microSense metrics

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21 February 2005

Mr. Lakshman One
School of Engineering Science
Simon Fraser University
8888 University Drive
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Re: ENSC 440 Functional Specifications for a Posture Measurement and Data Logging System

Dear Mr. One:

The attached document, *Functional Specifications for a Posture Measurement and Data Logging System*, defines the functional requirements of our proposed posture sensing device. Our device will incorporate inclination measurement, data storage, and data transmission capabilities, and aims to satisfy the physical constraints suggested by its intended usage as an unobtrusive human monitoring tool.

The functional specifications describe the functional and physical requirements of the system and its subcomponents at the production stage. The document also outlines the testing procedures that will be used to verify the proper operation of our device. Many of the requirements have been defined in consultation with Dr. Steven Robinovitch of the School of Kinesiology at Simon Fraser University and Dr. David Rempel of the University of California Ergonomics Program, who will be the primary users of our system. Their valuable input gives us confidence that our final product will satisfy their particular research needs.

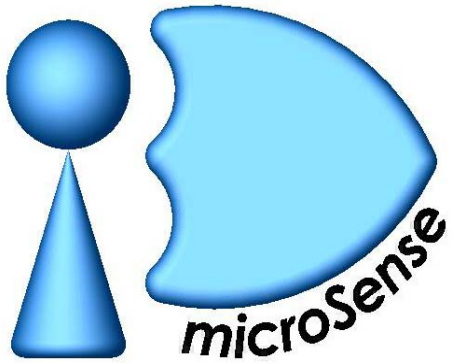
The microSense team is comprised of three dynamic engineering students: Brandon Ngai, Lawrence Wong, and Josephine Wong. If you have any further comments or concerns, please contact us by e-mail at ensc440-u-sense@sfu.ca or by phone at (604) 724-8864. Thank you for your time.

Sincerely,

Josephine Wong

Josephine Wong
President and Chief Executive Officer
microSense metrics

Enclosure: *Functional Specifications for a Posture Measurement and Data Logging System*



Functional Specifications
for a

Posture Measurement and Data Logging System

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Executive Summary

microSense metrics seeks to develop an affordable and well-designed posture measurement and data logging device that will enable researchers to track and capture natural human movement.

Our system will incorporate commercially-available micro-electromechanical system (MEMS) inclination sensors with data storage and transmission capabilities. The system will comprise of a number of independent sensor units, each capable of measuring the angle of inclination of one part of the subject's body as it moves through a dynamic range of motion. The data logger records the data in memory until the data can be transmitted to a computer terminal for further analysis. A direct Universal Serial Bus (USB) link will be used to transfer the recorded data onto the computer.

Due to the nature of the application, the sensor units will have to meet requirements in environmental, physical, operational, and power qualities. As well, each sensor unit will be required to undergo stringent quality assurance testing. Our design will be guided by these requirements.

We plan on completing our design and prototyping by April 2005.

Table of Contents

Glossary

CSV	Comma Separated Values (Excel file format)
MEMS	Micro-electromechanical System
USB	Universal Serial Bus
USB 2.0	Hi-Speed Universal Serial Bus

1. Introduction

microSense metrics is developing an affordable and functional posture measurement and data logging system that will aid researchers in preventing injuries in construction workers and the elderly [1]. Our system will track the angle of inclination of the subject's body as it moves through a range of motions. The system's data logging capabilities will enable us to capture this dynamic data and retrace the subject's movement for further analysis.

This document will act as a guide in the design of our final product by establishing the basic functional and physical requirements of our system. As well, the testing procedures that will be used to verify the proper operation of our device will be described. Possible future enhancements to the product will also be proposed.

The functional specifications of the system are subdivided into general system requirements and functional block requirements.

Each requirement is denoted:

F[*xx*-*X*] Description of functional or physical requirement.

where *xx* is the requirement number, and *X* specifies the priority of the listed function.

Requirements that will be met by the production stage will be denoted F[*xx*-A]. Possible future enhancements will be denoted F[*xx*-B].

2. System Overview

The microSense posture measurement and data logging system will merge the angle measurement capabilities of existing inclination sensors with the data capture capabilities of a data logging device. Our system can be subdivided into three major functional blocks: data acquisition, data processing and storage, and data transmission. The functional requirements of the system will be examined in each functional block.

Our system block diagram is shown in Figure 1.

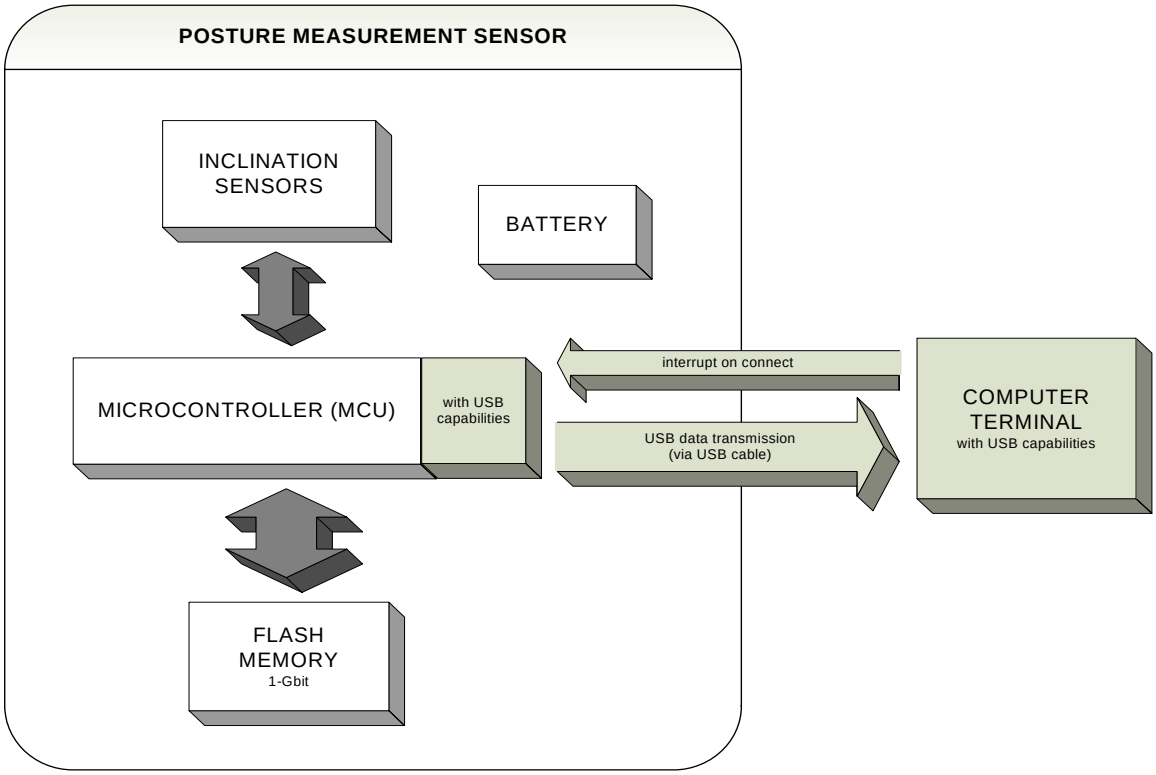

Figure 1: System Block Diagram

In the data acquisition stage, the continuous output of the inclination sensors is sampled at a user-specified sampling rate. The data measurements are then digitized and committed to the built-in memory. At the end of each test run, the captured data is transferred from the module to a computer terminal via the Universal Serial Bus (USB). Once downloaded, the raw data is parsed and processed by an in-house software package and outputted as a Microsoft Excel-compatible comma separated value (CSV) data file.

3. System Requirements

This section establishes the general system requirements for our device.

3.1 Environmental Specifications

F[01-A] The device should operate in both indoor and outdoor environments.
F[02-A] The device should operate between −20 ºC and 40 ºC.
F[03-A] The operation of the device should not be affected by RF signal interference.
F[04-A] The device should be water-resistant. The subject should be able to wear the device in the shower for 30 minutes without damaging the device.
F[05-A] The device casing should not be made from corrosive materials.

F[06-B] The device should operate between −40 ºC and 60 ºC.
F[07-B] The device should be waterproof. The subject should be able to submerge the device in the bath for 1 hour without damaging the device.

3.2 Physical Specifications

F[08-A] The device should weigh less than 200 grams.
F[09-A] The device should withstand a 2 meter fall.
F[10-A] The device should withstand 200 pounds of pressure.
F[11-A] The device should not exceed 10 cm by 5 cm by 2.5 cm in size.
F[12-A] The mounted device should not cause pain or injury to the test subject.
F[13-A] The device casing and mounting apparatus should not cause skin irritation for the test subject.
F[14-A] The device should have an accessible USB port.

F[15-B] The device should weigh less than 100 grams.
F[16-B] The device should not exceed 5 cm by 3 cm by 2 cm in size.

3.3 Modes of Operation

F[17-A] The device should have a data acquisition mode.
F[18-A] The device should have a data transfer mode.
F[19-A] The device should have a configuration mode.
F[20-A] The device should have an error-reporting mode.

3.4 Standards Compliance

F[21-A] The device should employ standard USB 1.1 data transfer protocols [2].
F[22-A] The data processing software should output the captured data in CSV file format [3].

F[23-B] The device should employ standard USB 2.0 data transfer protocols [4].

3.5 Power Requirements

F[24-A] The device should use commercially-available batteries.
F[25-A] The batteries should power the device in data acquisition mode for 2 weeks.
F[26-A] The device should have a light-up battery status indicator.

3.6 Other Requirements

F[27-A] The cost of production of the device should not exceed $500 per unit.
F[28-A] The device should have an on/off switch.
F[29-A] Each sensor module should operate independently of other modules in a test environment.

F[30-B] The cost of production of the device should not exceed $200 per unit.

4. Data Acquisition

This section outlines the functional requirements for the data acquisition components in our system.

4.1. General Requirements

F[31-A] The device should measure inclination with respect to gravity.
F[32-A] The device should measure inclination in the x- and y-axis.
F[33-A] A sample time should be assigned to each sample.

F[34-B] The sampling rate of the device should be programmable.

4.2. Performance Requirements

F[35-A] The device should have a measurement range of ±180°.
F[36-A] The device should have a resolution of ±0.5°.
F[37-A] The device should be able to operate at a maximum sampling rate of 30 Hz.
F[38-A] The operation of the device should not be affected by the speed of rotation of the test subject.
F[39-A] The operation of the device should not be affected by the temperature and humidity of the environment.

5. Data Processing and Storage

This section outlines the functional requirements for the data processing and storage components in our system.

5.1. General Requirements

F[40-A] The device should provide indication when error occurs.
F[41-A] The device should not overwrite the data in its memory without user input.
F[42-A] The memory chip should be rewritable.

5.2. Performance Requirements

F[43-A] The device should be able to store up to 14 days of data at 30 samples per second.

6. Data Transmission

This section outlines the functional requirements for the data transmission components in our system.

6.1. General Requirements

F[44-A] The device should interface with a computer terminal via an USB cable.

6.2. Performance Requirements

F[45-A] The transferred data should be verified to ensure that the data transmission was successful.

F[46-A] The data should be transferred according to USB 1.1 specifications.

F[47-B] The data should be transferred according to USB 2.0 specifications.

7. Data Processing Software

A software package will be developed in-house to support data communications between the sensor modules and USB-enabled computer terminals.

F[48-A] The data processing software should support Windows 2000/XP.
F[49-A] The data processing software should convert the acquired raw data into angular measurements with associated timestamps.
F[50-A] The angular measurements should be able to be exported to a Microsoft Excel-compatible file format.

F[51-B] The data processing software should support Windows 95, Windows 98, and Windows NT.
F[52-B] The data processing software should support Linux.
F[53-B] The data processing software should support Mac OS X.

8. Quality Assurance

Each segment of the system will be tested thoroughly to ensure proper operation.

F[54-A] The device should be tested at 0 °C and at room temperature.
F[55-A] The device should be tested after 30 minutes of exposure to water in a shower.
F[56-A] The device should be tested after being dropped from a height of 2 meters.
F[57-A] The device should be tested to ensure that the chosen battery can power the device for 14 days.
F[58-A] The device should be tested to ensure that the data acquisition performance requirements are met.
F[59-A] The device should be tested to ensure that the memory can store 14 days of data at 30 samples per second.
F[60-A] The device should be tested to ensure that the data can be transferred from the sensor to a Windows 2000/XP computer terminal via USB.
F[61-A] The software should be tested to ensure that the measured raw data can be converted to time-stamped angular measurements.
F[62-A] The software should be tested to ensure that the output CSV file is compatible with Microsoft Excel.

F[63-B] The device shall be tested after being submerged in a bathtub for 1 hour.
F[64-B] The device should be tested to ensure that the data can be transferred from the sensor to any USB-enabled computer via USB.
F[65-B] Each sensor module will be tested in accordance to a standardized test plan.

9. User Documentation

A user manual will be provided.

F[66-A] The user manual will be written in English.
F[67-A] The user manual will be available in electronic format from the microSense metrics website.

F[68-B] The user manual will be available in French.
F[69-B] Additional user support will be provided via email and by phone.

10. Conclusion

This document outlines the functional and physical requirements of the microSense posture measurement and data logging system. It also explores possible enhancements that our team may incorporate in the future.

The document further outlines the test procedures that will be used to verify the operation of our devices, and will guide us in ensuring that our final product meets the functional specifications that have been established.

11. References

[1] J. Wong, L. Wong, and B. Ngai, "Project Proposal for a Posture Measurement and Data Logging System," microSense metrics, Burnaby, Canada, January 2005.

[2] USB Implementers Forum, "Universal Serial Bus Specification Revision 1.1," Compaq Computer Corporation et al., September 1998.

[3] J. Repici, "The comma separated value (CSV) file format," February 2005, http://www.creativyst.com/Doc/Articles/CSV/CSV01.htm.

[4] USB Implementers Forum, "Universal Serial Bus Specification Revision 2.0," Compaq Computer Corporation et al., April 2000.