Feb 16, 2011

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
8888 university drive
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Functional Specification of an Intelligent Lifeguard System for Swimming Pools

Dear Dr. Rawicz,

Please find enclosed a document describing the functional specification of an intelligent lifeguard system designed by GESS Inc. iLifeGuard is an underwater communication system built to prevent the loss of lives due to drowning by alerting the lifeguards when a swimmer is in need of help. Children below the age of twelve and adults with medical conditions are more likely to face the risk of drowning. As such, they form the backbone of our target audience.

The functional specification is intended to state the requirements that our proof-of-concept design will fulfill. In addition, this document contains the standards our product will have to comply with in order for it to be marketable and safe for use.

GESS is comprised of five passionate and industrious engineers namely: Suleiman Mohamed, Mehdi Elahi, Elis Micka, Gurman Thind and myself. The product has an immense social benefit which we intend to service by providing a reliable, affordable and appealing life saving device. For any questions or concerns please contact us at ssk15@sfu.ca.

Sincerely,
Shivam Kishore
Shivam Kishore
Executive Manager
GESS Inc.

Guardian Electronics System

22nd January 2011

Functional Specification for

Executives:

Shivam Kishore – Chief Executive Officer
Elis Micka – Chief Design Engineer
Suleiman Mohamed – Chief Software Engineer
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Submitted to:

Dr. Andrew Rawicz – ENSC 440
Mike Sjoerdsma – ENSC 305

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Executive Summary

According to Lifesaving Society [1], a Canadian charity organization, drowning in swimming pools is the third leading cause of accidental death for people 60 years of age or older. Each year almost 500 Canadians die in water-related incidents. Red Cross [2] reports that approximately 6% of drowned populations in Canada are toddlers and infants. Though young children below the age 12 and adults 60 years or older face the greatest risk of drowning, people of all ages who have medical problems are also prone to the risk of drowning.

Current swimming pools have lifeguards around the clock. However, due to the large number of swimmers, lifeguards have to divide their attention and may at times misunderstand a gesture for help. Making a device that alerts lifeguards the instant a swimmer needs help would tremendously reduce the risk of drowning and lessen the emotional burden experienced by lifeguards who would live through the guilt of not saving a swimmer under their watch.

The integration and development of iLifeGuard will occur in two phases. These phases will involve the integration of three devices at different locations. At the time of use, two of the devices will serve the purpose of underwater communication. Since one of the aforementioned devices will be partly in water, the signals sent from this device will be received by the third device held by the lifeguard.

The first phase will support the transmission of a signal reliably over any possible distance within a swimming pool with standard dimensions. Also, the second phase will ensure the relay of the above signal to a receiver at a maximum distance of 15m outside the pool. This maximum distance is a varying factor that will depend on the choice of the receiver.

The final product will confirm to all pertinent standards and guidelines, including those of Canadian Standards Association (CSA) and Canadian Health Association (CHA).

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1.0 Introduction

iLifeguard is an intelligent underwater communication system that through a relay of signal transfers alerts the lifeguard when a swimmer is in a state of drowning. By keeping track of the duration the swimmer stays at a particular depth, iLifeguard system will be able to communicate with the lifeguard outside the pool ensuring the safety of the swimmer. The requirements for the iLifeguard, as proposed by GESS Inc., are described in this functional specification.

1.1 Scope

This document describes the functional requirements that must be satisfied by the iLifeguard system. This assemblage of requirements completely describes the proof-of-concept device and the standards our product will have to comply in order for it to be marketable and safe for use. The listed requirements will lay the foundation for the design of iLifeguard and will be referred to in future documents.

1.2 Intended Audience

The functional requirement is intended for use by all members of GESS Inc. The CEO of the company shall use this document to monitor progress through the development stage. Furthermore, these requirements shall act as guidelines for the design engineers and shall be kept in mind throughout the design and the implementation phase of the system. During the testing phase this document will be used by engineers to assess the similarity in the functionalities of the actual system and the one described in this document. Lastly, this document will help marketers and investors understand our product, which can aid in the design of user trials.

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1.3 Classification

Throughout this document, the following convention shall be used to denote functional requirement:
[R#] Functional Requirement [n]

Where # is the functional requirement number and n is the precedence of the requirement as determined by the following:

[i] – The functional requirement applies to the proof-of-concept (prototype) system.
[ii] – The functional requirement applies to the production system.
[iii] – The functional requirement applies to both, the proof-of-concept and the final production system.

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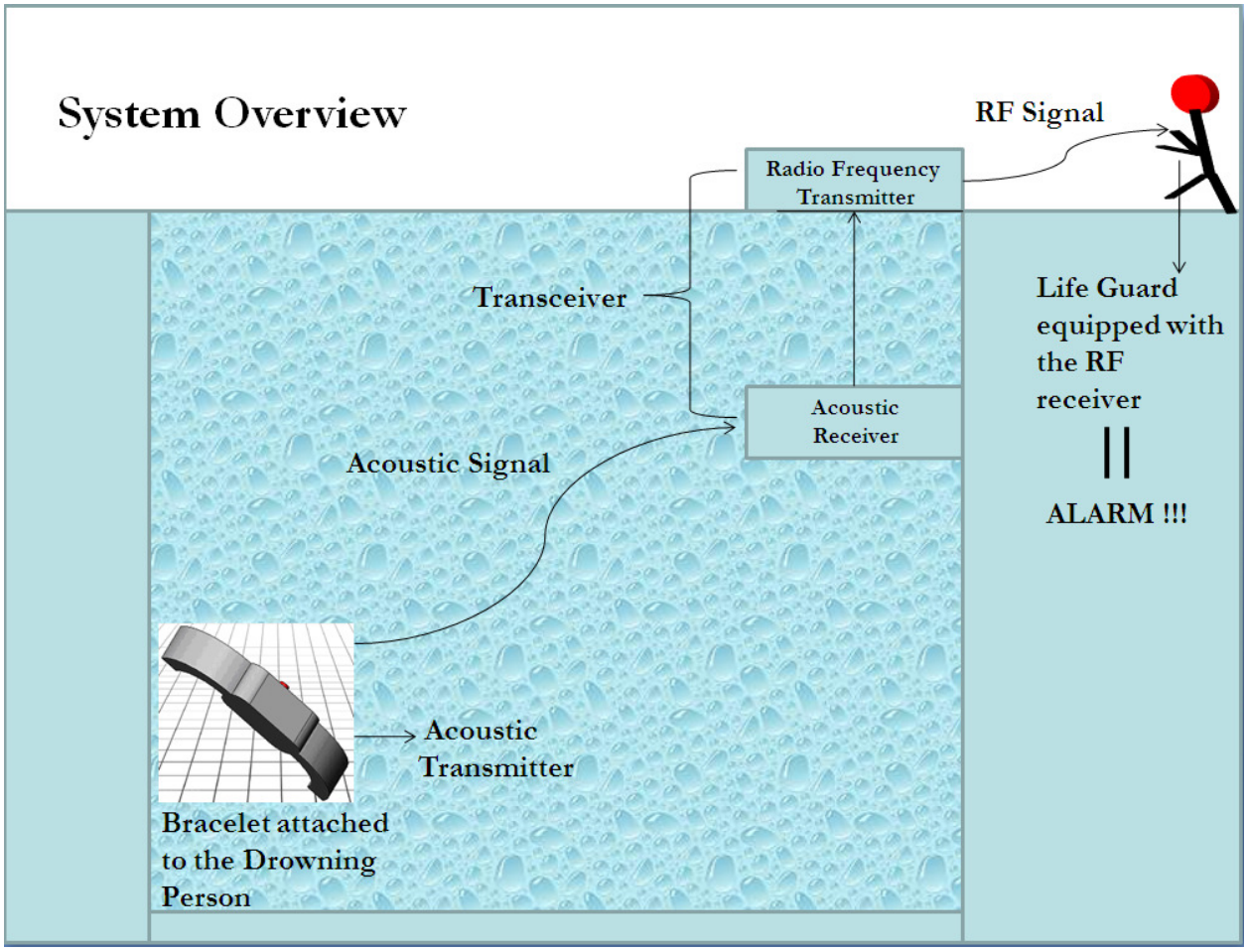
2.0 System Overview

The iLifeGuard System's mode of operation is based on acoustic and radio wireless communication between three devices. The first is a bracelet worn by the swimmer which is responsible for sending a signal when a swimmer is at risk of drowning. The second device is installed at the top corner of the pool. It is responsible for receiving signals sent by the bracelet while at the same time relaying the received signal to the third device carried by the life guard which peeps whenever a swimmer activates their bracelet. Figure 2.1 below shows an overview of the configuration of the iLifeGuard system.



. Figure 2.1 – System Overview

3.0 System Requirements

System requirements are divided into 4 categories, general requirements, bracelet requirements, transceiver requirements and receiver requirements.

3.1 General Requirements

[R1] The overall retail price of the product should stay under $1200. [i]
[R2] The retail price of the bracelet should stay under $20. [ii]
[R3] The product should operate effectively underwater at normal swimming pool temperatures. [iii]
[R5] The bracelet must have a good hold on user's wrist. [ii]
[R6] The overall system must cause any harm to the swimmer. [iii]
[R7] Inside the water there should only be acoustic signal communication. [iii]
[R8] Outside the water there should only be RF signal communication. [iii]

3.2 Bracelet Requirements

3.2.1 General Requirements

[R9] The bracelet will be able to measure the underwater pressure at the user's location. [iii]
[R10] The bracelet will be able to create a 100 KHz acoustic signal commanded by an embedded microcontroller. [iii]
[R11] The bracelet shall have a low power use in idle state for standby modes. [iii]
[R12] The pressure sensor and the microcontroller must communicate with each other in real time. [iii]
[R13] The bracelet shall have a price of approximately $50. [i]
[R14] The buzzer installed in the bracelet should always be able to output approximately 100 KHz acoustic signal under water. [iii]

3.2.2 Physical Requirements

[R15] The bracelet needs to be fully water-resistant. [iii]
[R16] All the electronics should be contained inside the bracelet so there is no contact with the water. [ii]
[R17] The bracelet should be a fancy looking device so that children would not be tempted to take it off. [ii]

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[R18] It should be tolerable and resistant to sudden pressure hits. [iii]

3.2.3 Electrical Requirements

[R19] The bracelet should operate from a 3-5V range at a current rating of maximum 240μA. [iii]

[R20] The maximum power consumption of the bracelet should not exceed 10V. [ii]

3.2.4 Environmental Requirements

[R21] It should operate within typical swimming pool water temperatures (25-28°C) [2]. [iii]

[R22] The noise from the bracelet should be minimal at approximately 100 KHz which cannot be picked by unaided human ear [3]. [iii]

[R23] The bracelet should not produce excessive heat. [iii]

3.3 Transceiver Requirements

3.3.1 General Requirements

[R24] Process all the signals received from the bracelet via an embedded acoustic receiver and radio frequency transmitter. [iii]

[R25] The acoustic receiver should easily detect the acoustic signal transmitted by the bracelet. [iii]

[R26] Furthermore, the transceiver should differentiate between numerous noises inside the pool and the acoustic signal from the bracelet. [iii]

[R27] Transmit RF signals to a receiver outside the swimming pool. [iii]

3.3.2 Physical Requirements

[R28] The transceiver should have a low power use in the idle state when in standby mode. [iii]

[R29] It should be fully waterproof. [iii]

[R30] It should be resistant to all water pressure hits. [ii]

[R31] The microcontroller and the receiver should be connected by two wires and the wires need to be long such that the microcontroller is outside the pool and the receiver is deep inside the water. [i]

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[R32] The part of the transceiver outside the water should be covered in waterproof material such that it avoids contact with the water from splashes etc. [iii]

3.3.3 Electrical Requirements

[R33] The transceiver should operate from a 3-5V range at a current rating of maximum 240μA. [iii]
[R34] The maximum power consumption of the transceiver should not exceed 0.0122 Watts. [iii]
[R35] The attached cable from the microcontroller to the microphone receiver should be no less than 1.5 meters. [i]

3.3.4 Environmental Requirements

[R36] The microphone receiver inside the water should operate under normal swimming pool water temperatures (25–28 °C). [iii]
[R37] The operation of this device should be silent and the microcontroller should pick up the signal after filtering the noise. [ii]
[R38] The device should produce minimal amounts of heat. [iii]
[R39] The receiver should be only for underwater use whereas the microcontroller and the transmitter part of it should be for air use only. [iii]

3.4 Radio Frequency Receiver

3.4.1 General Requirements

[R40] It communicates directly with the transceiver just outside the swimming pool through RF signals. [iii]
[R41] When it receives a signal from the transceiver it should alert the lifeguard that an alarm has been activated and that someone in the pool is possibly drowning [iii]
[R42] It should extract the RF signal from the transceiver by means of filtering the AC at 2.4GHz signal. [iii]
[R43] The receiver should provide clear indication of the alarming signal to the lifeguard [ii]

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[R44] All the RF signals around, possibly from cell phones or any other electronic devices should not interfere with the RF signalling between the transceiver and the receiver. [iii]

3.4.2 Physical Requirements

[R45] The receiver's electrical wiring should be carefully routed within the waterproof surrounding. [i]
[R46] The receiver should have a low power use in the idle state when it is in standby mode. [iii]
[R47] The receiver's physical size should not exceed 5.0 cm X 5.0 cm X 5.0 cm and should weigh less than 50 grams. [ii]

3.4.3 Electrical Requirements

[R48] The receiver should operate from a 3-5V range at a current rating of maximum 240μA. [iii]
[R49] It should have water protection so the circuitry inside does not come in contact with the water and cause system crashes. [iii]
[R50] The maximum power consumption of the transceiver should not exceed 0.0122 Watts.

3.4.4 Environmental Requirements

[R51] The system should be able to operate within typical room temperature (15^0C–25^0C) [5]. [iii]
[R52] The receiver should create flashing lights and an alarming noise through a speaker that should be noticeable to the lifeguard. [ii]
[R53] The receiver should only work in air and not underwater. [iii]

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4.0 Additional System Specifications

4.1 Standards

Source	Standard	Title
CSA	C22.2 NO. 60065-03	Audio, Video and Similar Electronic Apparatus – Safety Requirements
CSA	C108.1.1-1977 (R2003):	Radio Frequency Interference Measuring Instrument
CSA	C22.2 NO. 61010-1-04	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements (Adopted IEC 61010-1:2001, MOD) (Tri-National standard, with UL61010-1 and ISA 82.02.01)
CHA	Code 24	Guidelines for the Safe Use of Ultrasound: Part II - Industrial & Commercial Application
ITU-T	-	Standards defining how telecommunication networks operate and interwork

4.2 Reliability and Durability

4.2.1 Bracelet:

[R54] The bracelet should be able to withstand day to day wear usage since people will go to the swimming pool on an everyday basis. [ii]

[R55] The bracelet should only be repaired by trained technicians. [iii]

[R56] The battery life of the bracelet should be no less than 500 hours. [ii]

[R57] All the circuit components should be modularized such that it is easy for repair. [ii]

4.2.2 Transceiver:

[R58] The microphone receiver part of the transceiver needs to be resistant to corrosion since it will be constantly under water. [ii]

[R59] Furthermore, the device should also be resistant to the numerous chemicals inside a swimming pool like chlorine etc. [ii]

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[R60] The microcontroller part of the transceiver needs to be fully waterproof since the electronic components must be isolated from the water. [iii]

[R61] The transceiver should not be serviceable by the end user but only by trained technicians. [ii]
[R62] The battery life of the transceiver should be no less than 2000 hours. [ii]
[R63] Just like the bracelet, all the circuit components should be modularized such that it is easy for a repair when needed. [ii]

4.2.3 Receiver:

[R64] If the device is in need of a repair only trained technicians should try and fix it and not the end user. [ii]
[R65] The receiver also need to be completely waterproof since in a swimming pool area water is present everywhere. [ii]
[R66] The battery life for this part of the system should also be no less than 2000 hours. [ii]

4.3 Safety

4.3.1 Bracelet:

[R67] The bracelet should be safe for people to wear it with a zero risk level. [iii]
[R68] The current in the bracelet should be in the micro level such that even if it comes into contact with the user`s skin the effect would not be dangerous. [iii]
[R69] All electrical and electronic components should be enclosed by waterproof material. [iii]
[R70] The design of the bracelet should be appealing to the typical user, should not slip off the user's wrist and should be loose enough to be taken off when needed. [ii]
[R71] The bracelet should not combust or create any heat such that it damages the waterproof material. [iii]
[R72] The bracelet should not have any sharp edges that could cause injury to the users. [iii]

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4.3.2 Transceiver

[R73] The microphone should not create high currents that may damage the microcontroller. [iii]

[R74] The microcontroller and the RF signalling components should be completely sealed to prevent water damage of the device. [iii]

4.3.3 Receiver

[R75] The receiver should not overheat and should be waterproof. [iii]

[R76] There should not be any sharp corners such that the lifeguards get injured. [ii]

[R77] Trained technicians should be able to easily figure out if there is a malfunction and the repairmen should be able to fix it easily. [ii]

[R78] The flashing lights and the loudness of the receiver through the speaker should not harm the people around but should just be a normal alarm system. [iii]

5.0 Conclusion

The functional specification clearly outlines the requirements, capabilities and the parameters that are to be met by the iLifeguard system. The requirements were categorized based on whether they will be implemented in the proof-of-concept (prototype) device or in the production device. The prototype device is currently well underway and is positively expected to meet all the requirements stated in this document.

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6.0 References

[1]	"The Facts About Drowning In Canada" , [online] 2001, http://www.redcross.ca/cmslib/general/factsaboutdrowning.pdf
[2]	"New Canadians at Higher Risk of Drowning", [online] 2010, http://www.lifesavingsociety.com/PDF/LSResearchResultsRelease_FIN_ENG.pdf
[3]	"Hearing range" ,[online] 2011, http://en.wikipedia.org/wiki/Hearing_range

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