NewBALANCE Technologies

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April 25, 2006

Dr. Andrew Rawicz
Simon Fraser University
Burnaby, British Columbia
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Re: ENSC 440 Post Mortem for a Sensory Assistance Balance Device

Dear Dr. Rawicz:

Please find attached *Post Mortem for a Sensory Assistance Balance Device*. The document outlines the project's status quo, timeline, deviation from the original proposal and design, and budgetary and time constraints. In addition, it will provide an account of challenges our group faced in carrying out the projects. Finally, personal comments from each team members will be provided.

NewBalance's team consists of Siavosh Jalili, Sakshi Nagalia, Atefeh Palizban, and Jerry Yu, each of whom brought their own unique and valuable expertise and experiences to our team.

If you have any questions or concerns regarding our proposal please do not hesitate to contact me by phone at 778-895-5920 or by e-mail at ensc440-newbalance@sfu.ca.

Sincerely,

Atefeh Palizban

President and CEO
NewBalance Technologies

Enclosure: Post Mortem Report for a Sensory Balance Assistance Device

NewBALANCE
Technologies

Design Specification for
Sensory Balance Assistance Device

Project Team: Siavosh Jalili
Sakshi Nagalia
Atefeh Palizban

Post Mortem for

Contact Person: Siavosh Jalili
ensc440-newbalance@sfu.ca

Submitted to: Dr. Andrew Rawicz ENSC 440
Steve Whitmore ENSC 305
School of Engineering Science
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GLOSSARY

MCU: Microcontroller Unit

PCB: Printed Circuit Board

PWM: Pulse Width Modulation

SPI: Serial Peripheral Interface

INTRODUCTION

NewBalance Technologies (NBT) has undertaken the task of developing a sensory device, Equilibra, that would assist people with balance—"sixth sense"— disorders for the past 14 weeks. This document looks at the process of research, design, and development in hindsight, in the hope of providing the reader with an understanding of what could be improved in similar cases, or in the future process that might concern the future development of Equilibra.

Equilibra's Status Quo

Equilibra's accelerometer measures the inclination in either four direction and sends the data to PIC18F8722 microcontroller. If the inclination data indicates a posture that is outside the centre of mass and potentially dangerous, vibratory and auditory signals are generated in order to enable the user to avoid a fall.

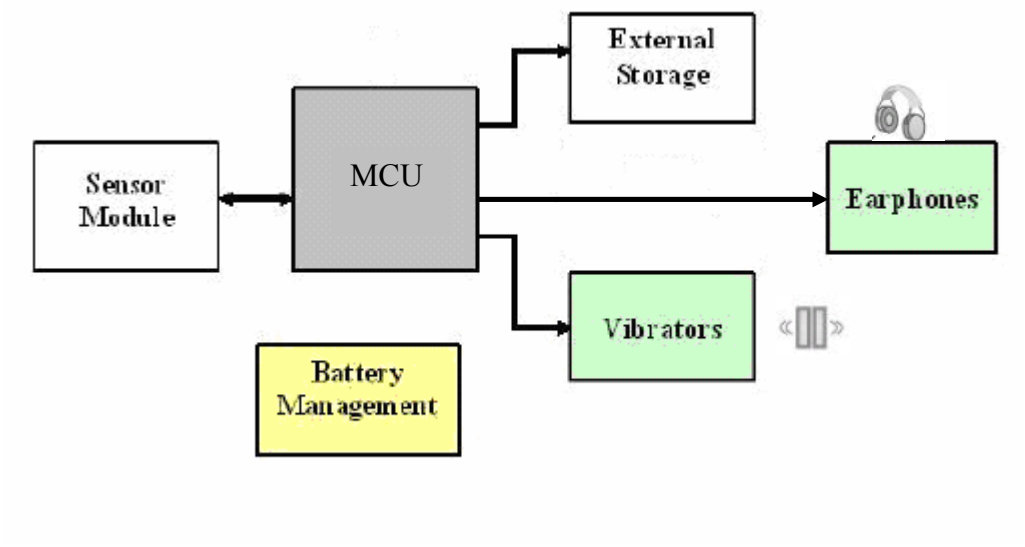

Figure 1: Equilibra's Status Quo Block Diagram

DEVIATIONS AND VARIATIONS

NewBalance Technologies has been able to develop a system whose functionality and operation only meets some of our initial objectives. Greatest challenge we faced was in the area of data acquisition and analysis. The data obtained from the sensor proved to be inconsistent, volatile, and inaccurate. This predicament prevented us from making any significant progress in other areas of the project. We were unable to have our printed circuit board (PCB) and the packaging ready due to time constraints and complications we encountered in ordering and receiving a very crucial component for our project. One of the highlights of Equilibra is its portability and light weight, features whose implementation has been postponed due to the constraints just described.

Currently, our proof of concept consists of three different circuit boards: PIC microcontroller development system, accelerometer (ADIS16201) evaluation board, and vibrators and speakers.

The design initially envisioned is depicted in figure below. By comparing the following diagram with that of Figure 1, we could see the deviations in the current proof-of-concept device.

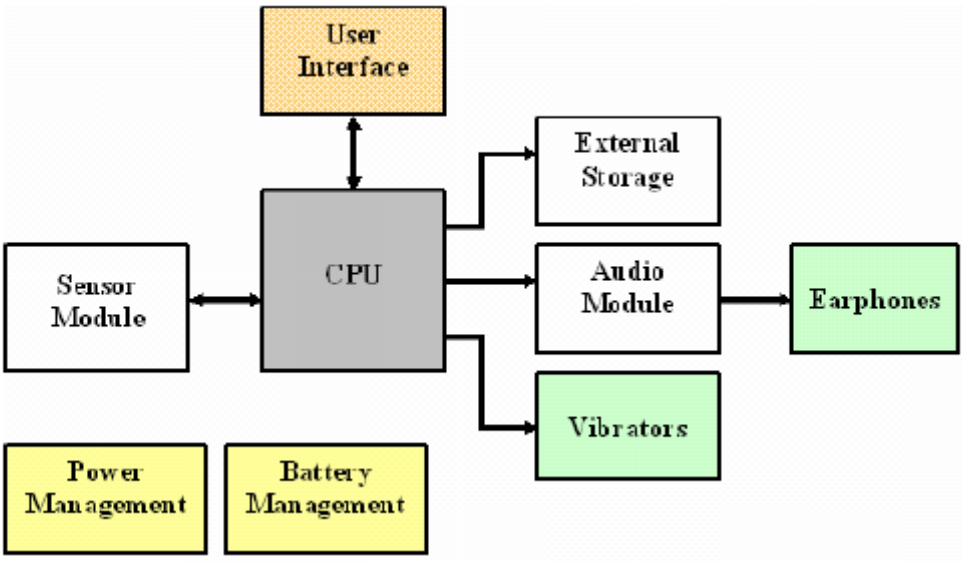

Figure 2: System Block Diagram as Initially Envisioned

The Audio Codec circuit, displayed as Audio Module in the figure above, whose purpose was to provide the user with 3-dimensional sound system, was damaged during the last week of March. While the damage incurred—capacitors connecting pins to the ground were blown—might have been reparable, we simply lacked the time to attend to such matter. As a result, we replaced the rather intricate Audio Codec circuit with a PC speaker obtained from a disposed computer.

FUTURE DEVELOPMENT

Our team believes that Equilibra is a product with a substantial market. Balance disorders are very common and there is no compatible solution available to people suffering from such problems. Completion of the project as initially intended coupled with addition of features that will bring more convenience to the user

Actuators

The current dual axis accelerometer will be replaced with an angular rate sensor (gyroscope) to address two issues: first, the inaccuracy of the accelerometer, and second, the inability of the current sensor to provide accurate measurements of inclination when the user is moving in any direction but a straight path (please refer to deviation section). NBT will search for a gyroscope that operates within the standard voltage for a hand-held device (i.e. 3.6 volts), or will alternatively use a 3-axis accelerometer.

PCB Design and Implementation

Printed circuit board will be designed, and the related documentation will be sent to a manufacturer that will provide us with the PCB. The PCB shall be subject to rigorous testing and debugging. The areas of problem will be identified, the design will be improved and corrected, and new PCB will be ordered. This process will continue until we are satisfied that Equilibra meets all our expectations and objectives.

Packaging

After Equilibra's final PCB is received and approved, the device will be enclosed in a light package suitable for portability. A conceptual image of such package is depicted below:

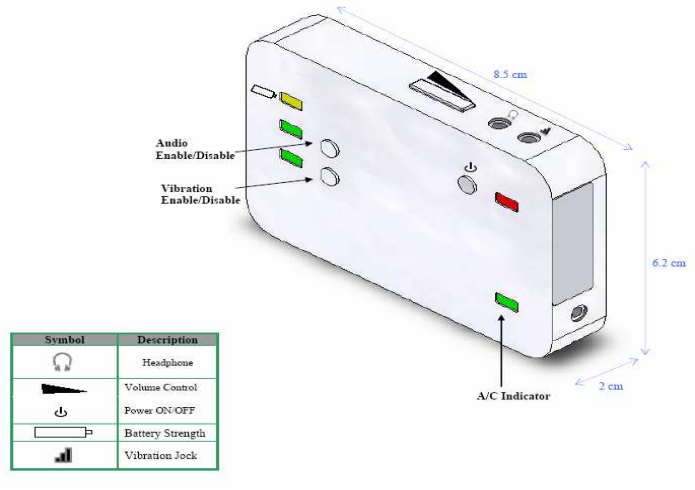

Figure 3: Conceptual Image of Equilibra's Package

Additional Features

Blue Tooth

Addition of Blue Tooth technology will enable user to hear the auditory signals using the wireless technology needless of headphones, wires, etc.

3D Audio System

The production device will employ a 3-dimensional surround sound system that will produce a tone simulation generated from the direction of inclination, thereby enabling users to distinctly identify the direction in which they are leaning.

BUDGETING AND TIME CONSTRAINTS

Budget

Our team has been successful in keeping the cost of development of Equilibra within the budget outlined in our proposal. Support from manufacturers as well as careful search of components and taking into consideration both operational and economic factors assisted us in maintaining a relatively low budget. The following table provides a comparison between our estimated cost and actual cost incurred.

Table 1: Estimated Cost vs. Actual Cost

COMPONENT NAME	ESTIMATED COST	ACTUAL COST
Development Board	$350.00	$238.27
IC Components	$250.00	
Accelerometer		Received at no charge
Audio Codec		$73.64
PCB Printing	50.00	Deferred
Modeling	40.00	Deferred
Equipments and Tools	30.00	Deferred
Accessories	20.00	
Earphones		Provided by group members
Vibrators		$16.27
Total	$740.00	$385.55

The total cost indicated above does not reflect the total cost associated with the development of Equilibra. Given the issues discussed in Deviations and Variations section of this report, there are some expenses to be incurred in the process of development of Equilibra.

Time

We have been proved to be right about any reservation and skepticism we had about timeline and scheduling of this project. While we were able to complete the documentations on time, the actual development and design deviated from the initial schedule. Figure 3 shows the Gantt's chart for our project as it had been planned in foresight and as it looks in hindsight. The blue bars correspond to the time we had allocated at the end of the 4th week to each phase of the project. The hatched red bars indicate the extent of departure from the initial schedule.

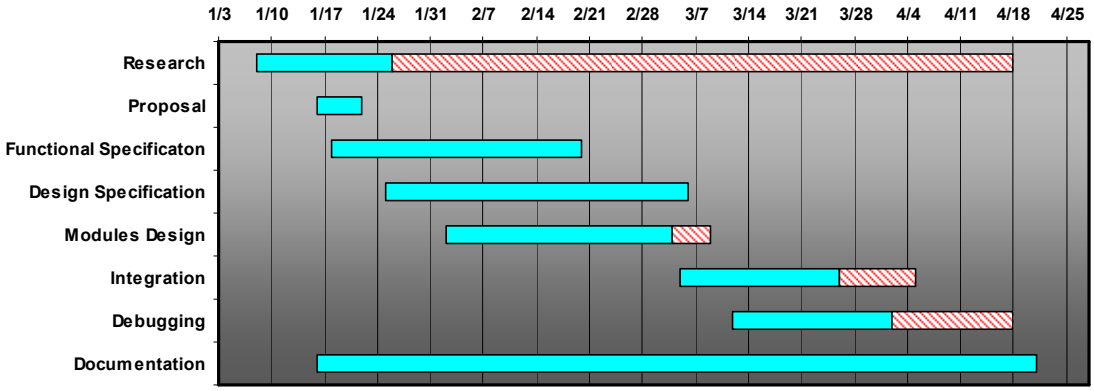

Figure 3: Gantt's Chart

As it can be viewed form the above chart, the Research phase of the project never actually ended, and it is still ongoing. Integration phase started with a two weeks delay, and the debugging lasted until the day of demonstration.

PERSONAL COMMENT AND EXPERIENCE

Atefeh Palizban

As the Chief Executive Officer, I was in charge of coordination, scheduling, delegation, and task allocation. I had to make sure that differences and conflicts are resolved without compromising the teamwork spirit. As part of my responsibilities, I made sure meeting met our criteria for being open and efficient. I also made sure that the deadlines and milestones were met. In cases of complications and predicaments, I made sure group members maintain high spirit and morale, and did my best to prevent undue stress and conflict.

On technical side, I contributed to software development. In particular, I studied and implemented the different features of MCU and their interaction with external modules like the sensor.

Developing or improving my leadership skills during the past 14 weeks is the most rewarding aspect of this experience. I learnt how to mediate negotiations, tradeoffs, and assist group members in reaching an agreement. I found compromise, mutual respect, and are necessary elements in reaching an agreement. The experience with all its upheavals has enriched my academic experience, and has prepared me further for taking a role in the real world.

Siavosh Jalili

To me, the experience was a fourteen weeks marathon characterized by many days of despair, and scarce hours of hope! There were moment of ascend to the summit of success followed by a disheartening descent into the valley of void. There were days when we clearly saw the light at the end of the tunnel, and then, there were those where an ominous darkness encompassed us, and all we could see was each others' grim and exhausted faces, and all we could hear was our sullen sighs.

Making contacts with business, manufacturers, and support foundation for people who suffer from balanced disorders was one of the most rewarding aspects of this project. Through correspondences with these parties, I was able to get a sense of doing business in the real world.

I was able to develop further my software skills and my knowledge of SPI and its application in an embedded system. I learnt a great deal about accelerometer. In particular, I discovered the flaws associated with these actuators, and learnt about their real applications. I have also been able to familiarize myself with the sound circuit, as in Audio Codec, and learn about the science behind effective sound generation.

One of the most interesting part of this project was learning about balance mechanism in human body, balance disorders, and their impact on the lives of people who have to deal with such problems.

The most rewarding part of the experience was getting in touch with balance disorders support organizations, and actual people who suffer from such disorders. Listening to their concerns, feedbacks, personal experiences, and expectations from a product aimed at helping them was very enriching. The knowledge I have accumulated through such contacts will prove most useful in similar projects in the future.

Our frequent meetings became a medium for free flow of opinions. I believe the meetings could have been more effective, had we have a clearer road map.

While my disappointment, frustration, and impatience gave way, at times, to rather unpleasant attitude my group members had to deal with, I know that our friendship in the process and in the wake of this project has grown stronger. We are a testament to this Friedrich Nietzsche's famous quote: "what does not kill us makes us stronger".

Yang (Jerry) Yu

As the Chief Technical Office of New Balance Technologies, I started off by defining a specific vision for this project. I was largely responsible for the electronic portion of the project, from components evaluation, orders, to soldering and wiring. I was initially in charge of the system design and focused on hardware aspect.

My responsibilities also include development of the firmware according to the requirements of the hardware specification, debugging and interfacing with the hardware.

I also learned success in project is not only about brilliant ideas, but also about efficient execution while maintaining team dynamics.

Sakshi Nagalia

During the past 3 months I acted as the Chief Financial Officer of the NewBalance Technologies. As part of my responsibilities, I tirelessly pursued sources of funding. Our team was able to receive $500.00 in funding from ESSEF (Engineering Science Student Endowment Fund). In addition, were able to receive our sensor for free from Analog Device Inc. Throughout the project, I made sure that the expenses stayed within the allocated budget, and we were successful in working well within our budget until the very end.

Due to my past experience at Research in Motion, I was able to assist the group in developing the software for transferring of data between SPI, PWM, and MCU. Through this project, I learnt about inclination measurement actuators, and developed further my software development skills.

The teamwork also proved to be a very rewarding aspect of this project. I learnt a great deal about group dynamics, and the approaches we may adopt to maximize the efficiency of the group while minimizing tension and conflict.

Acknowledgments

We wish to thank Analog Devices Inc. which kindly provided us with the sensors we used throughout the project. In particular, we would like to thank Mr. Mark Looney for his continuing technical support.

We would also like to thank British Columbia Balance and Dizziness Disorder (BADD) society for providing us with valuable feedback on our product. Their words of encouragement persuaded us to stay on the course throughout the project. The members of the society shared useful experiences and offered opinions on how to improve the product to meet their needs.