harmony innovation

Progress Report for the

Musical Rehabilitation Assistance System

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1. INTRODUCTION

The Medical Rehabilitation Assistive System (MRAS) is a wearable device that will track and analyze a patient's ambulatory movements and provide useful audio feedback. Harmony Innovation intends to demonstrate a proof-of-concept on April 10th, 2015 for the benefit of the public and its stakeholders.

The MRAS consists of three development areas: Electronics, Software, and Kit. The Kit, worn by the patient, houses the Electronics. Sensors contained within the Electronics read motion and transmit data to the Software, which performs analysis and returns feedback in the form of music. The MRAS is intended to enhance the ambulatory rehabilitation process for both the patient and the therapist. It allows the patient to evaluate their performance when the therapist is not directly involved or absent.

2. SCHEDULE

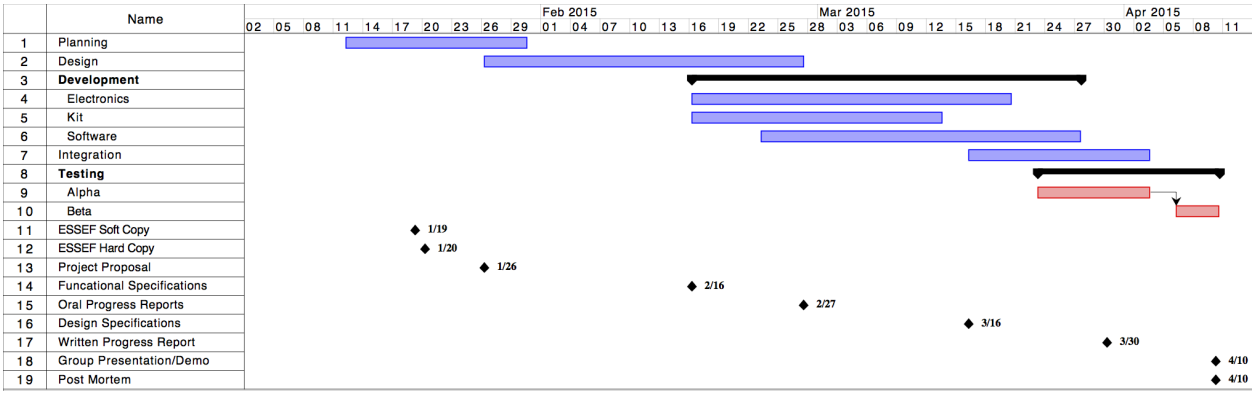

Figure 1: MRAS development plan with milestones

Figure 1 shows the development plan for the MRAS as defined during the Design phase. The original plan followed an Agile management strategy, with no overlap between phases and a gate review process between each phase. This was abandoned during the Design phase when it became clear that some overlap was necessary. The result is that the Design phase was extended, the Development phase was pushed back by one week, and the Integration and Alpha Testing phases end simultaneously. From the beginning, the last three weeks of the project were designated for Testing. This was to create an early soft deadline, which, if missed, still left three weeks to complete Development and Integration before the hard deadline on April 10th. Currently, the project is 2-3 workdays behind schedule. The specifics of the schedule drift are discussed in the section 4. Corrective measures for this are detailed in the section 5.

3. Financial Review

Table 1 shows the expenditures and funding sources for the MRAS.

EXPENDITURES	$274.47
Arduino UNO R3 Mega 2560	68.87
Arduino Wireless Bluetooth Transceiver Module	12.97
9V Batteries	11.16
Kootek Arduino GY-521 MPU-6050 Module x 8	60.54
Manufacturing of Controller and MPU Enclosures	82.85
CAT5 Connectors	38.08
FUNDING SOURCES	$650.00
ESSEF Funding	650.00
TOTAL REMAINING	$375.53

Table 1: MRAS Cash Flow

As demonstrated, the team has been successful in keeping costs down. The MRAS is required to retail for less than $500, and this is clearly possible. Further savings can be found by switching from additive manufacturing to injection moulding to reduce the cost of manufacturing the Controller and MPU enclosures, and purchasing components in bulk to reduce the cost of the electronics. The only items not accounted for in the budget above are the vest and the wiring, which were salvaged or received with no cost to the project.

4. Progress

4.1 Electronics

Development and integration of the Electronics is currently on schedule. We are able to receive data from four sensors simultaneously, and to transmit the data to a PC. All components have been tested and function properly. Extra stock is also on hand should a replacement sensor be needed. Remaining work includes integrating all of the components into the Kit, so that the device is physically complete and wearable.

4.2 Kit

Development and integration of the Kit is currently on schedule. By switching to additive manufacturing over traditional machining, the Controller and MSU enclosures were complete ahead of schedule. The Controller enclosure has a placeholder faceplate, which is serviceable for demonstration purposes if the final version cannot be manufactured in time. Work remaining includes construction of the straps and integrating the enclosures into the straps and vest, a total of 1-2 workdays.

4.3 Software

Development and integration of the Software is currently behind schedule. It became clear early in the Development phase that the analytical component of the Software would be dependent on the Electronics, and the feedback component of the Software would be dependent on the analytics. As a result, workdays were allocated away from the Software and into the Electronics. Now that the Electronics have been developed to a nearly final state, workdays are being shifted back to the Software, and other Software development resources are being exploited. There are approximately 3-5 workdays remaining in this development area.

5. REMEDIATION

With the Electronics and the Kit on track, workdays have been allocated to the Software. The decisions made early on to use MATLAB as our development platform for the Software and to exclusively use Arduino-compatible components in the Electronics have proved to be wise. There are a number of online resources that detail processes for marrying Arduino components to MATLAB, some even providing code for reading and analyzing data for the specific model of sensor being employed in the MRAS. This has significantly accelerated the development process, and has drastically reduced the number of workdays needed to complete the Software. It has also added a new dimension to the MRAS, allowing us to present real-time visual representations of what the sensors are doing.

6. SUMMARY

Currently, the development of the MRAS proof-of-concept is 2-3 workdays behind schedule. The Electronics and Kit are projected to deliver on time, while the Software has slipped behind. Thanks to the incorporation of a Testing phase at the outset, using additive manufacturing for the Kit, exclusively selecting Arduino-compatible components for the Electronics, and using MATLAB as the development platform for the Software, there remains sufficient flexibility in the schedule to accommodate the drift. Current mitigation strategies look to address the Software issue and have it back on track in time for the Beta Testing phase. Harmony Innovation is confident we will present a functional proof-of-concept Musical Rehabilitation Assistance System on April 10th, 2015.