Progress Report

Smart Abdominal Binder

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1. Introduction

At Influx Medical, we are in the process of designing and implementing an abdominal garment system, to help patients who experience low blood flow by applying pressure to the abdomen to increase diastolic and systolic blood pressure, called The Smart Abdominal Binder. It consists of a mechanically adjustable abdominal binder that is connected to a stepper motor. This mechanical binder is controlled by the Arduino from the readings it observes from a pressure sensor underneath the abdominal binder, which records and displays the pressure applied by the belt. Influx Medical has also integrated a blood pressure monitor in order to sense when the patient's blood pressure has dropped below the normal threshold.

2. Schedule

Due to a change in the design of our project, going from a pressurized inflatable abdominal binder to a mechanically contractible binder, our hardware and software design is one week behind the outlined schedule. Furthermore, due to inaccurate readings of numerous sensors that we purchased, our pressure sensor design also had to be modified. As a result this has delayed our integration of the first phase of the prototype by one week.

3. Financial

Currently Influx Medical has spent almost 90% of its funding from its estimated budget. For the funding of the project, we are working closely with Dr. Carlo Menon, which after applying for the Wighton Engineering Development Fund; he is covering the remaining costs of the project. The details are summarized in the following table:

Table 1: Financial breakdown

Project Budget with Contingency	$415
Expenditure Amount to Date	$418
Future Expenditures	$75
Funding from Dr. Menon	Up to $700
Expenditures covered by Dr. Menon to date	$150
Remaining amount for contingency	$57

4. Progress

Planning and Research

In order to determine what kind of binder to be used, several researches about the current market, similar products, the benefits and drawbacks have been done during the time interval between composing function specification and design specification. Afterwards, we changed the original desire to replace the pressurized inflatable abdominal binder with mechanically contractible binder. Software and hardware designing and functionality researches have been finished before design specification as planned, and the modification in mechanics did not have any large impact in the software design logic.

Parts and Material Acquisition

Group members have been separated into two groups, the hardware and the software; each team is responsible of purchasing components that meets the requirements. All parts are now assembled and tested except for the BPM (blood pressure monitor). The spool has not yet been attached on the motor but it is a simple process. The BPM will arrive in the following week so that we proceed to test it.

Meetings

According to the schedule and milestone, we have two basic group meetings every week that every member needs to attend on Tuesday mornings and Friday afternoons right after classes. We report what has been accomplished, remaining problems and what still need to be completed by each person in the past seven days and set plans for the following week. One or two extra group meeting time in engineering lab 1 are booked as well due to members' current schedules for integration and testing.

Tests and Measurements

Regarding mechanical testing, the designed spool along with the stepper motor has been tested; the average pressure needed on the abdominal binder is 70 mmHg in safety range. In the software aspect, the LCD and the pressure sensor connected to Arduino MCU system has been tested; the pushbutton-switch operation states has been tested; the BPM and Arduino data transmission and analysing is to be tested in the next week. Lastly, for the hardware the Arduino functions properly with the LCD, stepper motor and the spool; the Arduino running on the battery only is being tested.

Design Progress:

1. Hardware Aspect

The completed task is the stepper motor**.** It is able to behave following the outputs from the microcontroller. It is able to wind or unwind the wire, pause immediately when receiving a call from the Arduino, and the rotational force can be varied by changing the turning speed of it through the Arduino; moreover, it will rotate back to the starting point once it gets terminated by a push button. The remaining task is for the reading values of the pressure

sensor in Arduino to be normalized by testing different weights of mass. The entire system has yet to be tested running exclusively from a battery.

2. Software Aspect

The completed parts of the project are the user interface LCD display. The display is working properly with the LED backlight on and it displays characters. The Arduino digital pins are confirmed to be working as well since information can be displayed to the LCD. The rotary encoder to adjust target pressure and time duration is completed; the desired functionality of the knob and button is confirmed to be working. The stepper motor is tested to be working and can be controlled properly using the Arduino. The remaining tasks include programming the behavior of the stepper motor. Also, the code for the BPM data analysis system is not yet tested which acquires the measurements sent from the BPM over serial and converts the data from HEX to Ascii entity number. The algorithm to convert the pressure sensor voltage reading to pressure in mm Hg is not implemented yet.

5. Remediation

Considering the easiness to obtain the components, system operation time, and the size of the device, the binder had been changed to be mechanically controlled by a stepper motor instead of using an air pump and a pneumatic valve to inflate the binder. Due to this hardware parts change, the schedules of hardware design and software design have been delayed. We had anticipated the delay issue and decided to implement hardware and software design work simultaneously to meet the original schedule. We are now caught up the planned schedule and started working on Integration and Debug step at first week of this November. Moreover, potential solutions to the wire tangle issue that may arise from the spool coiling procedure are being explored; a proper sized spool with grooves has been designed in Solidworks for immediate 3D printing. We are to finish the integration and debug on November 25th. The demo time is on December 15th thus the extra two weeks to work provide us time to explore more solutions to unexpected troubleshooting.

6. Conclusion

Influx Medical has dedicated many hours to the completion of the Smart Abdominal Binder, but the overall progress of the design has had some delays. However, we believe that with the change in our final product from the original one proposed, the system will be more efficient, less costly, user friendly, and ideal for hospital and wheelchair conditions. The product is about 70% completed; the integration of the hardware and software part is progressing steadily. Despite facing minor remediation, the proposed modifications will not affect the completion date. Influx Medical's Smart Abdominal Binder is on track for completion and concept demonstration for the scheduled demo date.