SUN SMART School of Engineering Science, Burnaby, BC, V5A 1S6

February 15, 2009
Dr. Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Functional Specification for a Portable UVB Monitoring System

Dear Dr. Leung:

Please find attached the functional specification document for ***Portable UVB Monitoring System***. In this project we are designing and implementing a highly portable device that is capable of measuring the UVB component of the sun. This device comes equipped with informative features such as a SPF suggestion for any specific UV index at any moment.

This functional specification document will focus on high-level requirements of our project. The requirements apply to either or both of the proof-of-concept and the production phases of our project.

Sun Smart consists of three fourth and fifth-year engineering students: Nima Edelkhani, Kimia Nassehi and Daryoush Sahebjavaher. If you have any questions or concerns about our proposal, please feel free to contact me by phone at (604) 992-1364 or by e-mail at nedelkha@sfu.ca.

Sincerely,

Nima Edelkhani

Nima Edelkhani
Sun Smart Inc.

Enclosure: ***Functional Specification for a Portable UVB Monitoring System***

SUN SMART

Functional Specification for the

Portable UVB Monitoring Device

Project Team: Nima Edelkhani
Kimia Nassehi
Daryoush Sahebjavaher

Contact Person: Nima Edelkhani
nedelkha@sfu.ca

Submitted to: Dr. Patrick Leung – ENSC440
Steve Whitmore – ENSC305
School of Engineering Science
Simon Fraser University

Issued Date: Feb 16th 2009

Version: 1.2

EXECUTIVE SUMMARY

In North America many people spend their leisure time outdoors mostly in summer. In addition to that many people work outdoor throughout the year. This means many people are exposed to the UV rays of sun for long hours. This exposure causes many health risks including different types of skin cancer. Sun exposure causes 90% of skin cancer cases and its estimated that 62,480 melanoma cancer cases will be diagnosed this year with nearly 8,420 cases resulting in death [1]. Skin cancer can be easily prevented by practicing sun safety from young ages. Cancer prevention can save more than $1 billion cost associated with direct curing of non-melanoma cancer.

Portable UV Monitoring System developed by Sun Smart is a great product for practicing sun safety. This device informs the user of UVB index at the location and suggests the required amount of SPF to be applied. This device is small enough to fit on user's wrist like a watch, can be installed on cell phones and many other portable devices and can be used on all beach equipments. This device gives the opportunity to know the most dangerous hours to be exposed to the UV rays and helps users prevent sun burn and skin damage.

This project consists of two phase: phase one is proof of concept prototype and the second phase will be the downsized final product that fits on a wrist watch. By the end of the first phase this device will include full functionality by programming the Butterfly board in C language. These functionalities include:

- A working clock which can be set by users
- Calibrated UV reading by the sensor
- Showing required amount of SPF to be applied due to current UVB level
- Two push buttons which will help user switch menus on the watch

In the second phase we will optimize our design by reducing the size of this device to fit on a wrist watch. This will include a PCB design which is going to have at least two layers and will contain our Atmega169 microprocessor, LCD, UVB sensor, flash memory and other required components. These components need to be carefully soldered to the PCB board and tested to make sure they perform full functionality. The process of completion for this device is estimated to end on April, 16, 2009.

TABLE OF CONTENT

LIST OF FIGURES

GLOSSARY

PUMS	Portable UV Monitoring System
JTAG	Joint Test Action Group

1. INTRODUCTION

The Portable UVB Monitoring System is a small, light, inexpensive monitoring system that can be installed on many portable devices in order to help users practice sun safety. This device will display amount of UVB level at the location which then suggests the required amount of SPF that user needs to apply. This device will update the UVB index constantly so user can rely on this device to alert them if the exposure is dangerous or if they are using the wrong level of SPF. The PUMS device is easy to use and helps every user experience safe sun exposure during all seasons and will provide outdoor workers with a reliable reference to UVB rays.

1.1 SCOPE

This document describes the functional specifications of PUMS. It will explain phase one: proof of concept prototype and phase two the downsized final product.

1.2 INTENDED AUDIENCE

The Sun Smart members will go back on the functional specification document regularly in order to make sure every functionality is derived according to the explanations in this document. This document can also help all members with providing a reference to check with project progress. Design engineers can use every detailed design specification to compare the resulting product with the expectations explained in this document. Test engineers can use the functional specification document to check resulting functionality and find defects. Environmentalists shall read this document and propose additional functionalities.

1.3 CONVENTIONS

The development of PUMS has two major phases: the proof of concept phase and the end user product prototype phase. The following conventions are used to distinguish between these two stages throughout the document:

The functional requirement contents are written in “[R1-II] Functional requirement” format, where the cardinal number refers too the statement number and the roman numeral refers to the development phase. I refers to the proof of concept phase, II refers to the prototype end user product and III refers to the final commercial product.

2. GENERAL REQUIREMENTS

We present the general requirements associated with the Portable UVB Monitoring Device in this section:

2.1 SYSTEM OVERVIEW

Figure 1 shows a general system overview of the portable UVB monitoring device:

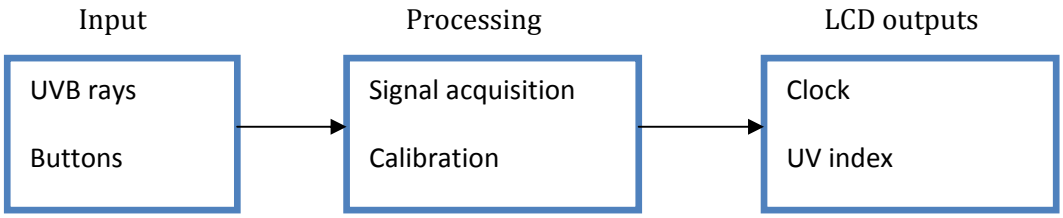

Figure 1: System overview

The system would consist of three sub-units: an analog UVB sensing circuit, a digital processing unit and an LCD display. The Portable UVB monitoring system will sense the UVB radiation magnitude, display the corresponding UV index and recommend an appropriate SPF. Moreover, the device will be small enough to fit inside a watch and it will incorporate a user friendly interface that allows users to easily gain access to the clock, UV index or SPF levels.

Figure 2 shows a simple user interface state diagram:

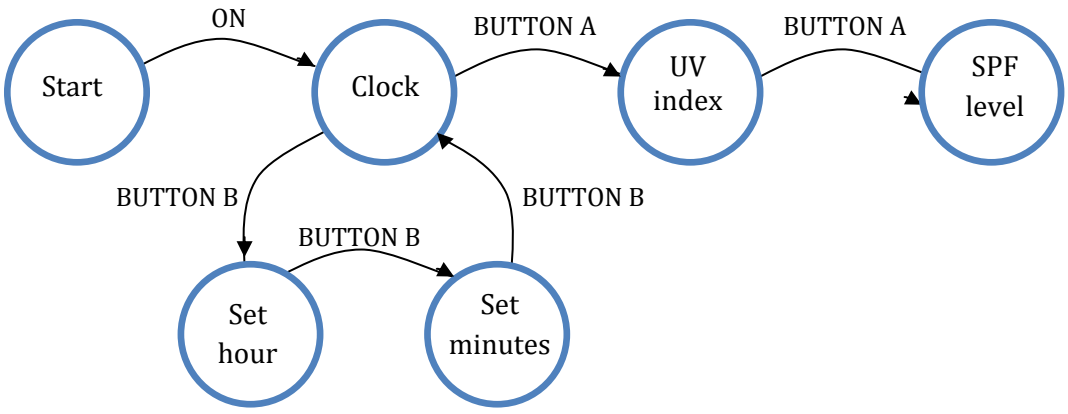

Figure 2: State diagram

Due to limited time and budget our product may have the following optional functions:

- Calendar/reminder
- Power save mode/enhanced power consumption
- Buzzer
- A log that saves a history of the acquired UVB readings in memory
- Battery meter/checker

2.2 SYSTEM REQUIREMENTS

[R1-II] The UV Portable Monitoring System should be small enough to fit on a wrist as a watch

[R2-II] The UV Portable Monitoring System should be small enough to fit on a wrist as a watch

[R3-II] This device should be user friendly and easy to use by all customer with any educational back ground

2.3 PHYSICAL REQUIREMENTS

Our commercialized device has extreme size limitations since it has to fit on the wrist like a watch. Therefore we have researched and found the smallest possible components that fit our specifications. The major parts are: LCD, microprocessor, sensor, battery, flash memory, passive components, side push buttons and op-amps. All these devices are surface mount.

[R4-II] The LCD can be no larger than 13.5mm x12mm with depth of 7mm,

[R5-II] Atmega169 microprocessor should fit into a space of 14mmx14mmx1mm

[R6-II] The UV sensor is located on the PCB and consumes a space of 2.8mmx3.2x2.43

[R7-II] The battery is the largest component which also requires a battery holder and takes 16mm x 25mm x 3mm

[R8-II] Our flash memory is large enough to store the PUMS operating system

[R9-II] The passive elements packaging can be anything equal to or less than the 0805 package

[R10-II] Push buttons can't be any larger than 5mmx7.7mmx2.6mm

[R11-II] LM358AM op amp is 5mmx6mmx1.3mm

2.4 ELECTRICAL REQUIREMENTS

2.4.1 MICROPROCESSOR REQUIREMENTS

[R12-II] The microprocessor has to have at least one A/D channel in order to be able to communicate with the sensor

[R13-II] The microprocessor has to have a serial output pin (I2C) to power the custom LCD

[R14-I] has to have enough number of pins to connect to 32 pin LCD on the butterfly board

[R15-III] It has to be programmable in C language

2.4.2 LCD REQUIREMENTS

[R16-III] LCD has to have at least four numerical digits in order to show the clock, the SPF and UV index

[R17-III] It has to be powered up with 3 V circuit global VCC

[R18-III] LCD has to have low power consumption

[R19-II] This device has to include a controller

2.4.3 SENSOR REQUIREMENTS

[R20-III] The sensor has to sense UVB rays

[R21-III] It has to have linear behavior with respect to UVB

2.4.4 MEMORY REQUIREMENTS

[R22-II] The memory should be a 4Mb flash memory

[R23-II] The flash memory should be compatible with Atmel Atmega169 Microprocessor

2.4.5 POWER REQUIREMENTS

[R24-III] All circuit components need to be powered up by a 3V battery

[R25-II] All components on circuit can draw an accumulative current less than 100 μA

2.5 USER INTERFACE REQUIREMENTS

2.5.1 GENERA REQUIREMENTS

[R26-III] General idea is to have a user friendly UI in order to be useful for anyone

[R27-II] Our User Interface consists of an LCD and two side push buttons

[R28-II] The lifecycle can't be anything smaller than 50,000 cycles

2.5.2 USABILITY REQUIREMENTS

[R29-II] The default state on the LCD is the clock

[R30-II] User can set the clock using both push buttons. They can display the UVB and SPF by pushing one of the push buttons

2.6 SOFTWARE REQUIREMENTS

[R31-III] The software has to be in C language

[R32-III] It has to take less than 4 Mb memories due to our flash memory capacity restriction

2.7 RELIABILITY REQUIREMENETS

[R33-II] The device has to operate for a temperature range of -30 to 80 degrees centigrade

[R34-II] It has to be fairly resistive to physical shock since it's a portable device

[R35-II] The electrical components should be reasonably resistive against external magnetic fields and electrical noises

2.8 USER DOCUMENTATION REQUIREMENETS

[R36-II] The users will be provided with a Quick Start Guide and a detailed User Manual at the time of purchase

[R37-II] Both above documents will be multilingual in order to be used globally

[R38-II] Both the user manual and the quick start guide documents are prepared for users with minimal to no electrical knowledge

3. System Test Plan

It is worth mentioning that for testing and debugging our butterfly board in the first stage of project there are some sophisticated methods such as connecting through JTAG port for on-chip debugging of Atmega169 microprocessor. We decided to avoid the adaptation period for such testing schemes and go with easier, more conventional methods described below. This decision was made after consultation with Dr. Leung considering that our system is not extremely complicated.

In the first phase of our project (the proof-of-concept phase) we have two main techniques for testing. One for before the LCD is fully functional and one for after. Before the LCD on the butterfly board was fully functional we depend on simulation and outputting signals to output port pins and then probing the aforementioned output pins to test and debug our code. After the LCD worked properly, we used the LCD to output pieces of information for the purpose of testing and debugging the system.

The UV-sensor and the accompanying amplification stages were built and tested separately before being connected to the butterfly circuit. In this part we used the conventional pin-by-pin check and probing with a digital multimeter to measure the voltage at various nodes of our circuit to test this block.

In the second phase of our project we are going to design a PCB and shrink the whole system to a watch-size device. Out method of testing in this stage of the project will first be a node-by-node connection check. Then to debug the circuit we will break it down to sub blocks and test the inputs and output of each block separately to be able to spot the block that is not working.

To make sure that in the second phase of our project a specific type of battery can power up the whole system, we bought a similar battery and powered up our proof-of-concept circuit which is very similar to our final product in terms of components. This testing experiment made us even more confident that our battery can indeed power up the final product.

4. CONCLUSION

This document outlines the complete list of functions and requirements of the Portable UVB Monitoring System. The project is divided into three phases: a proof of concept phase (I), an end-user prototype product phase (II), and commercialized product phase (III). Sun Smart will deliver phase I and II of the PUMS project by the date April 5, 2009.

REFERENCE

[1] The Skin Cancer Foundation, “2009 Skin Cancer Facts”, The Skin Cancer Foundation, 2009, Available: http://www.skincancer.org/Skin-Cancer-Facts/, [Accessed: February, 13, 2009]