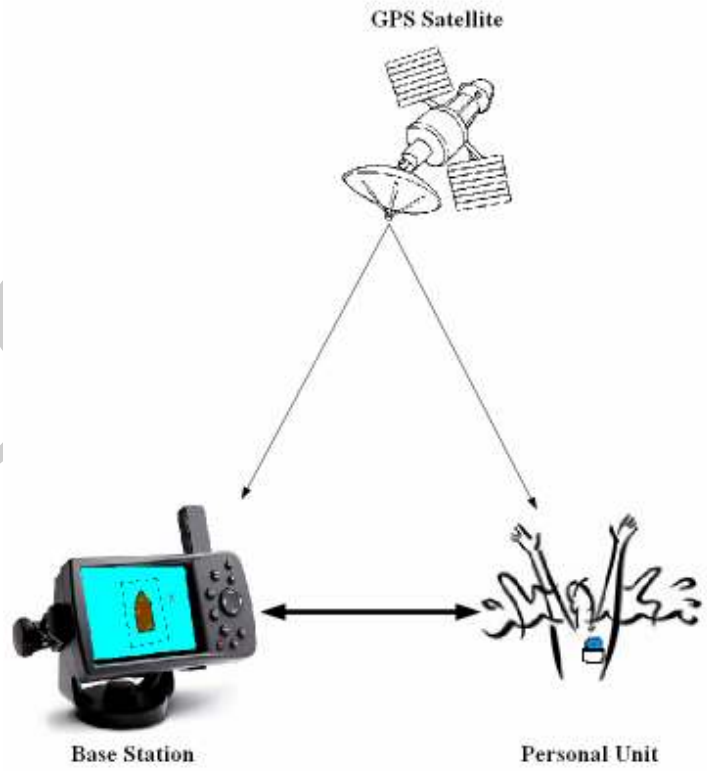

Figure 1: High-Level System Diagram of the GeoPreserver™ System.

3. Physical Requirements

This section outlines the specifications required in order to ensure that the hardware will operate safely, and effectively. A note about the functional specifications notation — the items are labeled according to the convention,

 # - Classification,

where # is the specification number, and the classification is one of the below:

[P] – Prototype Only.
[F] – Final Product Only.
[B] – Both the Prototype and the Final Product.

3.1 Personal Units Requirements

3.1.1 Overview

1-B Each unit must have a unique serial code for registration to the base station

The serial code is required to distinguish the personal units from each other.

3.1.2 Physical/Aesthetics

2-F The units must be waterproof up to 15 meters of submersion
3-F The units will be a maximum size of 12cm×6cm×4cm
4-F The units will weigh less than 300 grams
5-F The units will have the means to securely attach to the user
6-F The units will have smooth edges
7-F The units will remain buoyant when dropped into the water
8-F The units will notify the user when its batteries are low

These physical requirements ensure that the users can easily carry a personal unit without much discomfort, and the units will be intact through normal use conditions.

3.1.3 Durability/Operating Conditions

9-B The units must be able to transmit with the use of an external antenna above water
10-B The operation of the units shall not be affected by the presence of interfering signals
11-B The units must operate underneath the users lifejacket or flotation suit
12-B The units must operate in all kinds of weather
13-B The units will not have any wired connections to the base station

15-F The units will operate at temperature -30°C to 40°C
16-F The units must survive being dropped into water from 30 meters or less
17-F The units must survive a drop from shoulder height onto a hard surface
18-F The units must function under constant motion of the vessel
19-F The units must survive depths of 2 metres or less
20-F The units should operate underwater

The above specifications cover the environment in which the device is to operate. This includes stormy weather in Atlantic or Arctic regions on a rocking vessel, or in the water. Wireless operation is required for the safety and convenience of users.

3.1.4 Performance/Quality/Accuracy

21-F The units will have a service life of 5 years
22-F The units will not dissipate more than 5°C of heat
23-F The units must provide positioning accurate to within 5 meters
24-F The units must transmit their locations at least once every 5 seconds when inside the geofence
25-F The units must transmit their locations at least once every second when outside the geofence

These specifications were chosen as reasonable performance measures for our device. The positioning accuracy requirement was chosen based on reasonable performance of most GPS modules. The units should transmit less often when on the vessel in order to conserve device power; however, when overboard, the devices should transmit more often in order to provide tracking information for rapid rescue.

3.1.5 Power Consumption

26-F The units will have a Mean Time Before Failure (MTBF) of greater than 10000 hours
27-F The units will have a charge time of less than 12 hours
28-B The units will operate for at least 2 days on a single charge
29-B The units must consume less than 800mW

The above power consumption specifications allow for a reasonable service life of the unit. The power consumption specification is an upper bound estimate based upon consumption of common parts.

3.2 Base Station Requirements

3.2.1 Overview

30-B The station must be capable of registering individual personal units to a base station
31-B The station must display the location of each registered personnel
32-B The station must display the location any non-registered personnel carrying a GeoPreserver™ within range
33-B The station must accurately display and notify the operator when a registered unit has crossed the geofence
34-B The station must be capable of shutting down and rebooting the entire system
35-B The station will indicate when the system is powered on
36-B The station will have a light to indicate errors
37-B The station will have a power/reset switch
38-F The station must be capable of running the interface software

The base station must be able to perform the necessary operations of the GeoPreserver™ system. It must be able to track the crew registered to the boats, as well as be able to detect nearby overboard persons from other vessels so rescue operations can be commenced when necessary. The station must be able to turn on and off, and notify the crew when an overboard situation has occurred.

3.2.2 Physical/Aesthetics

39-P The prototype station will communicate directly with a PC
40-F The station must be a standalone device that can be mounted to the interior of the boat
41-F The station must have a display no less than 10cm × 10cm
42-F The station must be less than 30cm × 20cm × 5cm
43-F The station must weigh less than 10 pounds
44-F The station must have an adequate interface, buttons and external inputs to use interact with the display effectively

The base station must not be much larger than a small laptop that can fit in the interior of the boat. A weight of 10 pounds was arbitrarily selected to allow for an easy mounting or transport, while not being too prone to moving about on the boat. The display size was arbitrarily selected as being adequate for the purpose of conveying the status of the system. Although the prototype will rely on a PC for interfacing, the final product should be standalone so that the user does not require additional hardware.

3.2.3 Durability/Operating Conditions

45-F The station must be waterproof in accordance with IEC 60529 IPX7

46-F The station must operate on 12V
47-F The station must not consume more than 700W
48-F The station must have an internal backup power source in case there is a power failure on the boat
49-F The station must be able to withstand all associated forces while being on a boat, such as continuous rocking, vibrations, and shock
50-B The number of units in the proximity of the station will not affect the quality or accuracy of the station

The base station must be able to withstand the normal operating environment. Hence, it must be water-resistant, operate at a common ship voltage of 12V, not consume much more power than a hair dryer, and function in the event of a power failure. Additionally, the presence of multiple personal units should not detract from the performance of the base station.

3.2.4 Performance/Quality/Accuracy

51-F The station must indicate location of personnel within 5 meters
52-B The base station can support up to 20 personal units depending on the final CPU specifications

The base station must be able to locate the position of personnel within a reasonable margin of error and support a sufficient number of crew on fishing vessels. In this case, the number 20 was arbitrarily assigned to easily exceed the average crew size for a typical fishing boat.

3.3 Requirements Common to Both the Personal Units and the Base Station

3.3.1 Reliability

53-B The units must not heat up causing inaccurate operation
54-B The units must be able to transmit and receive in all locations in any external environment
55-B The units must be able to transmit and receive at rates capable of supporting the maximum number of units in the system without data loss
56-B The units must be able to transmit and receive at distances of up the maximum distance supported by the hardware.

The system should be accurate within specifications at all times, and transmit sufficiently fast enough to administer the maximum number of personal units supported. They must also have a range long enough so that the base station can detect and locate nearby overboard crew that it may have passed or that may have been swept a distance by waves. This distance is defined by the hardware, and should be a sufficient distance that would be useful in tracking.

3.3.2 Regulations

57-F The units must pass CSA Standards
58-F The units must pass fishing/marine standards of electronics (NMEA standards) [1]

For the safety of users, the system must pass all CSA standards. For proper system operation in the intended environment, the system must pass the appropriate fishing and marine standards for electronics, including NMEA regulations [1].

4. Display and User Interface Requirements

The user interface for the GeoPreserver™ base station allows the user to setup the GeoPreserver™ for their vessel and store crew data for each fisherman on the ship. This data is used to track the location of each crew member and to determine if a MOB situation has occurred. The interface will consist of a display screen, navigational buttons and a keypad for crew data input.

For reference, we repeat the functional specifications notation. The items are labeled according to the convention,

 # - Classification,

where # is the specification number, and the classification is one of the below:

[P] – Prototype Only.
[F] – Final Product Only.
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4.1 General Requirements

59-B Interface must possess a visual display to convey GeoPreserver™ information to the user in an intuitive fashion
60-B Visual display must be lit in some fashion to be viewed at all hours of the day
61-B Interface must have navigational buttons and a keypad for the crew data input
62-B Interface's display must update with the crewman's location and status information as the system is operating

The interface must allow for the system status to be viewed easily by users in any light conditions. A proper means of inputting information and navigating the interface must be provided. In addition, the information conveyed by the system must always be up-to-date with the most recent information provided by the personal units.

4.2 Interface Requirements

63-B Interface must allow the user to view the status of the GeoPreserver™
64-B Interface must have the ability to program and store a DOCK location so that fisherman leaving the boat at the dock will not sound the alarm
65-B Interface must indicate, both graphically and with detail, a MOB situation
66-B Interface must give a graphical estimate as to the location of a MOB with respect to the boat

67-B Interface must allow the user to store crew member information into a crew database
68-B Interface must allow the user to edit, delete and view crew member information in the crew database
69-B Interface must allow the user to register and unregister a personal unit from a crew member
70-B Interface must allow the user to input vessel dimensions for geofence configuration
71-B Interface must allow the user to input the position of the base station with respect to the vessel
72-B Interface will provide the user with a method of overriding a MOB alarm
73-B Interface will provide a status bar indicating the general states of the GeoPreserver™ such as Normal, System Offline, MOB situation
74-B Interface must provide an option to turn on/off the GeoPreserver™ (entire system)
75-B Interface must have a self test function, to test the connected personal units
76-B Crew members initials will be shown on the display as they are tracked by the system
77-F Display must have a manual and automatic zoom feature for viewing the ship and crew data
78-F Interface must allow user to calibrate the geofence perimeter

The interface must allow the user to easily perform the necessary operations of the GeoPreserver™. This includes viewing the state of the system, registering personal units and crew to the system, and configuring the geofence. It should also provide a means of testing the personal units to verify proper system operation, and provide a means of overriding the alarm in case of false alarm.

4.3 Performance Requirements

79-F Interface will update crew location information at a rate dependant on the receiving rate of base station
80-F System should be able to track a maximum of 20 people

The interface must always be up-to-date with the most recent information provided by the personal units, and be able to handle the maximum number of support units.

4.4 Reliability Requirements

81-F Interface should be stable and crash-free

The interface must be stable because a crash cannot be afforded during a MOB situation. Because the prototype's interface will be communicating with a PC, stability cannot be guaranteed since the operating system may have other third-party programs running. The final version will not be communicating with a PC, and can be made stable.

4.5 Error Handling Requirements

82-B Interface should notify the user of errors through the use of a status bar
83-B If GeoPreserver™ does not receive tracking information from a personal unit, it will determine the status of the unit's last known location and act accordingly

If the system is not performing properly, the user must be alerted via the interface. Also, if a signal is lost from a personal unit, the system will base the person's status on their last known location. This method provides the best and easiest way to interpret the situation. If a crew member was last on board, they may have gone inside the ship where their signal cannot be reached. If the crew member was overboard, it is likely that the member is either underwater at a depth low enough to interfere with transmission, or that they have moved out of range. Knowing the last known location of a crew member in a MOB will help in being able to locate them.

4.6 Constraint Requirements

84-F Interface will function as part of an embedded system
85-P Interface will function on a personal computer

While the prototype will require a computer for interfacing, the final product should be an embedded system that requires no additional hardware, so the interface will be integrated.

5. Prototype vs. Final Revision

There are several major differences that are outlined in the functional specifications between the prototype and the final revision. Here they will be outlined again for clarity.

5.1 Manufacturing

All aspects of manufacturing will be left for the final revision. These include things such as smooth edges, waterproofing and shock testing. The prototype will only include the finalized boards that will be mounted in some sort of enclosure. The final manufactured enclosure will not be included in the prototype. This is due to time constraints and valuable time required to make sure the functionality of the project is met, rather than physical aspects.

5.2 Accuracy

In order to lower our budget, accuracy is sacrificed in our prototype. OEM GPS receivers dramatically increase in price as accuracy is increased. Therefore, to save on our costs for our first prototype, the accuracy will be only within 5 meters. This can be improved drastically when more expensive GPS receivers are bought for final revisions. Furthermore, tuning software algorithms and more accurate transmitters/receivers will also be left for final revisions. The theory behind the project will not be sacrificed, but some accuracy may be in order to save costs.

5.3 Connection to PC

The final revision will be a standalone device with complete embedded software. However, to save time, the base station will be connected to the PC in the prototype. In this case, the base station will exploit the functionality of the PC's monitor, keyboard and other interfaces already available.

5.4 Certification and Standards

While certain standards and certification will be kept in mind, such as keeping the user safe from electric shock from the electrical devices, actual certification will not take place until the final revision is made. Certification of our product will lead to high budget costs which cannot be funded; thus, these will be left for later. However, the safety of our device will not be compromised and meeting the standards of certification will be closely followed in our prototyping.

6. Conclusion

The functional specification above describes the capabilities and requirements of the GeoPreserver™. The system's functionalities are categorized into its physical, performance, and operating conditions requirements. By meeting these specifications, we will ensure consumer safety and product reliability. The list of requirements provides a useful guide for sourcing our components, as well as designing our project. The prototype is projected to be completed by April 2006.

References

[1] National Marine Electronics Association (NMEA). 20 Feb. 2006 <http://www.nmea.org/>.

[2] Trimble. All about GPS. 15 Jan. 2006 <http://www.trimble.com/gps/>.

[3] USGlobeSat Inc. 2005. USGlobalSat GPS Forums. What is IEC 60529? 20 Feb. 2006 <http://www.usglobalsat.com/forum/topic.asp?TOPIC_ID=30>.