# ENSC 305W/440W Grading Rubric for Functional Specification

| Criteria | Details | Marks |
|---|---|---|
| **Introduction/Background** | Introduces basic purpose of the project. | **/05%** |
| **Content** | Document explains the functionality of the proposed product without excessive design content (i.e., outlines the "what" rather than the "how"). | **/10%** |
| **Technical Correctness** | Ideas presented represent valid functional specifications that must be considered for a marketed product. Specifications are presented using tables, graphs, and figures where possible (rather than over-reliance upon text). | **/15%** |
| **Process Details** | Complete analysis of problem. Justification for chosen functionalities. Sources of ideas referenced. Specification distinguishes between functions for present project version and later stages of project (i.e., proof-of-concept, prototype, and production versions). Comprehensively details current constraints. | **/20%** |
| **Engineering Standards** | Outlines specific engineering standards that apply to the device or system and lists them in the references. | **/10%** |
| **Sustainability/Safety** | Issues related to sustainability issues and safety of the device are carefully analyzed. This analysis must cover the "cradle-to-cradle" cycle for the current version of the device and should outline major considerations for a device at the production stage. | **/10%** |
| **Conclusion/References** | Summarizes functionality. Includes references for information from other sources. | **/05%** |
| **Presentation/Organization** | Document looks like a professional specification. Ideas follow in a logical manner. | **/05%** |
| **Format Issues** | Includes letter of transmittal, title page, executive summary, table of contents, list of figures and tables, glossary, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted. | **/10%** |
| **Correctness/Style** | Correct spelling, grammar, and punctuation. Style is clear concise, and coherent. Uses passive voice judiciously. | **/10%** |
| **Comments** | | |

October 17, 2013

Mr. Lakshman One
School of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S6

Re: Ensc 440 Functional Specification For Vital Band

Dear Mr. One,

Enclosed is the functional specification for our device, the *Vital Band*, which outlines our Ensc 440 capstone project. Vital Band is designed to measure heart rate and body temperature of the user. This device will eliminate the need for manual pulse palpation and thermometer.

The functional specification provides requirements for Vital Band's system's functionalities and specific components such as pulse sensor, temperature sensor, microcontroller, LCD and battery. Sanil tech will use this document to be a guide for research and development activities.

Snail Tech consists of four skilled and hard working fourth year engineering science students: Ardavan Kalhori, Amir Kassaian, Sepehr Sheikholeslami, and Ghazal Saray-sorour. If you have any questions or concerns about our proposal, please feel free to contact us by phone at 604-374-8116 or by email at aka66@sfu.ca.

Sincerely,

Ardavan Kalhori,
CEO
Snail Tech

Enclosure: Functional Specification for Vital Band

# Functional Specification:

# Vital Band

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**Submitted to**
Mr. Lakshman One – Ensc 440
Mr. Mike Sjoerdsma – Ensc 305
School of Engineering Science
Simon Fraser University
**Issued Date**
October 17, 2013

## Executive Summery

The 21st century is categorized by a demanding lifestyle, full of distractions. People simply pay less attention to their health as they go along their busy lives. The result of which could be attributed to the steady increase in the number of heart attack related hospitalizations [1]. Since the two most prominent determinants of health are cardiac function and body temperature, we are seeking to introduce a product that would make heart rate and body temperature measurement convenient not only for the elderly, but also for young athletes.

In order to appeal to the masses, the product needs to be very easy to use and relatively inexpensive. Therefore, we propose a wearable wristband capable of both heart rate and body temperature monitoring. While the market is filled with similar products, we seek to differentiate Vital Band in its capability of being individualized, accurate and competitively priced.

Heart rate is to be measured via an optical sensor situated at the top, so that the user could place his/her fingertip on the sensor and read an accurate measurement within seconds. Another feature is detecting skin temperature, an indicator of body temperature, using IR temperature sensor or an adhesive mounted surface temperature sensor.

At initial setup, user chooses his/her appropriate age-group via a simplistic interface. The device will then let user know when there is abnormality regarding his/her heart rate.

This document outlines the functional requirements of the device, which include cost, physical, usability, safety, environmental and other requirements. The initial prototyping is estimated to cost around $750. Upon final usability and design testing, the finished prototype is to be mass-produced, which would decrease the cost substantially to around $150, making Vital Band not only technologically, but also price-wise competitive in the market

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# 1.Introduction

Vital Band consists of a pulse sensor, IR temperature sensor, microcontroller, LCD and a battery. Pulse sensor measures the heart rate and IR temperature sensor measures the body temperature. User has to place his fingertip on the pulse sensor for about 5 to 10 seconds to be able to see his heart rate accurately on the LCD. Body temperature is displayed consistently as long as the device is on because the wristband is close to the user's body at all times. Microcontroller is used to communicate with sensors and LCD to display the data. A battery is used to power the wristband and an on/off switch will connect or disconnect the battery from the controller.

## 1.1 Scope

This document illustrates the functional requirements that will be met by Vital Band. The requirements listed in this document will describe the functionalities of both individual components and the system as a whole. This document will be used as an important reference to the Snail-Tech Company during the implementation and development of Vital Band.

## 1.2 Intended Audience

The functional specification document is intended to serve as a reference to the member of Snail-Tech team. The engineers will use the document to ensure that the product meets the stated criteria of the model.

## 1.3 Classification

In this document, the following notation will be used to define the functional requirements:
[R-n-p] A functional requirement.

Where 'R' is the functional requirements, 'n' is for the requirement number and 'p' is the priority of the requirement, which is denoted by the following:

I. The requirement applies to the prototype model.
II. The requirement applies to the production model.
III. The requirement applies to both prototype and production model.

# 2.System Requirements

## 2. 1 System Overview

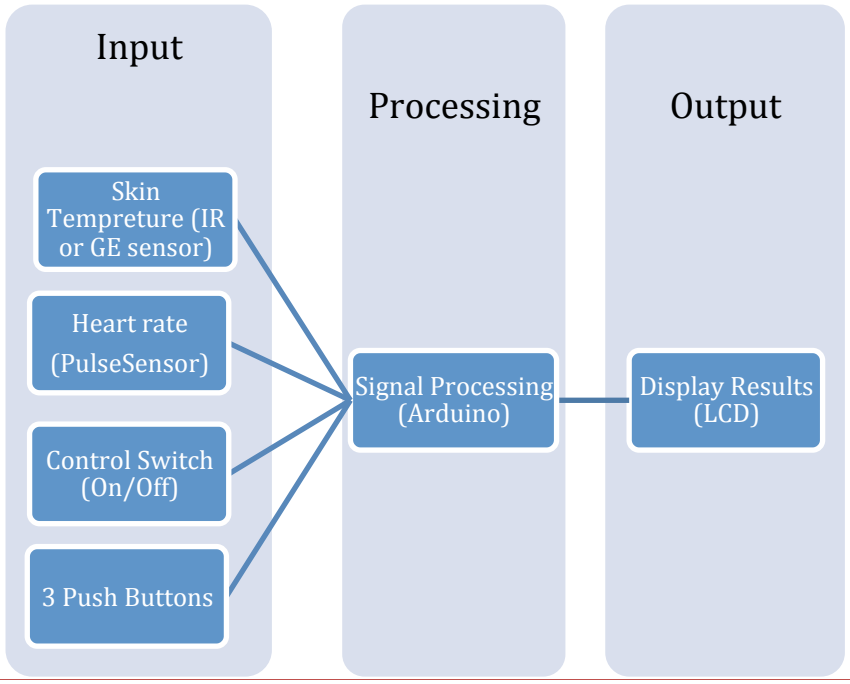


**Figure 1: Functional Block Diagram Illustrating the General Process**

## 2.2 General Requirements

[R-1-II] The retail price of the wristband shall be less than $150 CAD.
[R-2-III] Device will be ready to use immediately once it has been turned on (negligible delay).

## 2.3 Physical Requirements

[R-3-II] The weight of the wristband shall be less than 100g.
[R-4-III] The vital band shall be worn around the wrist.

[R-5-III] The wristband will be adjustable to be worn comfortably by using velcro strap.
[R-6-III] The LCD shall be 1.3" to fit on the wrist.
[R-7-I] The pulse sensor shall be placed on top of the wristband for easy access.
[R-8-III] If IR sensor is chosen for temperature measurement, it shall be placed on the side of the wristband facing user's skin. If the surface-mounted skin sensor is chosen, it shall be placed on the bottom where it has contact with the user's skin.
[R-9-II] The pulse sensor shall be replaced with a more robust sensor to provide more accuracy and ability to measure heart rate in real time (without the need to place forefinger).

## 2.4 Performance Requirements

[R-10-II] The heart rate shall be displayed for 10 seconds after the finger is removed.
[R-11-III] User will be notified when the heart rate is too high.
[R-12-III] The body temperature shall be displayed at all time (when ON).
[R-13-III]

## 2.5 Power Requirements

[R-14-I] A 3.7 V battery will power the device.
[R-15-I] The battery shall need to be recharged only every 10 hours of usage.

## 2.7 Reliability Requirements

[R-16-I] Margin of error in heart rate measurement shall be no more than 15%.
[R-17-II] Margin of error in heart rate measurement shall be no more than 5%.
[R-18-III] Accuracy of IR temperature sensor in the operating range (30~40°C) will be ±0.6°C [2].
[R -19-III] Perspiration on the skin due to exercise shall not interfere with the performance of the wristband.

## 2.8 Environmental Requirements

[R-20-I] The outer body of the wristband will be made with ABS plastic, which is recyclable [3].
[R-21-I] The recyclable sign shall be shown on the wristband.

[R-22-I] The wristband will be a velcro strap, which is recyclable.

### 2.9 Safety Requirements

[R-23-I] The wristband shall be worn in dry environment.
[R-24-II] The wristband can be waterproof.
[R-25-III] The battery and the Arduino shall be electrically isolated to avoid risk of electric shock (contact with more than 10 milliamps of currents could be harmful [4])

## 3. Engineering Standards

Vital Band shall conform to the following standards:

| Standards | Title |
|---|---|
| **CAN/CSA-C22.2 No. 60601-1:08** [5] | *Medical electrical equipment — Part 1: General requirements for basic safety and essential performance* |
| **ISO/IEC 62366: 2007** [6] | *Medical Devices – Application of Usability Engineering To Medical Devices* |

**Table 1: List of Relevant Standards**

## 4.User Interface

The user interacts with the wristband via a set of buttons on the side and an ON/OFF switch (Figure 2-4).

Figure 2: Vital Band in OFF State


Figure 3: Vital Band in ON State (Temp. Measurement Only)


Figure 4: Vital Band in Full Functionality

### 4.1 General Requirements

[R-26-III] The wristband will be turned on using an ON/OFF switch.
[R-27-III] Once the device is ON, it will continuously measure skin temperature via either the IR sensor or the GE skin sensor.
[R-28-III] In the first page, user should be able to choose his/her age group (first time only), which is stored for future analysis. This is to be done via the three buttons on the side (Two UP and DOWN buttons, one SELECT).
[R-29-III] The LED on pulse sensor will indicate whenever the device is ready for heart rate measurement.
[R-30-I] User shall place the fingertip on top of the pulse sensor.
[R-31-I] Heart rate will be displayed 10 seconds after the fingertip is place on the sensor.
[R-32-III] User will be alarmed (via LCD) in case the measured heart rate exceeds the nominal age-compensated healthy heart rate (pre-calculated).
[R-33-II] The user will be able to also choose his/her desired exercise intensity, and receive alarm feedbacks accordingly.

### 4.2 Usability Requirements

[R-34-III] The device will be intuitive to understand and work with.
[R-35-III] The font on LCD shall be large enough for elderly to be able to read.

## 5.Test Plan

The test will be done to make sure that the device meets the functional specification. The test procedure will be divided into three sub-groups based on specific components in the system, which include the pulse sensor and skin temperature sensor and the software.

To test each component, the following procedure will be done.

### 5.1 Skin Temperature Sensor

The wristband will be worn around the wrist and the power switch will be pushed to turn on the device. The temperature shall be displayed on the LCD in less than 5 seconds. This test will be done with both candidate sensors (IR and surface-mounted).

## 5.2 Pulse Sensor

The wristband will be worn around the wrist and the power switch will be pushed to turn on the device. After the LED of the sensor is on, the fingertip will be placed on top of the sensor and the heart rate shall be displayed on LCD in less than 10 seconds.

## 5.3 Software

1. The device will be turned on when the switch is on and the setting screen will be displayed.

2. The setting screen will prompt the user to select age group and it will be saved unless the select button is pushed for 5 seconds, which allow the user to select another age group.

3. It will display a screen showing both the temperature and heart rate.

4. The heart rate will be displayed only if it's within a range (it will detect when the fingertip is on the sensor) otherwise it will display 4 dashes.

5. If the heart rate is above the range (ex. 220 - his/her age) then a message "High Heart Rate" will be displayed underneath the heart rate and the heart rate icon will be replaced with the blinking one.

These tests will ensure that our prototype will meet all the requirements listed in this document in terms of functionality and reliability.

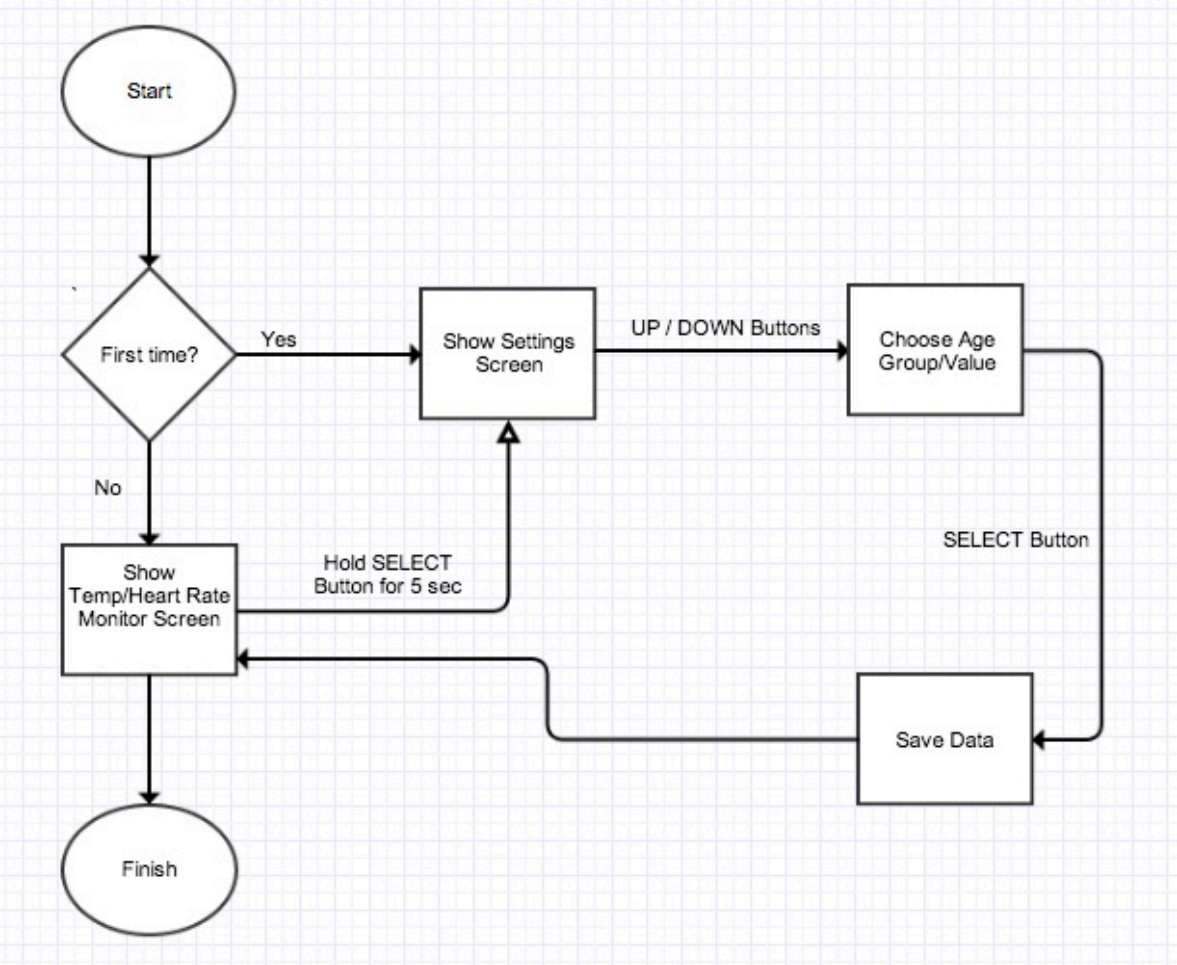


**Figure 5: Software Flowchart**

## 6. Conclusion

This document summarizes the general, specific and functional requirements of Vital Band. The main purpose of the intended product is robustness and ease of use; therefore there is a limited number of buttons through which the user can interact with the device. Most of the features are shared between the prototype and the final product. However there are a few distinctive features reserved for the final product, which include (but not limited to) the following: lower production costs, ability to choose exercise intensity, and a more efficient heart rate sensor.

The prototype is scheduled to be ready no later than December 1st 2013. Upon achieving the intended functionality and positive feedback from the judging committee, the final product is to be manufactured and entered into the retail market within a year, namely, December 1st 2014.

## 7. References

[1]http://www.heartandstroke.com/site/c.ikIQLcMWJtE/b.3483991/k.34A8/Statistics.htm#stress
[2] http://www.epictinker.com/IR-Temperature-Sensor-p/ft-irtemp.htm
[3] http://en.wikipedia.org/wiki/ABS_plastic
[4] http://electrical.about.com/od/electricalsafety/a/amperagekills.htm
[5] Canadian Standards Association, *CAN/CSA-C22.2 No. 60601-1:08 – Medical electrical equipment Part 1: General requirements for basic safety and essential performance*. Canadian Standards Association, 2nd edition, 2008
[6] ISO/IEC 62366:2007, *Medical devices – Application of usability engineering to medical devices.* Geneva , International Electrotechnical Commission. 2007