POSTMORTEM

Smart Abdominal Binder

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Date Issued: 12/15/2014

Revision: 1.1

1. Introduction and Background

According to Spinal Cord Injury Canada, there are 86,000 people who live in Canada with spinal cord injuries (Farry, 2010). It is also estimated that there are over 4,300 new cases of spinal cord injuries in Canada each year (Farry, 2010). The Canadian government estimated annual costs for dealing with patients that have spinal cord injuries are $3.6 billion of which $1.8 billion is being directed to health care costs.

Thus there are many patients in Canada alone that suffer from spinal cord injuries. Spinal cord injured patients have many of their bodily functions affected. Areas in the brain normally control blood pressure and heart rate, where signals from the brain send messages through the spinal cord to constrict or dilate blood vessels.

However patients with spinal cord injury have these signals interrupted, and in many cases inactive movement causes low blood pressure requiring medication. The cost of medication for the government can be an economic burden, and our company plans on reducing the government's annual costs by designing a smart binder to be worn around the abdomen. Thus, InFlux Medical has been founded in order to relieve spinal cord injured patients of autonomic dysreflexia, which promises to be socially beneficial and profitable. Our purpose is to make our garment easy fitted, not tight so that it does not interrupt breathing patterns, easy to put on and take off, be made of breathable material, and also to fit the individual without having him looking socially awkward. With an increase each year in spinal cord injured patients, it is time to think of an innovative approach to ease these individuals of their hardships. InFlux Medical is motivated to take on such a challenge in order to help shape a brighter future.

At Influx Medicals, our aim is to create an automated mechanical abdominal binder that will ultimately increase an individual's blood pressure through the use of compression around the abdomen. The abdominal area has been chosen for our garment to be placed, since the splanchnic bed (abdominal cavity) has the highest reservoir of blood throughout the human body (Claydon, et al., 2011). There has been adequate research done to show that the use of an abdominal binder is one of the most efficient methods to increase the stroke volume of the individual, which in effect increases the individual's blood pressure (systolic/diastolic) (Smit, et al., 2004).

Influx Medical's design of the smart abdominal binder (SAB) will implement a unique solution that will provide spinal cord injured (SCI) patients suffering from orthostatic hypotension (OH), a hassle free solution for reducing their blood pressure. Our product has a blood pressure monitor (BPM) integrated into the design such that that will continuously measure a patients systolic/diastolic blood pressure, in order to prevent the subject from experiencing the effects of light-headedness or dizziness due to adequate circulation of blood throughout the circulatory system. Once the blood pressure of the patient falls below a certain threshold, the BPM will alert the abdominal contraction unit to start tighten the abdominal binder around the abdomen. With continuous measurements showing the individuals blood pressure, the contraction unit will continue to exert pressure (40 mmHg) around the abdomen until the blood pressure is back to its standard value.

The SAB offers an exclusive product that will provide useful features for patients
suffering from SCI, such as continuous blood pressure monitoring, user controlled pressure settings, and a hassle free procedure. The design solutions for the SAB are described within the design specification document.

2. System Overview

Figure 1: Product

The purpose Influx Medical is to provide patients with a contractible abdominal binder that will prevent autonomic dysreflexia (caused by medications taken to increase blood pressure) and orthostatic hypotension. With this product, the user will be able to control the amount of pressure exerted to the abdomen or have the device provide automated contraction on its own. The user will have a reliable contractible device that will last up to 4 hours, and that can be used at any time throughout the day.
The SAB is an integration of multiple systems that together create a reliable and cost effective product. The contractible binder, stepper motor with planetary gearbox, blood pressure monitor, and software components constitute the core of Influx Medcial's SAB. The figure below depicts the basic diagram of the individual components that make up the SAB. Influx Medical made certain that the components used in the design of SAB were medically graded and safe for use by the patient and caregiver.
The system inputs include a latch button that turn the device on and off, and also a rotary knob that adjusts the pressure applied to the abdomen area manually (in some situations the user can be paraplegic, thus they can manually apply pressure if they desire, where in other cases the physician will set the device with an indicated time such that the contractions are automated). Furthermore, the blood pressure monitor

is also an input that will be attached to a RS-232 shield, which will take measurements and return the data to the MCU via serial port. Additionally, the pressure sensor will sense the applied pressure and communicate to the MCU to make the design have a closed loop feedback. The MCU communicates with the stepper motor via a driver in order to contract the mechanical binder. The MCU is responsible for signal processing and communication of different subsystems. The GUI displays information such as applied pressure and elapsed time, which informs the user about various system information and statuses.

3. Mechanical Binder

The design of the SAB requires a mechanical pressure garment that is contractible, such that it can provide up to 40 mmHg of pressure. Numerous studies have shown that the effect of abdominal compression of 40 mmHg, has increased an individual's stroke volume and blood pressure, thus for our purposes a pressure of 40 mmHg will be sufficient (Deng, et al., 2004). Therefore, through careful research, Influx Medical has found a mechanical binder that will supply sufficient pressure as needed, called Cybertech S.P.I.N.E LO/L1-S1. The mechanical binder's one-hand adjustment accommodates any changes in body position or weight distribution, which is important for our design since our patients will be of various sizes. Furthermore, individuals whom are suffering from OH become overheated, which will cause them to sweat profusely. Cybertech's mechanical binder is design to allow air circulation, which reduces the heat buildup and retention near the body, thus increasing patient comfort. Furthermore, patients suffering from OH, cannot distinguish whether their bladder is full or not, thus the design requires one that does not exert force on the bladder sack. Cybertech's mechanical binder resides on the upper portion of the abdomen area, which does not exert any force on the bladder sack. Furthermore, since the binder is placed over the abdomen, it does not interfere with breathing patterns such that it would limit respiratory functions or make them irregular. Additionally, the design of the abdominal binder is such that the patient can put on the garment with ease, which is designed so that it is comfortable for a long duration of use.

4. Pressure Sensor

The pressure sensor in this device is being used to make a closed loop in the system so the pressure being applied by the mechanical binder can be read and adjusted by using the stepper motor and controlled by the Arduino. A suitable sensor for our system would be a flexible sensor which would be suitable for the human skins. The requirement on the geometry of the sensor would be to pick up the pressure on all around the abdomen underneath the binder , therefore it needed be thin and long and be able to curve as the human body. The range on the sensor needed to cover more than 0-40 mmHg since that is the important pressures for our readings. Given all the requirements and specifications and after testing with numerous force and pressure sensors, we decided to use with the 408 Force Sensing Resistor (FSR) model which is flexible and suitable for the human skin and has the shape of a long strip with the width of 6 inches and length of 24 inches and very small amount of thickness. Therefore we would be able to use the pressure sensor underneath the mechanical binder and we could extend the reading from one side to another side of the abdomen. Specifications on 408 FSR, such as short Long Term Drift, high Force

Resolution, low Break Force and suitable Force Sensitivity range make this pressure sensor even more applicable for Influx Medical. To find the best slope of force curve (Voltage vs Force) sensitive to the range of the pressure needed we used a phidget voltage divider kit which we were able to adjust the slope of the force curve by varying the resistance using a potentiometer on the voltage divider kit. Since the FSR is a force sensor, we were supposed to convert the voltages into the pressure, therefore we were able to borrow and use a very accurate and calibrated pressure sensor and able to collect data and calibrate the FSR. We were able to find a function to fit through the graph of the data collected for the voltage vs the pressure being applied and use the function to code the Arduino to output the right pressure with respect to the voltage received and display it on the LCD display. After multiple test, the result of both pressure sensor and the FSR match with low error margins.

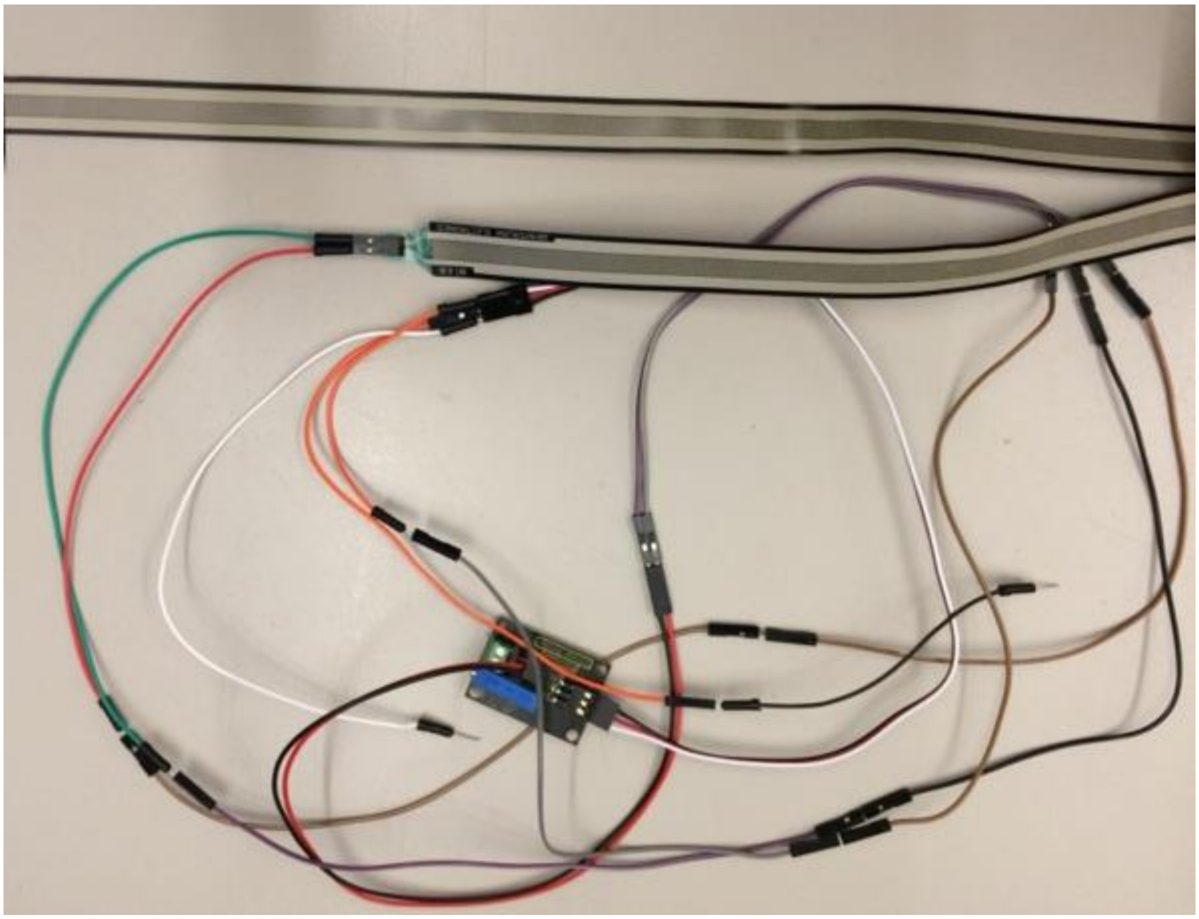

Figure 2: Picture of the 408 FSR connected to the phidget voltage divider.

5. Stepper Motor

The InFlux Medical teams design requires a pressure supplier unit that is controlled by the microcontroller and to supply sufficient torque to pull the wire on the binder; a stepper motor with planetary gearbox is used along with the mechanical binder as the pressure supplier unit. The selected motor is a 4-wire bipolar stepper motor; it needs 2.8V voltage supply, rotates 1.8 degree for each step, and has a rated current of 1.68A with 36 N-cm rotational force. The planetary gearbox has 27:1 ratio to the motor; in the other words, it enhances the motor output torque by approximately 27 times, therefore the gearbox guarantees that the motor can supply sufficient tension to the binder. The pressure supplier unit also includes a motor driver responsible for the communications between the motor and the Arduino. It has 3 input pins that are connected to the Arduino board which are Direction pin, Step pin, and Ground pin. It has another 2 input pins that are connected to the power supply which are responsible for powering up the motor. It has 4 output pins that are connected to the motor, such that the pins are separated by two pairs responsible for the A and A' leads and B and B' leads of the bipolar motor. Additionally, a designed spool with grooves is 3D printed and attached to the motor which is responsible for winding the wires. Our team has also 3D printed an enclosure for the stepper motor and attachments such that is highly dense in order to support the structure.

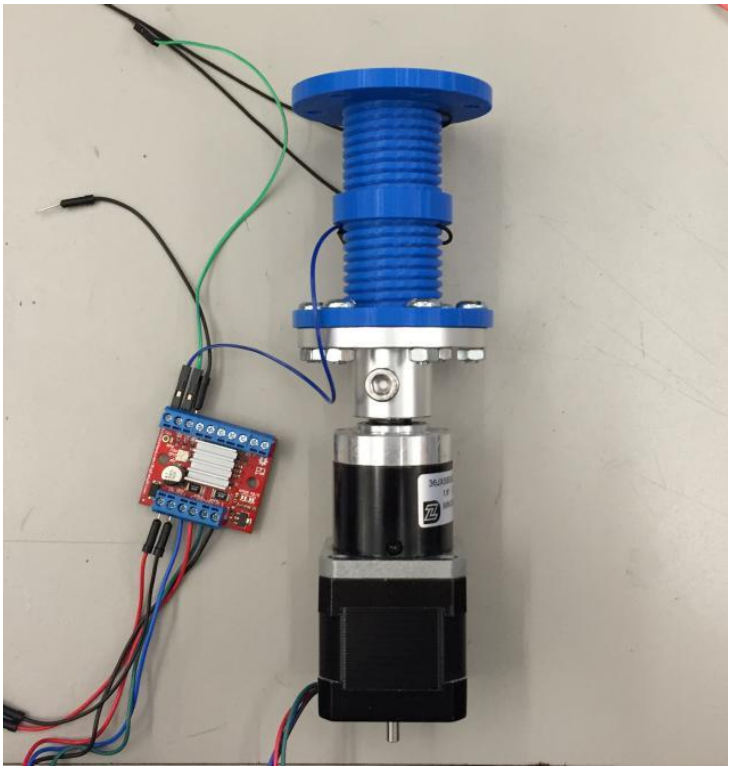

Figure 3: Stepper Motor with Planetary Gearbox and Big Easy Driver

Arduino MCU, RS232 Shield and Software

The Arduino Uno is selected for this product because of its compact size. It has enough digital pins for our system as well as extra analogs pins unused. All the digital pins are used and A0-A2 analog pins are used. The Arduino is powered by a 12V source and has 5V output for powering the LCD and the pressure sensor. A RS232 shield is attached to the Uno to have a DB9 port to communicate with the blood pressure monitor. Arduino IDE 1.0.5 is used . The software logic in the main loop has some fundamental functions that make the whole system operate. The binder function is responsible for rotating the motor.

TimedAction library is used to make the LCD displays only a few times a second to give the binder function priority; the LCD does not need to be updated very often. In the loop there are also functions to debounce buttons and for hit detection. Also 2 interrupt pins are used pin 2 and 3 and they are used for the rotary encoder to update the target time duration and pressure. It is very important that the interrupt pins are for the encoder because the motor is reacting based on the pressure and time. Also there are functions to receive measurement which converts the incoming bytes in HEX to decimal. This function is important because the system operates based on the readings from the BPM.

Liquid Crystal Display

A HD47780 based controller 16x2 LCD with a LED backlight is used.It uses the LiquidCrystal.h library thus it is simple to program. It displays the target time, target pressure, current elapsed time , actual pressure and the status of the BPM. It will also display systolic, diastolic and the pulse after the BPM makes a measurement. It is also displays a communication port fail message if the BPM is not connected.

Blood Pressure Monitor

The model used is the A&D UA767PC. It is an affordable well documented system with serial output and commands. It has pressure adjustment for initial estimate of the systolic blood pressure and it has a simple interface with one button operation. Pressing the button once will initiate measurement and holding the button will show history measurements. It has a RS232C 3.5mm compact port. The cable is the AX-K01502-US which is a 3.5mm plug on one end and a female DB9 connector on the other end. A null cable modem adapter is used to connect two DCE devices together which is the BPM and the RS232 Shield.

When the BPM is showing the clock it is in idle state. A command is sent to the BPM from the Arduino to wake it up and it will display stationary dash marks indicating communication mode. Afterwards, a command is sent to open the communication port and the dash marks move scroll. Sequentially, a command is sent to initiate a measurement. After the measurement is completed, the BPM sends HEX codes to the Arduino and the values are compared against the system thresholds to determine whether the binder contracts or not.

6. Cost and Materials

Table 1 - Cost of each component

Equipment	Cost

Arduino Uno R3(x1)	$33.00
Rotary Encoder w/Detents(x2)	$11.70
LCD display 2x16 TS1620-9 (BLUE)(x1)	$15.00
Power Adapter, AC?DC, Switching(x1)	$7.95
Push Button IP67 Waterproof(x2)	$9.00
DC Power Jack 2.1MM Female w/ Pigtail(x1)	$1.50
Hook up Wire AWG26(x1)	$5.00
1Lb Bare Wire Spool(x1)	$1.50
½ Lb Bare Wire Spool(x1)	$1.00
Universal Aluminum Mounting HUb for 5MM(x1)	$8.50
Battery Rechargable SLA, Lead Acid, 12V, 4AH(x1)	$16.95
Lead Acid Battery Charger 12V 500mA(x1)	$29.50
Rocker Round Switch W/Red Light(x1)	$2.95
Cybertech BRace, Medium(x1)	$139.00
12V 0.4A stepper motor(x1)	$25.00
easy driver(x1)	$15.00
header(x1)	$1.00
Velcro(x1)	$15.60
SEN-09375 - Force Sensitive Resistor 0.5"(x1)	$6.95
SEN-11207 - Flexiforce Pressure Sensor(x1)	$24.95
DEV-13029 - RS232 Shield V2(x1)	$11.95
PRT-10088 - Arduino Project Enclosure(x1)	$11.95
PRT-08084 - Screw Terminals 3.5mm Pitch (2-Pin)(x1)	$4.75

PRT-08235 - Screw Terminals 3.5mm Pitch (3-Pin)(x1)	$4.75
PRT-00115 - Female Headers(x1)	$1.50
PRT-12795 - Jumper Wires - Connected 6"(x1)	$1.95
A&D DB9 Serial cable(x1)	$98.00
A&D USB cable(x1)	$37.85
12V, 1.7A, 416 oz-in Geared Bipolar Stepper Motor	$44.00
8mm Set Screw Hub	$13.73
Pololu 8-35V 2A Single Bipolar Stepper Motor Driver A4988	$6.61
12mm Push Button Switch	$0.56
13x13x7mm Aluminum Heat Sink with Thermal Adhesive Tape	$2.32
Break Away Female Headers	$1.67
HEXBUG Nano Robot Creature (Random Color)	$4.99
Order Adjustment	$-4.99
Big Easy Driver	$28.00
Header Socket	$0.80
Gender Changer DB-9 Null Modem GC-701N	$3.20
LCD Display 2X16 TS1620-1(Green)	$15.00
Trossen Innovation - Sensor Package	$56.00
Serial Cable DB9 M/M	$3.80
12V 3A AC adapter	$25.00
Shipping/Handling	$122.35
What we spent in total	$874.32

What the system costs only accounting for the parts it requires to operate	$563.46
Overhead	$289.66

From the above table, the actual budget turns out to be doubled the number we originally planned for. This is mainly due to a revision on our design which modified the inflatable belt design to a mechanical binder powered by a motor design. A Cybertech brace is much more expensive than a single belt or shirt. What's more, the overhead also contains the fee of a larger motor when power shortage problem occurs; the fee of a new LCD when the only one is damaged; the spool and enclosure which are not used in the final product; the fee of replacing an average belt or shirt to the Cybertech Brace mechanical binder and many small components we did not consider in the original budget calculation but needed in the development process.

7. Schedule

Influx Medical constructed a project plan to ensure that all the deadlines were met by the teammates and also to guarantee the success of the SAB. Figure 5.1 shows the project planning that was done in the project proposal document and the actual planning that went into the design of the SAB.

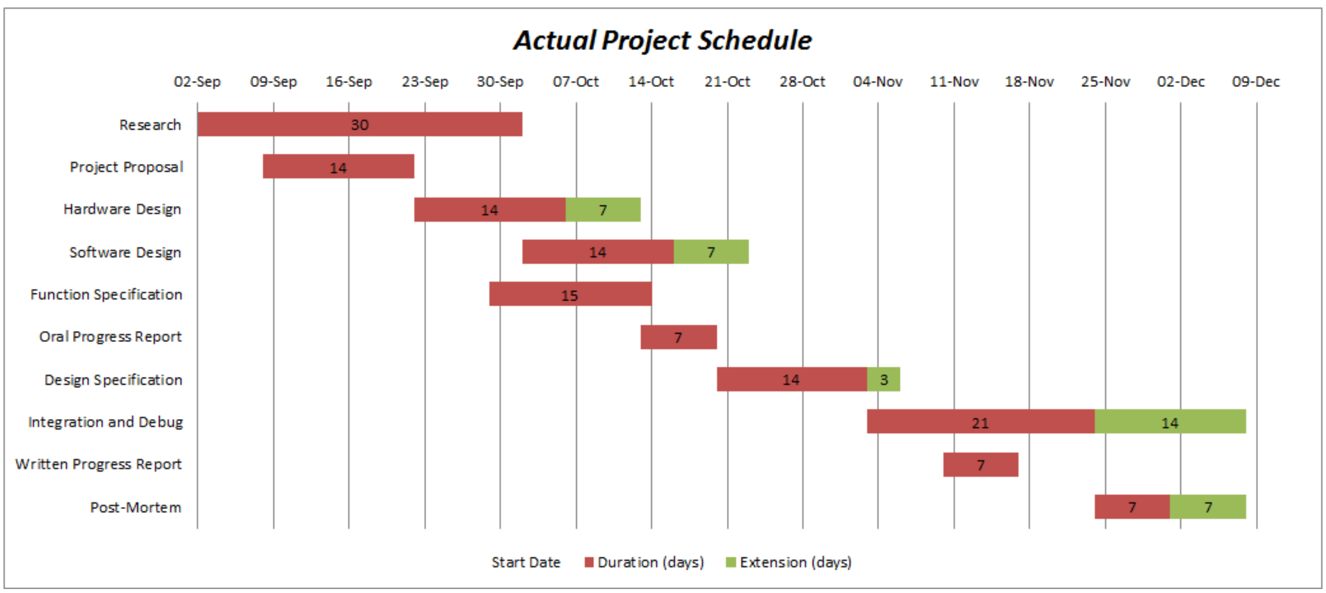

Figure 4: Progress diagram

The development milestones were set in such a way that the software and hardware components were developed and tested individually but in parallel, such that we can ensure proof-of-concept delivery. As shown in our Gantt chart, our hardware and software design took longer than expected. This is due to unforeseen changes in our project, such as going from an air pressurized system to a mechanical system.

Furthermore, our integration and debugging stage also took longer due to changes in our system components, such as stepper motor and sensor modifications. Furthermore the additional features that we decided to add also caused discrepancy, however they made the system more user friendly. Even with these schedule delays, we are still able to meet the final demo deadline of December 15.

Technical Challenges Encountered

Influx Medical faced multiple challenges throughout the semester that helped improve everyones understandings on design specifications and component selection. Firstly, our original design required the use of an inflatable abdominal binder. In order to proceed with this design it required multiple subsystems that made the system more complex and costly. The system required the use of a pressurized air tank, diaphragm pump,and pneumatic valves. Since our device is aimed for patients in hospitals and care facilities, this would make the design loud and less likely to be portable. Influx Medical's resolved the issue by using a mechanically contractible abdominal binder, which required the use of a stepper motor and a contractible binder that used a set of intricate and proprietary pulley systems. Furthermore, the FSR sensors that we would have liked to use gave a less accurate reading of pressure, thus we had to buy a more expensive sensor in order to compensate for this issue. Additionally, the mechanical pulley system in our design required a stepper motor that can output a relatively high torque, which required us to make modifications to the existing motor purchased. Our team had calculated the torque required for a given pressure before the purchase of the motor, but our calculations were not accurate. However, we solved the problem by adding a planetary gearbox with a 27:1 ratio in order to increase the output torque.

8. Team Dynamics

Each member of the Influx Medical team worked together on numerous parts of the SAB. There were many technical problems that came about during the course of the semester, however each member took responsibility in resolving the issues that were faced. Each member of the Influx Medical team had a good knowledge base for all the aspects of the SAB. This was a great asset in our design, such that if a team member was absent, all other members can contribute to the completion of a given task. The table shown below outlines the responsibilities corresponding to each team member and their contributions in the development and implementation of the SAB.

Table 2: Work distribution

High-Level Task	Hamed	Shayan	Kevin	Simon	Jason	Christy
Administrative tasks		XXX		XXX		
Documentation	XX	XXX	XX	XXX	XX	XX
Budget and Finance	X	XX	X	XX	XX	X
Component and Material Research	XX	XX	XX	XX	XX	X
System Testing	XX	XX	XX	XXX	XX	
System Integration	XXX	XXX	XX	XXX	XXX	
User Interface		XX	XXX	XXX	X	
Hardware Design	XXX	XXX	X	XXX	XXX	
Software Design			XXX	XXX	X	
Software Debugging			XXX	XXX	XX	

9. Individual Reflection

9.1 Shayan Gaeni

It has been a great privilege for me to work on such an interesting, unique, and eventful project. Each member of Influx Medical contributed to make the completion of this project possible. Our team consisted of six dedicated engineers that are highly skilled and knowledgeable in their own respective fields. Before our group settled on the idea of the Smart Abdominal Binder, we had to put in countless hours to make sure that the idea presented was feasible and that it would be affordable. As a result, I got to learn about different concepts in system integration and design. Hamed Soltanishirazi, Simon Cheng, Jason Jiang, Kevin Liew, and Christy Tao are all well rounded engineers, and with the help of everyone we were able to resolve any issues faced throughout the semester.

As the CEO, one of my many responsibilities included organizing meetings, formatting and assigning documentation, keeping track of scheduales and due dates, and assigning tasks to different group members. Furthermore, also aided in the development and integration of the entire system. I helped measure various parameters of the device, such as sensor readings and testing's, motor specifications and functionality such as the integrated spool design and gearbox integration, and also soldering of different components. Additionally, I helped in the improvement of the overall design when faced with a problem, which required extensive research and past knowledge. The biggest lesson I learnt from this course was that you should always research every component details when selecting parts. I realized this when it came to the integration and debugging of our design, since many of components required the integration of a smaller subsystem in order for the desired outcome to be seen. Furthermore, I also learnt about microprocessor organization and communication with various subsystems. From servo motors to blood pressure monitors and force sensors, this has definitely helped improve my programming and system design attributes.

Apart from the engineering aspects, I also learnt how important and difficult it can be to work with a big group and to keep everyone involved and communicating. Furthermore, I learnt that the development cycle of a project is very dependent on how efficiently the group communicates and works together without problems or difference in opinion.

This semester has thought me a lot about successfully converting a conceptual model to a working prototype within a given deadline. Working with a group that did know each other initially, and coming a long way to the completion of the project has expanded my outlook on group dynamics and communication. The project was one of the most enjoyable and exciting learning experience, that combined all the skills and knowledge I have learnt throughout my education at SFU. I also learnt how important and useful an engineering journal can be, which made referring back to old research and design /functionality of the system a lot easier. It has been rewarding to see a product through all its stages in becoming a working prototype.

9.2 Simon Cheng

As a 5th year computer engineering student at SFU and as a Chief Risk Officer in the team, what I have learned the most is how much planning is needed and everything to consider when things do not go as planned. I learned that attention to detail is important especially when considering how all the parts will fit and work together. I realize now it is very important to be decisive when making a decision and to order parts earlier next time I participate in a project of this scale. I found there were often times we were waiting for parts to arrive, and not making the best use of our time during the time we wait. What I have reaffirmed is the need for communication in a team project; without it everything will fall apart very quickly. This project also reintroduced my thought regarding safety when working with power supplies especially when it comes to protecting the circuit and myself. The project also offered good opportunities to improve my soldering skills.

In this project, I was required to work with the Arduino UNO which I have never done before. What I discovered is that the Arduino is very easy to program for as it requires C programming language and the software provided is simple to use. I understand now how capable and how useful the Arduino is for projects. I have never worked programmed a LCD unit before but the library available to the Arduino to interface with it made it simple. This is also my first exposure to using a rotary encoder and how turning the encoder in each direction each step sends a different signal. For the push button on the rotary encoder and the standalone push button itself, I learned how de-bouncing is very important to consider to make sure a single press registers as exactly that, a single press and not multiple presses. This is the first project where I have to consider user safety and the Arduino controls mechanical movement of the motor. I had to think about and program logic to make sure the system behaves the way we want it to in terms of not providing any harm and hazards to the user wearing the binder. I also learned to program to read from a force sensor which I have never used before. The Arduino makes working with sensors fairly simple; it is a great solution. I learned a lot about debugging, especially with loose wires and contact. I also learned the difference between DCE and DTE devices and how a null modem adapter is required to communicate with like devices. The motor driver IC becomes very hot and I put a heatsink on it to cool it down. Writing a system test plan is very important and is mandatory for any product to make sure everything works as expected.

If I were to do this project again, I would make sure from the very first month that everyone is on the same page and that we've done enough research to make a decisive decision in order to be efficient throughout the entire term. I would also make sure by the functional specification documentation that we have the list of parts to order to know exactly whether the functional specification document makes sense with respect to all the parts. When it comes to the team members, I enjoyed working with everyone. Overall, I feel the project itself was a great learning experience.

9.3 Hamed Soltanishirazi

As a 5th year engineering physics student it has been a pleasure to be the Chief Operations Officer of the Influx Medical and being a part of this group. The most important thing throughout this project for me has been the teamwork within the group and observing a useable, marketable and helpful device being put together from the start as an idea to a working device. Beside the technical engineering material, what I have learnt the most in this project has been the importance of communication and teamwork that needs to be put into a project from the beginning to the end, for the project to move forward at all times and give a reasonable result. Another major factor that I learnt is the methodology and the way of dealing with numerous technical and non technical problems that we faced during this project. Dealing with different types of problems, especially problems that were not expected were a great learning opportunity since it would rise a reason and situation that we would start looking for a solution and a way to solve and resolve the problem. This was the time that our creativity, experience and background knowledge in engineering was put in to use.

At the beginning of this course we started as a group of engineering students who mostly did not know any of the other members, and did not know what the project would be going to be. Even though it took a long time for the members to find the best way to communicate with each other and to make the final decisions on the project and the design of it, throughout the project everyone became so comfortable and compatible with each that the group was able to catch up with the required schedule.

At the beginning of the semester I was able to make connections with Dr.Menon from the Applied Science department and Dr.Clayden from the Kinesiology department of Simon Fraser university to find a project which everyone in the group was interested and passionate about to work on. Further on I organized many meetings with each side and was able to make a link between the group members and the professors and could make sure that the requirements from each side was met.

I also researched in the literature on the topic of our project and made sure we understand the specifications required for the users for our device. I was also able to use my physics background in this project and do calculations and analysis for our Abdominal belt and pressure sensor. I also gained much information and experience with force and pressure sensors during this project and was able to find the suitable package with the right geometry and usability for our device.

Looking at the overall aspect of this project I have increase my knowledge on mechanical and electrical parts and their functionality and usage in the industry. Working with engineering students from different fields has helped me gain more knowledge and experience in electrical, computer and mechanical engineering. I was able to learn about the Arduino and its coding, also advanced my circuitry knowledge and experience in solving different obstacles that arose from using different parts. I also learnt about various motors and gearboxes and the communication between different devices.
Overall this project and course has been a great learning opportunity and one of the most beneficial and exciting times I have had during my program. I gained a lot of experience by working as a group which was made from different students with different backgrounds and also from starting a project from the very beginning as just an idea to a fully functioning device.

9.4 Jason Jiang

As a 5th year electronics engineering student at SFU and the Chief Technical Officer in the InFlux Medical team, it has been a great experience for me to work on this Smart Abdominal Binder design, and it has been a great pleasure to work with such highly skilled InFlux Medical members. Throughout the project, I have realized that one of the most important things was the group dynamics; communications with other teammates and always be an active partner are the key points. Besides that, another important thing was that be prudential to the project planning and try to plan everything ahead of the schedule especially when ordering the parts and integrating the system.

Since I major in electronics engineering program, I am flexible in both hardware and software design. I was responsible for the hardware design and latterly the system integration and debug. From hardware aspects, I mainly worked on the Pressure Supplier Unit. The finalized unit consists of a stepper motor and a motor driver, with a planetary gearbox attached as an enhancement for the rational force of the motor. I have learned how to build communications between the bipolar stepper motor and the Arduino microcontroller by using a motor driver, control the turning speed and direction of the motor as well as varying the output torque. Moreover, I have gained experience of applying Solidworks skill and 3D printing technology to achieve the project goals. A spool with grooves was designed and 3D printed in order to prevent wire tangle problem in the winding process; it was successfully implemented and has been working properly. Upon the completion of the spool, Arduino enclosure and the motor enclosure were designed and printed as well since they all required specific dimensions and could not be found from market. My problem solving skill has been developed as well. The binder requires more tension as it gets more tightened and the motor was not able to deliver enough torque once the tightness of the binder reached a specific point; to solve it, a planetary gear box with 27:1 ratio to the motor was used in order to enhance the torque. From software aspects, I have learned how to use the Arduino to control the mechanical movements of the motor, build the communication with the blood pressure monitor, normalize the readings from the pressure sensor. Moreover, my solder skill has been practiced and I have gained knowledge on electrical circuit protection, such as putting capacitors to make the input voltage smooth and constant, and connecting a fuse to limit the current flow in the circuit in order to avoid damages to the system.

Throughout the project, it has been a great learning experience and memory for me to work through it with my teammates; we shared thought to each other, and learned from each other. Even though we have been through a stressful time at the beginning since our group was just made during the first lecture and we did not have any project plans, we caught up latterly since the project topic was made. The project itself has been an amazing work, from the initial thought to gradually achieving the goals. Due to different academic background of each teammates, everyone was able to play a role in this project.

9.5 Kevin Liew

In the beginning, in addition to collaborating on the system design, I researched to find a suitable BPM that takes commands and outputs data. Additionally I searched for academic articles that validate our method versus orthostatic hypotension and give suitable pressures and durations for which to actuate the abdominal binder. I designed LCD display, knob, button and LED GUI subsystem, BPM interfacing subsystem. I also designed and implemented the LCD and LED error displays as well as the overall system template, including interactions between the pressure sensor, BPM, abdominal binder, and motor movement based on readings from the pressure sensor.

I also produced design, functional, and user documentation on the BPM and GUI subsystems as well as associated components and I wrote test cases for the BPM and GUI subsystems and worked on system integration testing and the test plan.

I also collaborated with Simon and Jason on coding as well as with Shayan and Hamed on designing the behaviour of the automated abdominal binder. I worked with Simon and Jason on implementing LCD data display, the GUI controls and the BPM interfacing code. We also spent a few days troubleshooting serial communication with the BPM. I worked with Simon on designing and implementing functionality of system start/stop button and integrating code for the LCD and GUI, BPM interfacing, and motor movement from pressure sensor readings for system integration testing. Simon and Jason wrote the low level code to move the motor and incorporated it into my system template. It was moving slowly so I sped up the motor movement. I worked with the entire group on system integration testing and debugging. During the course of this project, I gained the skills for designing, implementing, and debugging hardware-software systems for microcontrollers. I've also learned that RS232 serial cables may need null-modem converters even if they physically fit, depending on the DCE-DTE configuration of the endpoints. I've also learned about hardware design and the need to take the hardware specifications into account when designing the software. For instance, the hardware may have a limited number of interrupt pins and data pins. I have also gained hardware debugging skills. Sometimes a hardware problem could appear to software problem, so the software cannot reliably be debugged if the hardware is not assembled properly. Sometimes the problem could be a disconnection or soldering problem, or a dead component.
If I were to undertake a similar project, I would not take functionality of potential components for granted. There may be missing documentation or in our case, the documentation only applies to specially produced units. Instead I would correspond directly with the manufacturer to obtain documentation and confirm functionality. All hardware should be validated before assuming a software problem when debugging. I would also not rely on other people to order parts because our BPM debugging and system integration, testing, and debugging was delayed by almost a month due to shipment issues.

7.6 Christy Tao

As a 5th year student studying Computing Engineering, this is the first time I have chance working in a group of six on a project which is completely proposed by ourselves, designed by ourselves, implemented by ourselves, and tested by ourselves. It is a huge challenge that at the beginning none of us were experienced enough to make it professional but we successfully managed to concur multiple challenges to finally accomplish it.

Being the Chief Financial Officer of the project, I calculated the original budget for covering the whole project, researching for the battery and power unit to support the whole hardware and software system, assisting designing the user interface of LCD and translating then transmitting the HEX code generated by the BPM to Arduino to analyse. This project brought me into contact with medical engineering which I originally had no clue with. During the researching and developing process, I gained much knowledge about Arduino microcontroller, LCD, pressure sensor and the control unit. The things what Arduino could do amazed me though I never worked with it before. The power unit designed by me includes a safe circuit, and a rechargeable lithium battery supporting all components in both software and hardware systems in series. Because of the price and size, we changed the lithium battery to a lead acid battery. The testings on the power unit really reminds me how important it is to have an appropriate power, or the power shortage will kill the complete system.

The biggest problem we encountered was that we had different time schedules so that it was difficult for us to arrange meetings when everyone could attend, especially I am in co-op working full time. Group members are not familiar with each other, which makes it even more difficult to negotiate, however, we managed to meet two to three time a week, on a basis of everyone's routines. Every member in this group is determined, interesting and smart, I enjoyed every minute working with them and I am really appreciate for their help as well.

If there is another chance for me to do a similar project, first of all I will make a complete and precise time schedule to make sure not only my own but the group affairs are done in stages. I will ask for opinions as soon as possible when the design draft is formed for fear that any partial design is not logical so that the whole design needs to be done again. Materials and components need to be purchased ahead so that the waiting time for packages and money paid on UPS could be avoided. I will maintain a better balance between works at different locations in order to make sure I could spend more time on project itself but not on the way. I might make more backup plans for designing, implementing, testing or even debugging process to guarantee there is always a solution when the optimal one does not succeed even if the backup solution may not be perfection either. I will take more responsibility even if I am not the leader, trying my best to assist others on the problems they are working on even though it might not be my strength.

10. Conclusion

Influx Medical was determined to develop a mechanically contractible abdominal binder that had continuous physiological measurements, in order to help patients suffering from orthostatic hypotension. Throughout the semester, Influx medical with communication and teamwork , accomplished a proof-of-concept that reflected all the relevant functional and design specifications. On December 15, Influx Medical as able to demonstrate the completion of its Smart Abdominal Binder. Throughout the completion of this project, many group members had a unique learning experience that has helped them expand their knowledge for future design and implementation. The design of this project will be followed through by some group members in order to make it become a safe and marketable medical device. There were certain features, that throughout the semester our team contemplated on integrating into our system. Due to time constraints, our team did not add these enhancements. These included adding additional sensors, such as force sensors and gyroscopes in order to know the orientation of the patients body when using the device. Furthermore, our team had a discussion about integrating the contractible binder within a t-shirt such that it would be breathable and loosely fitted. Additionally, the area that the abdominal binder is covering is sufficient for increasing the patients blood pressure, however as published researches show, a larger area would increase blood pressure at a faster rate. After this semester, several students will continue to work closely with Dr. Menon to help improve and market this unique medical device.

Acknowledgment

Influx Medical will like to thank Dr. Carlo Menon for providing resources and information throughout the completion of this project. He helped us with the design and challenges of the project, the funding, supply materials, and helped achieve noteworthy milestones. Furthermore, we would like to thank Dr. Victoria Clayden for helping us with the physiological aspects of the project.

Appendix A: Meeting Minutes

Meeting Minutes

Date: September 9, 2014
Time: 10:30AM
Location: West Mall Centre - Simon Fraser University

Agenda: Brainstorm project ideas.

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Each person should think about good ideas for the proposal.
- Each person needs to discuss their idea next meeting.
- After we present our ideas we need to decide on one.

Action items:

- Decide on idea by September 19th to start working on proposal document.

Meeting Minutes

Date: September 12, 2014
Time: 4:00PM
Location: West Mall Centre - Simon Fraser University

Agenda: Discussion about project ideas.

Attendees: Shayan, Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Medical project idea 1: People in wheelchair have blood rushing down to feet and they might faint because of it, so we need to design some products to go around abdomen to pump blood/circulate blood.
- Medical project idea 2: Individuals with Parkinsons with “freeze” problem might walk through doors then freeze, so that we need to make some products to inform them.
- Medical project idea 3: When a person is falling, there’d be better a sensor detection so that the muscles will be electrically stimulated to contract and maintain balance.
- Daily life project idea 1: Heated clothing that is user controlled to adjust to a certain temperature so that the user feels comfortable. It can be a jacket, shirt, socks, gloves, etc. It might adjust heat to specific portions of the body too.
- Daily life project idea 2: A smart dog collar which will inform the owner where his pet is and if his pet is on the right track of walking within a chip embedded.

Action Items:

- The project topic must be set down by the end of next meeting.
- Each member researches on the topic he/she is interested in and communicates via emails to negotiate.

Meeting Minutes

Date: September 16, 2014
Time: 10:30AM
Location: West Mall Centre - Simon Fraser University

Agenda: Finalize the project topic.

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Medical project idea 1, the smart abdominal binder(SAB) is settled down to be the final project topic by every group member.
- Group members come up with the company name: Influx Medical.
- Group members discuss about the project topic, what we know about SAB, if there is similar products in the current market, why we should work on this, what kind of system we need to settle for this product, what kinds of challenges we may encounter with, etc.

Action Items:

- Do researches about the answers to the questions everyone raised in the meeting and try to solve it in the following week. For example: How much pressure needed to apply on the abdomen area in order to take both efficiency and safety into consideration? What kind of pumper we are going to use? Is it going to be mechanically controlled or automatic? How to guarantee the safety when patients are so fragile that little high pressure might hurt them? What if the patients cough? Will the tight garment interrupt breathing? Etc.
- The proposal should be started and separate parts should be assigned to different group members by the end of next meeting on the basis of the researches each one would have done.

Meeting Minutes

Date: September 19
Time: 4:00 PM
Location: AQ outside of K9500 - Simon Fraser University

Agenda: Assign proposal parts.

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Assigned Shayan Executive summary and Introduction
- Assigned Jason Hardware stage and Schedule
- Assigned Hamed Project Benefits and Risks
- Assigned Simon Software stage and Company Description.
- Assigned Kevin Market and Competition.
- Assigned Christy Funding and Conclusion.
- Each person has to write their own company profile.
- Each person write down references they have used so it can be formatted later.

Action items:

- Finish parts by September 21 and assemble them together.

Meeting Minutes

Date: September 21
Time: 10:30AM
Location: West Mall Centre - Simon Fraser University

Agenda: Finalize proposal document

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Went through the proposal document by each group member.
- Discuss about any problem or question anyone has in the past week.
- Decide on logo, company name again, official product name, etc.
- Determine the person who will finish up the work, edit, proofread and send it to the professor.

Action items:

- Hand in proposal in September 22nd.

Meeting Minutes

Date: September 26
Time: 10:30AM
Location: West Mall Centre - Simon Fraser University

Agenda: Discuss about the Smart Abdominal Binder functions.

Attendees: Shayan, Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Discuss the main functions the SAB should have: blood pressure display, blood pressure threshold, pressure control, time duration control, rechargeable battery, portable binder, etc.
- Discuss about the existed products in current market and their drawbacks.
- Discuss about the equipments we are going to use and parts we need to order.
- Set time schedule for the whole project including when to finish and when to finish each subsystem.
-
- Meet with Carlo to understand his requirements and standards: design should be comfortable for patients to use; easy to take on and off; generate air pump inflation when blood pressure drops below threshold(120/80mmHg or even lower); pressure sensor gives applied pressure on activated region of compression, etc.

Action items:

- Do more researches, deeply: how to guarantee the size and weight of the final product; how to transmit the data from blood pressure monitor(bluetooth) to display(LCD or some smartphone application); how to use Arduino to analyze the data receiving from the BPM and then sending to the pressure sensor, etc.
- Start the function specification.
- Draw the system overview and flow charts for different parts.Basically consisting of an air pump, pressure sensor, pneumatic valves, blood pressure monitor, Bluetooth portal, and an application device(smartphone), etc.
- Design circuit schematic for both hardware and software parts.

Meeting Minutes

Date: September 30
Time: 4:00 PM
Location: Applied Science Building - Simon Fraser University

Agenda: Finalize the Smart Abdominal Binder functions that will be included in the function specification.

Attendees: Shayan, Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Draw system overview sketch out for the SAB system.
- Arduino is decided as the microcontroller.
- The air pressure unit is consisted of a diaphragm pump and a pneumatic valve.
- The belt unit is consisted of an inflatable abdominal binder and a pressure transducer.
- Arduino reads pressure out of the valve.
- Arduino sends and receives data via Bluetooth path to turn on or off the air pressure unit.
- Arduino sends data to digital display showing pressure applied to abdomen (user-controlled).

Action items:
Due October 7th

- Assign parts to group members for functional requirements document.
- Meet with Dr. Menon to make sure the functionality we have designed for the SAB by far is complete and sophisticated or if there are more modifications needed to make.

Meeting Minutes

Date: October 7
Time: 10:30AM
Location: West Mall Centre - Simon Fraser University

Agenda: Assign Functional Requirements parts

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Assigned parts to members of the team.
- Assigned Shayan, Introduction and System requirements.
- Assigned Hamed, the abdominal binder and pressure sensor.
- Assigned Jason, the air pressure unit.
- Assigned Kevin, automatic Blood Pressure Monitor.
- Assigned Simon, general Bluetooth, Microcontroller, Mobile Application .
- Assigned Christy, interface and document formatting.

Action items:
Due October 14th

- Complete assigned part for functional requirements document

Meeting Minutes

Date: October 14
Time: 3:30PM
Location: West Mall Centre - Simon Fraser University

Agenda : Integrate Functional Specification document

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Review functional specifications document.
- Format document.
- Discussed about meeting with Carlo Menon to seek his opinion on the designing of the functionality on for the last time before the document submission.

Action items:

- Meet with Carlo Menon this week.

Meeting Minutes

Date: October 17
Time: 2:00 PM
Location: Applied Science Building - Simon Fraser University

Agenda : Meet Dr.Menon for advice on design

Attendees: Shayan,Hamed, Simon

Meeting Summary:

- The air pressure unit has been changed from pressurized inflatable belt design consisting of an air pumper to a mechanical binder with motor design.
- The reason to make this modification: the pressure applied to abdomen by the air pumper is too difficult to measure and control. The uncertainty in this added air pressure will result in inaccuracy in pressure sensor analysis and might cause fatal error when in practical use.
- Needs to figure out if a mechanical binder with motor design is the best replacement to the previous air pressure unit.
- Needs to figure out if any related unit should have change design due to the change in the air pressure unit.

Action items:
Due October 28th

- Decide on the final design of the complete system.
- Find appropriate parts needed and purchase by time.

Meeting Minutes

Date: October 28
Time: 3:30PM
Location: Applied Science Building - Simon Fraser University

Agenda : Decide on the parts list

Attendees: Shayan,Hamed, Jason, Simon

Meeting Summary:

- Talked to Dr.Menon to order the BPM and RS232 shield for us.
- We decided to buy motor parts, LCD, buttons and battery locally from Lee's Electronics to avoid shipping time to wait for.
- Found out where to obtain the Cybertech back brace locally as the basic binder to use.

Action items:
Due October 30

- Obtain Cybertech back brace from Relax the Back store as the basic part of SAB.

Meeting Minutes

Date: October 30
Time: 3:30PM
Location: Applied Science Building - Simon Fraser University

Agenda : Try the obtained cybertech back brace and discuss about Design Specification document

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Obtained back brace yesterday, tried it on in-store and seems to be the ideal product.
- Brace applies sufficient pressure to the abdomen.
- Assigned Shayan the Introduction and system overview
- Assigned Shayan and Hamed the mechanical binder part
- Assigned Hamed the Pressure sensor part
- Assigned Simon the MCU part
- Assigned Jason the motor part
- Assigned Kevin the LCD and BPM part
- Assigned Christy the Battery and power unit
- Discussed that each person should write the test plan for their assigned part

Action items:
Due November 7

- Finish and integrate all parts for the Design Specification document due.

Meeting Minutes

Date: November 2
Time: 3:30PM
Location: Applied Science Building - Simon Fraser University

Agenda : Discuss about oral progress presentation

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Assigned Shayan brief overview
- Assigned Simon status of project with respect to original timeline and budget
- Assigned Hamed Problems to be resolved
- Assigned overall progress to Kevin
- Assigned Jason Plan B
- Assigned Christy summary
- Talked about what each part should cover.

Action items:
Due November 7th

- Each person writes their own notes for presentation

Meeting Minutes

Date: November 7
Time: 1:30PM
Location: Applied Science Building - Simon Fraser University

Agenda: Discuss oral presentation and rehearse

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Confirmed each part each person will say
- Acquired motor,motor driver, Arduino and LCD from Lee's Electronics
- Discussed about meeting tomorrow to being testing the motor and LCD.

Action items:
Due November 8th

- Test Arduino input and output ports
- Power up motor and verify the motor turns using test code from the Arduino to the motor driver
- Power up the LCD and confirm the backlight works and that it can display characters

Meeting Minutes

Date: November 8
Time: 10:30AM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda : Demonstrate motor, motor driver and LCD functionality.

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Soldered headers onto the motor driver
- The motor turns successfully in both directions with some basic test code from the Arduino.
- The motor torque is increased significantly when powered as it should.
- Discussed about getting a mount for the motor in order to mount the spool.
- Could not power on the LCD, may be due to soldering errors.
- Mounted the push button and rotary encoder onto the breadboard.
- Talked about obtaining a force sensor from engineering lab

Action items:
Due November 11th

- Get the LCD to power on and to display characters sent from PC as testing.

Meeting Minutes

Date: November 11
Time: 10:30AM
Location:Applied Science Building Lab 1- Simon Fraser University

Agenda: Program most LCD,push button and rotary encoder code for the Arduino

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Programmed the LCD to display design specification GUI.
- Programmed the rotary encoder and push button.
- Obtained force sensor and applied test code to read voltage. Tested but it gives a faulty reading, cannot give 0V reading with no force applied to it.
- Researched about a new force sensor to order online.
- Discussed about sensor code, no need to change code for new sensor.
- Discussed about using some back up round force sensors in the mean time for testing weights.

Action items:
Due November 23

- Get new force sensor

Meeting Minutes

Date: November 13
Time: 2:30 PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Integrate software code and test force sensor strip.

Attendees: Shayan,Hamed, Jason, Kevin, Simon

Meeting Summary:

- Integrated push button and rotary encoder code with LCD code from November 11th.
- Discuss corner cases for LCD gui logic.
- Rotary encoder can increment target pressure and time
- Rotary and push button are debounced.
- LCD is able to display the desired readings from the GUI design.
- Tested basic motor code that is relate to final design. The motor can rotate to a certain number of steps and hold the position and reverse back to the starting position.

Action items:
None

Meeting Minutes

Date: November 15
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Divide progress report parts and parts still needed to be acquired.

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Talked about completing the progress report. Hardware team Shayan, Hamed and Kevin will write about hardware progress. Simon, Kevin and Christy will write about software progress. Each person will write parts they were responsible from the oral presentation onto the progress report
- Talked about getting more parts from Lee's , the motor mount is needed to attach the spool onto the the motor.
- Rocker switch is needed for battery solution.
- Discussed about battery solution whether to use lithium batteries or lead acid. Lithium will be harder to charge and will be a step up voltage regulator which may not supply enough output current at 12V stepped up from 3.7V. Using a lead acid battery will result in a heavy and less portable solution but for demonstration purposes a lead acid battery is sufficient for concept demonstration
-

Action items:
Due November 17th

- Submit Progress report
- Obtain Motor mount
- Obtain 12V Lead Acid battery

Meeting Minutes

Date: November 18
Time: 10:00AM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Integrate motor and force sensor code with LCD code from November 11th

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Integrated motor with current LCD and push button code.
- Integrated round force sensor with current code.
- Motor rewinds when it exceeds target pressure. It winds when the pressure is not achieved yet as expected.
- Discussed that we need to get the spool printed to mount onto the motor mount in order to test if the motor has enough torque as calculated.
- Designed the spool in solidworks and sent to get it 3D printed, will be available next week.
- Talked about the order for the new force sensor strip and the BPM, will arrive next week.
- Use temporary round force sensor to testing purposes while we wait.

Action items:
Due November 27th

- Receive 3D printed spool
- Receive force sensor strip

Meeting Minutes

Date: November 23
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Discuss about battery solution and test the new force sensor with the Arduino.

Attendees: Shayan,Hamed, Jason, Kevin, Simon

Meeting Summary:

- Received the new force sensor and potentiometer from mail.
- Connected sensor to the Arduino to test readings.
- Sensor reads about 0V with no weights on it.
- Discussed about how to get the voltage correlation with pressure.
- We need to find some material firm enough to place on the brace to get an accurate reading and put a pressure sensor along with the force sensor with the brace strapped to determine the relationship between.
- Places some weights on the sensor and adjusted the potentiometer for sensor sensitivity.
- Discussed about powering the system using a battery and what battery to get from Lee's Electronics

Action items:
Due November 27th

- Obtain a 12V Lead Acid battery with a charger from Lee's.

Meeting Minutes

Date: November 27
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Attendees: Shayan,Hamed, Jason, Kevin, Simon

Agenda: Mount spool onto the mount and the mount onto the motor. Test the BPM.

Meeting Summary:

- Received BPM but discovered it is the wrong model UA767PCNAC; website had wrong description.
- Send back BPM for refund.
- 3D printed spool is completed and received.
- Fit the mount onto the spool, found the inner diameter of the spool is too small but still fits well enough for testing purpose.
- 3D printed pool will need a 2nd revision.
- Attached the spool and mount onto the motor shaft.
- Attached the wires from the brace onto the spool.
- The wires follow the path lines on the spool.
- The motor does not have enough holding torque, it slips after a certain amount of wire has been winded.
- Discussed about getting higher amperage motor with higher holding torque from Lee's Electronic.

Action items:
Due November 30th

- Get the 1.2A stepper motor from Lee's Electronic
- Order the proper BPM model UA767PC from eBay

Meeting Minutes

Date: November 30
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Test and examine the BPM with batteries.

Attendees: Shayan,Hamed, Jason,Simon

Meeting Summary:

- Obtained 1.2A stepper motor from Lee's Electronics
- Retested the 0.4A stepper motor with spool, reconfirmed it does not have enough holding torque to wind brace wires. Motor slips after a certain length has been winded and torque exceeds motor holding torque.
- Easy driver does not sufficiently drive 1.2A stepper motor.
- Easy driver drives up to 750mA.
- 1.2A motor driven up to 750mA does not hold as well as the 0.4A motor thus we concluded we must obtain a better driver to retest the 1.2A motor.
- 1.2A stepper does not have enough holding torque when not driven to its rating.
- Discussed about the next step to take if the 1.2A stepper motor still does not provide enough torque when properly driven.
- Decided to order a gearbox stepper motor to guarantee torque requirement.

Action items:
Due December 4th

- Order new stepper motor with gearbox to arrive
- Order two 2A motor driver
- Order heatsink for the motor driver
- Resign spool for 3D printing to fit on stepper motor with gearbox

Meeting Minutes

Optional meeting

Date: December 1
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Test and examine the BPM with batteries.

Attendees: Kevin, Simon

Meeting Summary:

- BPM arrived.
- Discovered the BPM does not come with any data cables.
- BPM has the serial port.
- Researched where to buy a proprietary serial and usb cable for the BPM.
- BPM does not work with 1.2V rechargeable batteries.

Action items:

- Ordered for the serial cable for BPM with UPS Express to arrive on Wednesday
- Ordered the USB cable from eBay with USPS Priority International shipping

Meeting Minutes

Date: December 4
Time: 4:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Test new motor, new motor and connect BPM to the Arduino.

Attendees: Shayan,Hamed, Jason, Kevin, Simon

Meeting Summary:

- Received new stepper motor with gearbox and 2 motor drivers from RobotShop ordered on December 1,2014.
- Tried the new Pololu motor driver, damaged first driver as a result of not putting a capacitor between the motor power supply ground and positive.
- Tried another motor driver, still does not function. Does not power up motor.
- Obtained foam from engineering lab for brace but not long enough to cover entire abdomen.
- Obtained 4AA 1.5V batteries for the BPM.
- BPM works, takes blood pressure measurement with manual input on the start button
- Tried to communicate BPM to serial shield on Arduino. Ready signal ok but does not respond to input for it to initiate measurement. Suspected default cable.
- Waiting for USB cable for BPM to arrive next week.
- Confirmed new spool for the motor is being printed for tomorrow.

Action items:
Due by end of December 5th

- Buy the Big Easy Driver from Lee's Electronics
- Test stepper motor with gearbox with new big easy driver
- Buy a proper sized foam for brace Correlate force sensor voltage reading with pressure
- Solidworks design for enclosure and motor enclosure.

Meeting Minutes

Date: December 5
Time: 5:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Test new motor with the Big Easy Driver and establish voltage and pressure relation

Attendees: Shayan,Jason, Simon, Christy

Meeting Summary:

- Retested 1.2A motor with pololu driver. The motor does not have enough torque.
- Broke the pololu driver while measuring current.
- Bought Big Easy Driver to test 1.2A motor again, still does not provide enough torque.
- Soldered screw mounts onto the Big Easy Driver.
- Cut out padding to place onto the front side of the brace .
- Checked 3D printed spool, not done yet. Will check again tomorrow.
- Discussed about force sensor bending causing inaccurate readings, will test once padding is attached to the brace for tomorrow.
- Tested the newest 1.68A stepper motor with gearbox, spins properly. It has sufficient torque and the big easy driver can drive it up to 1.4A but it is sufficient for our purpose even though it is not running at its rated current.
- Took some measurements using the force sensor but decided it is best to do it only after the padding has been sewn onto the brace.
- Discussed about how to attach spool onto mount, decided to get screws and washers.

Action items:
Due December 6th

- Obtain screws and washers that fit the motor mount holes.
- Sew the padding onto the brace.
- Check the 3D printed spool progress.

Meeting Minutes

Date: December 6
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Establish voltage and pressure relation.

Attendees: Shayan,Jason, Simon, Christy

Meeting Summary:

-

Action items:
Due December 7th

Meeting Minutes

Date: December 9
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Get the Arduino to communicate to the BPM

Attendees: Shayan, Jason, Simon

Meeting Summary:

- Attempted to transmit wake signal to bpm, successful but unable to open communication port
- Tried sending code in hex and ascii, no response after waking BPM.
- Tried to wake and open using MATLAB, successful. BPM confirms to be working
- Verified the output of the Arduino matches MATLAB through a serial terminal called Termite.
- Concluded there must be a connection error from Arduino to BPM.
- Researched about reasons why, discovered potential solution. The BPM and RS232 shield on the Arduino are DCE devices which should be connected together using a null modem cable. We are using a regular DB9 cable.
- Concluded the reason why computer terminal can see the correct input is because the computer is a DTE device. DTE and DCE devices communicate through a regular DB9 cable while DTE or DTE or DCE to DCE needs a null modem cable.

Action items:
Due December 11th

- Buy a null modem cable adapter
- Arduino communicates successfully to the BPM

Meeting Minutes

Date: December 12
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Install spool onto stepper motor and establish voltage and pressure relation. Test and finalize motor code logic.

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Get the new cable to complete the BPM to Arduino transmission.
- Test the transmission by reading data sent from Arduino via PC USB port.
- Checked 3D enclosure for the motor and arduino. They are done.
- Place the parts into the enclosures to see if they fit.
- Get the wheelchair. Thinking about the way to integrate the system and the wheelchair.
- Deconstruct the wheelchair to make it more comfortable for patients to use.
- Assign separate parts for group members to write on post mortem.
- Prepare for the presentation powerpoint.

Action items:
Due December 13th

- Integrate separate parts together as a whole.
- Test the complete project.
- Debug the complete project.

Meeting Minutes

Date: December 13
Time: 3:00PM
Location: Applied Science Building Lab 1- Simon Fraser University

Agenda: Put all the parts in enclosure and create slide for presentation

Attendees: Shayan,Hamed, Jason, Kevin, Simon, Christy

Meeting Summary:

- Put everything in the enclosure.
- Run the test cases.
- Divide work for presentation.
- Slides for presentation are created.

Action items:
Due December 15th

- Prepare for presentation.