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

February 19, 2007

Re: ENSC 440 Functional Specifications for a Handheld Spectrum Analyzer

Dear Mr. One,

The attached document, *Handheld Spectrum Analyzer Functional Specifications*, outlines SonoSense Technologies Inc.'s functional specifications for the ENSC 305/440 project.

We are currently in the course of designing and developing a handheld device that analyzes various sound inputs from the surrounding area that are within the human hearing range, frequencies between 20 Hz and 20 kHz. The results of this frequency analysis are displayed visually in terms of certain frequency intervals and their respective power spectrums on the display unit of our Handheld Spectrum Analyzer. Our device also features an interactive menu with a display similar to common audio equalizers, allowing users to observe, save and compare various frequency spectrums.

The purpose of the enclosed document is to present the overall functionality of our prototype Handheld Spectrum Analyzer by highlighting all the phases of development and primary and tentative features, as well as its limitations. This document contains the specifications that will be completed before the proof-of-concept project demonstration deadline in late April. In addition, we will discuss future improvements and functional features that may be implemented in later stages of the production cycle.

SonoSense Technologies Inc. is compromised of four motivated, innovative, and talented fourth year engineering students: Sanaz Jahanbakhsh, Johnny Pak, Naureen Sikder, and Kenneth Wong. Should you have any questions or concerns about our functional specifications, please feel free to contact me by phone at (604) 722-0473 or our group e-mail address at ensc-440-project@sfu.ca.

Sincerely,

Sanaz Jahanbakhsh

Sanaz Jahanbakhsh
President and CEO
SonoSense Technologies Inc.

Enclosure: *Handheld Spectrum Analyzer's Functional Specification*

Handheld Spectrum Analyzer
Functional Specifications

SonoSense Technologies Inc.

Team: Sanaz Jahanbakhsh
Johnny Pak
Naureen Sikder
Kenneth Wong

Contact: Sanaz Jahanbakhsh
(604) 722-0473
ensc-440-project@sfu.ca

Submitted to: Lucky One
Steve Whitmore
Engineering Science
Simon Fraser University

Revision Date: February 19, 2007

Revision Number: 1.0

Executive Summary

The lack of user-friendly analyzers has made it difficult for musicians and other sound-based professions to reliably optimize the clarity of their performance. Despite the availability of digital sound conversion and optimization solutions in the market, only a handful of devices can detect the sources of interference anywhere. It is also important to ensure that sound quality is evenly distributed and perceived to be acceptable throughout the venue. The measured power distribution over various frequency ranges can be used to tune and arrange musical equipment to optimize the sound quality experienced by the audience.

The Handheld Spectrum Analyzer is a device that analyzes the spectrum of input sound sources received from either audio equipment or the surrounding environment. In addition, the device allows the user to move throughout the working area and observe the different power distributions of the sound spectrum. The proof-of-concept prototype for our Handheld Spectrum Analyzer should be able to accept surrounding sound as input, calculate its frequency spectrum and display its corresponding power bar graphs on the display unit. Furthermore, the device's interface will tentatively have other features, such as allowing the user to save and store captured spectrums for future comparisons.

The core of our development is the processing unit, which converts the inputted sound data into a measurable digital quantity that is used in visualizing its spectrum. The components connected to this core are the sound input unit and the graphical display, which will be built and integrated throughout our development stages in the next year.

During the proof-of-concept prototype development stage, our goals are to design a capable sound amplifying unit, an accurate processing algorithm as well as a working display unit. In the production stage, we will be implementing more advanced features in order to improve device capabilities and enhance end-user experience.

Table of Contents

List of Tables

List of Figures

1 Introduction

SonoSense Technologies Inc. is designing a product that will evaluate the spectrum of received sound data and display the results on a user interface. The main functionality of the Handheld Spectrum Analyzer is the presentation of sound wave strengths at various frequencies, ranging from 20Hz to 20 kHz, which can be utilized for audio equipment tuning and statistical purposes.

The following sections will discuss various aspects of the overall system. Features of other important subsystems like data manipulation, storage and user interface are also indicated. In addition, regulations that must be observed and followed during the development phase and final product are stated. Please note that the mentioned requirements under the "proof-of-concept" heading refers to the specifications that will be implemented before the demonstration date of April 18th 2007; meanwhile the "production unit" refers to those features expected for later stages of product development.

1.1 Intended Audience

This document is primarily targeted towards development and integration engineers as well as the quality assurance team. Once finalized, this document will serve as the set of rules and regulations for the SonoSense engineers to design various subsystems of the device. Successful implementation of any given features in the required time constraints will be used to monitor the status and progress of the project. The completion of development can be determined by comparing the proof-of-concept device features against those mentioned in this document. In addition to outlining the product's capabilities, these functional specifications act as a reference for exploring its market prospects.

1.2 Engineering Development Cycle

This proof-of-concept project is expected to have a complete engineering cycle starting from initial research to prototype and finally to market. A valid phase one prototype will be prepared by the 18th of April 2007. The end product will be developed and upgraded in three consecutive phases. The timeline of each of these three phases is shown in Table 1.

Table 1: Phase Development Chart

Phase	Time Frame
1	Jan. 2007 – Apr. 2007
2	May 2007 – Aug. 2007
3	Aug. 2007 – Apr. 2008

The first phase of development consists of initial research to actual implementation of the proof-of concept prototype, spanning from January to April 2007. Once the initial prototype is successfully constructed and tested, the second phase begins during which more features are implemented. Lastly, in the third phase, the portability and quality enhancement of the final product will be improved to increase its marketability. The product should be ready for market release by the end of April 2008. A very basic description of the main requirements for each phase is shown in Table 2. Through each development phase, additional features will be built upon the previously implemented features.

Table 2: Phase Development Description

Phase 1: Jan-April 2007
• Receive sound input from environment and sound sources
• Display Frequency Spectrum and power levels of input
• Simple user interface
Phase 2: April-Sep. 2007
• Exporting of collected data
• Loading of collected data
• Recording of sound sources
• Frequency analysis of recorded sound files
Phase 3: Sep 2007-April 2008
• Small form factor design
• Portable power source
• Portability

1.3 Scope

Throughout this document, we will focus on the primary features of the proof-of-concept prototype that will be implemented during the first phase of development. However, in order to provide the reader with a better understanding of the proposed unit, some of the more advanced features which will be implemented in later stages of development are also listed.

Based on their usability, features are assigned a priority rating: 'Must Have' and 'Tentative'; as suggested by these phrases, 'Must Have' features are essential in meeting the functionality objectives of each particular development phase, whereas the 'Tentative' ones are enhancements to improve the final product's user interface and interaction. When building the device, 'Must Have' features will be implemented first, while the 'Tentative' features are scheduled for design in the subsequent development phases, depending on time and funding availability. In the following list of requirements, the "Must Have" features are stated without labels, whereas 'Tentative' features are indicated

2 System Requirements

2.1 System Overview

This section will provide an overview of the Handheld Spectrum Analyzer outlining its input and output, as shown in Figure 1. The audible environment or instrumental sound with frequencies ranging from 20Hz to 20 kHz is considered the input source and the frequency spectrum of the incoming audio data displayed is the system's output.

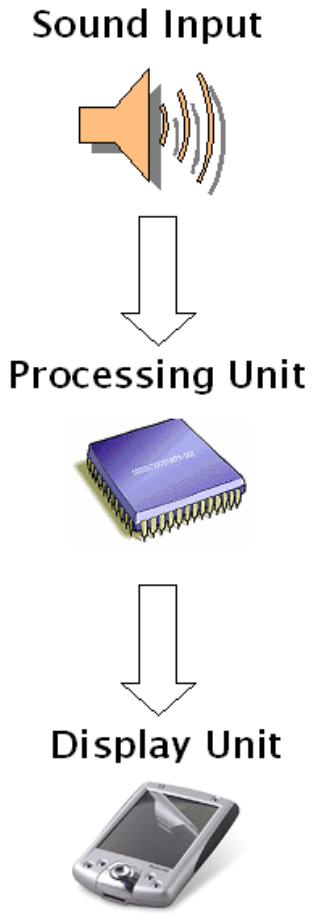

Figure 1: System Overview

Spectrum analysis results are realized in "real-time" and only sound sources within the audible range are processed. Upon the user's input, the display of sampling and refresh rates can be changed and captured spectrums can be stored onto the removable memory of the device for later comparisons on the device.

2.2 System Requirements

Because Sonosense's Handheld Spectrum Analyzer is a stand-alone and portable device after the final phase of development, the following physical constraints need to be fulfilled. In addition, the device's user interface will be running on an operating system, thus standard application development guidelines will be practiced to ensure compatibility and ease of use. Please note that the operating system will be selected based on its availability, development learning curve and advanced user interfaces.

The functional requirements for the final product should also be able to meet and compete with performance characteristics of similar consumer audio measurement equipment. This constraint is required to ensure the Handheld Sprectrum Analzyer's salability.

2.2.1 Physical Requirements

2.2.1.1 Proof-of-Concept Unit

1) In addition to a display unit, the device shall have a number of buttons for common functionality.
2) The proof-of-concept device shall be powered using a power supply and certain components of the device may be powered differently.
3) The device shall have a microphone and amplifier unit.

2.2.1.2 Production Unit

4) The device's dimensions shall be similar to those of available PDAs in the market.
5) The device shall have proper ventilation to avoid overheating of the processor.
6) The device shall be light enough to ensure ease of portability.
7) The user shall be able to choose between various sources of input.
8) The unit shall use portable power sources to supply the power for the components.
9) The user interface, necessary power components and all of the device's other components shall be placed within a rigid enclosure.

2.3 Operational Requirements

2.3.1 Environmental Requirements

10) The device shall be operating at normal room temperatures ranging between 0°C and 40°C [1].
11) The device shall withstand and operate under moderate room humidity (5% to 90%) and pressure.

12) The heat dissipation from the processing unit shall not exceed the maximum allowable temperature of 40°C.

2.3.2 Performance Requirements

2.3.2.1 Proof-of-Concept Unit

13) The system's response to the user's input display shall be faster than 70ms [2].
14) The display of the sampling rate shall be modifiable by the user. **(Tentative)**
15) The display unit shall have a backlight to improve its visibility in low lighting conditions.

2.3.2.2 Production Unit

16) The device shall be able to save data samples on an external memory unit.
17) The quality of the unit's microphone and preamplifier circuit audio output shall be comparable to professional audio equipment.

2.4 Compatibility Requirements

2.4.1 Proof-of-Concept Unit

18) The device's software shall be able to run on a selected operating system.

2.4.2 Production Unit

19) The user shall be able to read saved files from an external memory unit.
20) The device's selected audio input connector shall comply with the professional musical instrument requirements.
21) The unit's power supply shall be removable for replacement.**(Tentative)**

2.5 Reliability Requirements

The majority of this device's failures are based on the preamplifier components, firmware and operating system.

2.5.1 Proof-of-Concept Unit

22) The device shall be operable without major failures.
23) In the event of a software failure, the device shall be able to recover by restarting the application or power cycling.

2.5.2 Production Unit

24) The device shall be operable for 240 hours in stand by mode, or 3.5 hours while in active state [1].
25) Due to the long life expectancy of PCBs and low number of mechanical parts, the rate of failure during the device's first year of operation shall be less than 5% [3].
26) The device's display unit shall have a life expectancy of 15 million touches on each pixel or about 3-4 years of usage [2].
27) Application upgrades shall be available online enabling the end user to upgrade the device's software. **(Tentative)**
28) The unit shall not be repairable by the end user, since major failures are caused by circuitry or hardware malfunctions.
29) The device shall have a life span of at least 4 years when moderately used [4].

3 Interface Requirements

The following section will detail numerous user interfaces for our device. User interfaces are defined in this document as any function or process that accepts user input or produces a physical or visual feedback response.

3.1 General Interface

The following section lists common interface requirements for the end user:

3.1.1 Proof-of-Concept Unit

30) The device shall be capable of being turned on or off.
31) The device shall have a display unit for the purpose of providing feedback.
32) The device shall have a navigational control for maneuvering through the user menu.
33) The device shall have a microphone and/or sound input.

3.1.2 Production Unit

34) The device's application shall contain menu options for determining different functionality.
35) The user interface of the device shall have zoom functionality. **(Tentative)**
36) The device shall be able to save processed data to memory.
37) The device shall be able to reproduce old data on the display.
38) The device shall be able to display various rates of data sampling.

3.2 User Menu Interface

The primary conditions for the user interface are menu selection and visual feedback for the device. The main menu should be able to allow the user to access a number of different features.

3.2.1 Proof-of-Concept Unit

39) The interface shall have an option to exit.
40) The interface shall have an option to start data analysis.
41) The interface shall have an option to stop data analysis.

42) The interface shall have the ability to view data spectrum using the entire display area.
43) The interface shall have the ability to show the power levels of specific frequencies in the current window.
44) The interface shall have the ability to show the maximum power level within a specified frequency range.

3.2.2 Production Unit

45) The interface shall have the ability to retrieve saved data.
46) The interface shall have the ability to save collected data.
47) The interface shall have the ability to analyze a saved audio file.
48) The interface shall have the ability to show the frequency details at a specific point.
49) The interface shall have the ability to zoom into a specific region of data. **(Tentative)**
50) The interface shall have the ability to stop further data collection and freeze the current data displayed on the screen.
51) The interface shall have the ability to display the sound spectrums indicating maximum power level at specific frequencies in a text-based format.

4 Data Storage

Although the data storage component is planned for the second and third phase of product development, the specifications are listed in the following sections.

4.1 Data Export

The Handheld Spectrum Analyzer allows the user to export certain instances of measured power levels into a file.

4.1.1 Production Unit

52) The user interface shall support data storage to a file.
53) The data file shall be readable by a standard computer operating system.
54) Each file shall record data at a specific period in time.
55) The saved data file shall be stored in a specific format.
56) The data file shall have a time-date stamp.

4.2 Data Transfer

The accessibility of the saved data files by other devices is another important feature of the Handheld Spectrum Analyzer. The transfer conditions of the exported files are defined below.

4.2.1 Production Unit

57) The data file shall be capable of being stored on a removable media.
58) The removable media shall be capable of being read by a standard computer operating system.

4.3 Data Read

The device can load previously exported data files to analyze frequency spectrums, as specified below.

4.3.1 Production Unit

59) The data file shall be accessible by our application.
60) The data file shall provide the necessary information to reconstruct the frequency spectrum and its corresponding power levels.
61) The loaded spectrum plot from the data file shall have a time-date stamp.

5 Sound Recording & Analysis

In the second and final phases of the design process, the device will be able to record sound input into separate audio files.

5.1 Sound Recording

5.1.1 Production Unit

62) The recorded sound shall be stored in Windows Wave (WAV) format.
63) The recorded sound file shall be capable of being stored on removable media.
64) The recorded sound file shall be readable by programs on a standard computer operating system.
65) The sound file shall be recorded with a sampling rate of 44 kHz per second.

5.2 Sound Analysis

5.2.1 Production Unit

66) The saved sound file shall be readable by our device application.
67) The saved sound file shall be analyzable by our frequency analysis software.
68) A frequency spectrum shall be constructed from the loaded sound file.

6 Conclusion

Throughout this document, the expectations for the design of SonoSense's Handheld Spectrum Analyzer were outlined. The stated requirements will stipulate the end-product specifications to be completed by April 2008. All specifications defined have been comprehensively reviewed to guarantee the highest quality in terms of functionality and usability. To reiterate, the initial phase of proof-of-concept development is due at the end of April 2007, while a more refined product with advanced features is scheduled for completion at a later date. Also, specifications tagged with the term "Tentative" are of lower priority compared to other requirements. SonoSense's engineers have carefully planned each development stage to ensure the product's timely completion.

7 References

[1] Your Palm Treo™ 700p SmartPhone User Guide
http://palmone.r3h.net/downloads.palmone.com/documentation/treo700pcdma_UG.pdf

[2] Touch Screen Acts like a Mouse
http://www.touchwindow.com/miva/merchant.mvc?Screen=CTGY&Store_Code=TouchWindow&Category_Code=Mouse

[3] The Technical Life-Cycle of PCB's
http://www.chem.unep.ch/pops/POPs_Inc/proceedings/slovenia/neumeier2.html

[4] PDA Estimated Lifespan
http://palmtops.about.com/b/a/063524.htm