April 12, 2016

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

RE: ENSC 440 Post Mortem for ETA VitalTAG

Dear Dr. Rawicz

The enclosed document is the Post Mortem for our SFU engineering Capstone project VitalTAG. The team of ETA (Emergency Technological Applications) gathered inspiration for this project by investigating the severe lack of support that first responders can provide for paramedics. VitalTAG is designed to be a standalone device that any first responder can use on any victim. The device would measure and log the key vitals required by paramedics. Once at the scene, paramedics would be able to view the vitals of all victims in the vicinity on a pair of Recon Jet smart eyewear. All data logged can be retrieved from a VitalTAG via Bluetooth communication to a monitor or printer for further analysis if required. Our goal is to improve the capabilities of the first responders such that it reduces the time required by the paramedics to gather the essential vitals and would allow them to administer care near immediately.

This document provides a post mortem of our project. We provide a system overview with the problems we encountered. Our estimated and actual budgets along with group dynamics are covered followed by a workload distribution breakdown. Additionally, we discuss what we would have done differently followed by individually written contributions and learning outcomes from each member. Finally, a conclusion along with future work and recommendations are discussed.

The founders of ETA are Andre Chang, Jeetinder Ghataurah, Richard Chen, and Tony Yuen. We thank you in advance for your time and interest in our Post Mortem. For any reason, please contact us at jghataur@sfu.ca or (778) 997-JEET.

Sincerely,

Jeetinder Ghataurah, CEO
Emergency Technological Applications

Enclosure: Post Mortem for ETA VitalTAG wearable vital sensor

VitalTAG

Post Mortem

Project Team: Andre Chang
Jeetinder Ghataurah
Richard Chen
Tony Yuen

Contact Person: Jeetinder Ghataurah
jghataur@sfu.ca

Submitted To: Dr. Andrew Rawicz – ENSC 440W
Steve Whitmore – ENSC 305W
School of Engineering Science
Simon Fraser University

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Revision 1.1

Executive Summary

Paramedics and other first responders are one of the most important functions in modern day cities, they save hundreds of lives around the world every year. Despite their importance, they are equipped with outdated technologies. In specific, equipment's used to acquire Heart Rate, SpO_2 and Blood Pressure dates back to as old as the late 1800's. This forces paramedics to rely on time proven techniques, such as checking radial pulse using their fingers and a stopwatch. In a modern era of technologies, paramedics and first responders should be equipped with safe, robust and smart devices which can automate the measurement and logging of vitals, allowing them to focus on more critical tasks. ETA is aiming to accomplish this with VitalTAG, a platform that would allow paramedics to see the victim's vitals in a glance.

VitalTAG is a device that would be donned on a victim's index finger. Once VitalTAG is deployed, it would estimate the victim's Blood Pressure, Heart Rate and SpO_2 through photoplethysmogram (PPG). These metrics would then be displayed to the first responder through a pair of smart eyewear. In addition, all vitals are logged on the device for future reference. Moreover, VitalTAG does not limit paramedics to one-to-one operations. By tagging multiple victims with VitalTAG, paramedics can monitor all the victims' vitals at the same time.

This document provides a post mortem of our project. We provide a system overview with the problems we encountered. Our estimated and actual budgets along with group dynamics are covered followed by a workload distribution breakdown. Additionally, we discuss what we would have done differently followed by individually written contributions and learning outcomes from each member. Finally, a conclusion along with future work and recommendations are discussed.

Our team consists of electronics, systems, computer and biomedical engineers with at least 1 year of industry experience. We are a multi-disciplinary team well suited to tackle the task of providing paramedics and first responders with a robust and unified platform to obtain vitals.

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Glossary and Acronyms

BPM - Beats Per Minute
DC – Direct Current
First Responders – Any personnel first on scene prior to paramedics
GUI - Graphical User Interface
HUD - Heads Up Display - An electronically generated display of data superimposed on a user's field of view
I^2C - Inter-Integrated Circuit
PPG - photoplethysmography
POC – Proof of Concept
QFN - Quad Flat No-leads
SpO_2 –Saturation of Peripheral Oxygen

1. Introduction

VitalTAG is an innovative solution to retrieve crucial vitals for emergency purposes. Designed to be cost-effective and portable, VitalTAG will extend the ability of first responders and paramedics alike. The proposed design combines photoplethysmography (PPG), Bluetooth and smart eyewear technology to provide paramedics with real time vitals. Our solution, VitalTAG, can be seen below in Figure 1.

Figure 1: V1 Prototype of VitalTAG made in SolidWorks

1.1 Background

Paramedics currently resort to rudimentary tools such as stethoscopes, watches, blood-pressure cuffs and their refined abilities in order to assess the severity of the situation. When using these tools, both hands are needed, which prevents the aider from attending other matters or patients. Furthermore, responders who arrive first are not trained to measure specific vitals, limiting their assistance towards the paramedics and patients. Our solution is to unify these techniques and tools into a single device using the latest technologies, allowing more rapid and reproducible measurements. Thus enhancing the paramedic's ability to administer appropriate care to the most critical victims first.

2. System Overview

VitalTAG by ETA is a portable and continuous vital-measuring device encompassing the latest in microcontroller technology along with cutting-edge smart eyewear to enhance emergency victim care. A system block diagram is shown below in Figure 2 depicting the interaction between the Recon Jet smart eyewear and VitalTAGs.

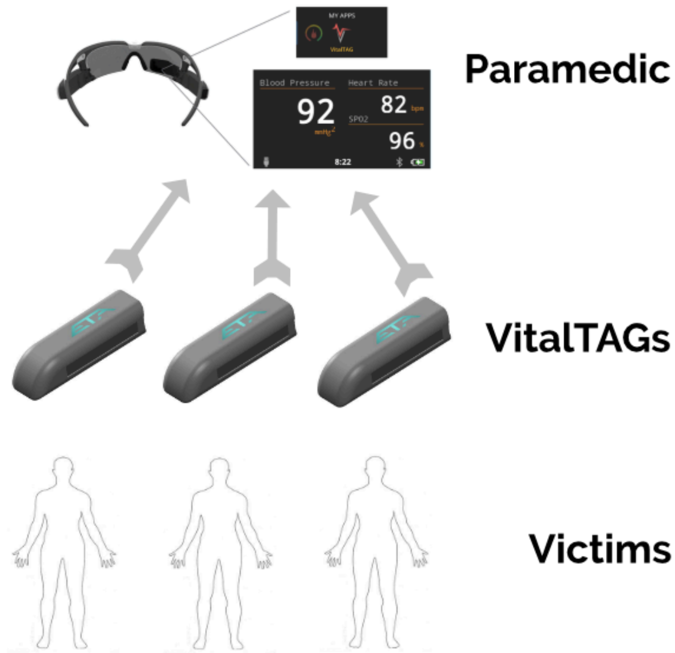

Figure 2: System Block Diagram

2.1 Enclosure

The enclosure not only provides the VitalTAG with a physically appealing image but also serves to address various functional requirements. The enclosure was 3D modeled in SolidWorks to hold all internal components, interconnections, and fit most fingers comfortably.

2.2 Smart Eyewear

The main functions of the smart eyewear are to connect to VitalTAGs and clearly display the vital measurements. The smart eyewear does not obstruct the user's general field of view while including features of good eyewear such as comfort and strength. Additionally, the smart eyewear GUI is easy to navigate for paramedics when toggling through multiple VitalTAG readings.

2.3 Circuitry

The PCB is the "heart" of the system as it is the bridge between the sensors and the smart eyewear. The main component of the PCB is the microcontroller, the ATMega328P. The circuitry will collect raw sensor vital data for software processing. The processed vitals are transferred to the smart eyewear via Bluetooth for the paramedic to view.

2.4 Sensor

The sensors are crucial as they provide the system with the raw vital signals. The raw signals are collected non-invasively and should work reliably with a variety of finger types. The collected raw signals are sent to the microcontroller for software processing.

2.5 Software

The software is the "brain" of the system as it handles the raw vital signal to extract the SpO_2, Heart Rate, and Blood Pressure. The processed vital data must be logged and transferred to the smart eyewear via Bluetooth. In addition, the software performs data analysis for alarm limits by continuously monitoring the processed vital data.

3. Proposed vs Actual Schedule

A comparison between our proposed schedule and actual schedule can be seen below in Figure 3. There have been several issues that have hindered the progress but were solved by working extended hours, using parallel development paths, and expedited shipping methods. With the solutions implemented the project stayed in tandem with the proposed schedule.

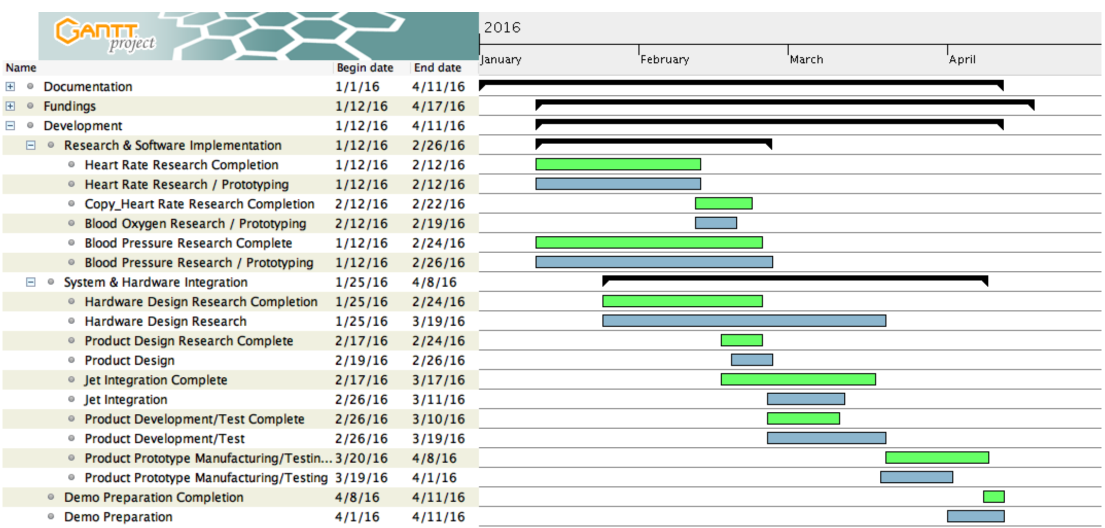

Figure 3: Proposed Schedule (blue) on Jan 22nd, 2016 vs Actual Schedule (green)

4. Proposed vs Actual Cost

Table 1 demonstrates that the project has a cost overrun of approximately 16%. Differences between estimated and actual expenditures are due to three main factors: deadlines, duplicates and component costs. In order to meet deadlines, the team found it necessary to add costs to decrease shipping times and upgrade priority listing for manufacturing. Multiple development boards (e.g. Arduino Unos, Genuino 101s, etc.) and sensors were purchased, enabling the team to work in parallel. Moreover, multiple microprocessors were purchased in order to develop multiple prototypes for proof-of-concept, testing and presentation. Given less stringent deadlines, it is possible that the actual expenditures might be closer to those theorized. Currently, the team of ETA has an expenditure of $1501.23, with a subsidy/funding of $693.00 thus creating a balance of $808.23 in deficit. In order to accommodate for the shortage in budget, ETA has divided net expenses equally. However, the team intends to apply for the Wighton Fund in the near future to recuperate the financial deficit incurred.

Table 1: Proposed vs Actual Cost

	Amount
Proposed Budget	$1295.50
Total Expenditures	$1,501.23
Total Funding	$693.00
Balance	-$808.23

5. Project Challenges

The challenges ETA faced and overcame during the development of VitalTAG can be segmented into 3 separate categories: hardware, firmware, and software.

Hardware

The biggest challenge we faced early on in the hardware development was surface-mount soldering a quad flat no-leads (QFN) packaged sensor, the MAX30100, on our custom printed PCB. To remediate the mounting problems, a revised PCB was manufactured with an increased pad size. In addition, solder paste with hot air to mount the sensor. Another revision required with the MAX30100 sensor was the need for pull up resistors on each of the I^2C lines. On top of that, the low impedance of the sensor required that a voltage regulator was needed in place of a voltage divider since the low impedance brought the voltage divider to ground.

Another challenge we faced was identifying and calculating the two capacitors needed for the crystal oscillator. Taking into consideration the parasitic capacitance of the traces, the capacitor needed to be within a range for the crystal oscillator to begin oscillating. Additional features were added to allow better access to the programming pins needed to flash the ATmega328p chip on the revised PCB.

For the 3.3V voltage regulator that connects to the raw signal of the battery, we learned that the use of a buck-boost DC-to-DC converter without the proper circuitry could drain a lithium polymer battery below its rechargeable level.

Firmware

The first major challenge faced in firmware development was our limited experience working with integrated pulse oximetry and Heart Rate sensors. The signals acquired from the MAX30100 sensor were perceived as noise due to the high DC-value nature of PPG. After the PPG signal was correctly interpreted, we found that high frequency noise from the MAX30100 sensor proved to be another challenge. A sampling rate of 100Hz caused the MAX30100 sensor to pick up constant high frequency noise, affecting the signal processing results. A software low pass filter was implemented as a solution to the problem, reducing high frequency signals and kept the low frequency PPG signal.

Another major challenge faced later on in the firmware development process was the unstable DC values of the PPG signal. Due to the nature of our enclosure design, the PPG signal acquired using our 3D printed case has a much greater DC offset compared to the signal acquired from the MAX30100 development board. This made our original value-based algorithms unstable and inaccurate. Many hours were spent on developing and implementing value-independent algorithms to overcome this issue.

Software

In the early stages of software development, the restrictions imposed by the HUD's small screen and limited interaction methods proved to be a major challenge. The challenge was greatly amplified by the limited resources on the Internet since the HUD is a relatively new technology.

The Bluetooth communication between the firmware and software was also a challenging part of the project. Data received from the firmware was unsynchronized and a custom protocol was implemented on both the firmware of VitalTAG and software on the HUD to synchronize the Bluetooth data transfer.

6. Group Dynamics

The ETA team consists of 4 professional, talented, and astute multidisciplinary engineering students: Andre Chang (Electronics Engineering), Jeetinder Ghataurah (Biomedical Engineering), Richard Chen (Systems Engineering), and Tony Yuen (Computer Engineering). The 4 members of ETA have extensive experience with one another through years of classes, projects, employment, and extracurricular activities.

Group meetings took place at least once a week for 6 to 7 hours. Additionally, informal meetings occurred to accomplish the goals and adhere to the schedule. As the term progressed, the frequency of group and informal meetings increased. To keep all documentation and work unified the team employed several tactics and used Dropbox, Google Docs, GitHub, WhatsApp, and Habitica. A Dropbox shared folder was used to save the majority of our documentation and files and could be accessed remotely. Google Docs was used when several team members were simultaneously modifying a file. A WhatsApp group chat was used to communicate meeting timings and updates. Habitica is a mobile game application that was used to inspire team members to monitor and complete their tasks.

Having several years of prior experience working with each other, the team had no serious problems. Tasks were evenly yet selectively divided to compliment each team member's strengths. Communication was emphasized with frequent group messaging that further avoided any issues. All decisions, despite the gravity, were discussed amongst the group and a vote was taken once each member was able to voice their opinions.

7. Workload Distribution

The various tasks were distributed amongst the team evenly but targeted towards their experience, expertise, and interest. The ETA team encouraged all members to voice their opinions and contribute to all tasks at hand while completing their assigned workload. Table 2 illustrates the workload distribution and contribution.

- Primary (P) – A primary contributor who leads the task work and ensures weekly goals are met.
- Secondary (S) – A secondary contributor who greatly assists the task work with the primary contributor(s).

Table 2: Workload Distribution

Task	Andre	Jeetinder	Richard	Tony
Research	P	P	P	P
Heart Rate POC				P
SpO_2 POC			P	P
Blood Pressure POC		S	P	P
Software Development				P
PCB Design	S		P	
PCB Population	S		P	
Smart Eyewear Integration				P
Smart Eyewear GUI	S	S	S	P
Enclosure Design	P		S	
Enclosure 3D Printing	P	S	S	
Final Product Testing	P	P	P	P

Data Collection		P	S	
Part Ordering			P	
Meeting Minutes	P	S	S	
Business Case	P	S		
Finances			P	P
Business Case	P	S		
Documentation	P	P	P	P

8. Personal Reflections

8.1 Andre Chang – Chief Operating Officer, ETA

Before walking into this course, our team spent many nights brainstorming different project ideas that we thought would be fun or "cool" to build. After much discussion and no results, we learned that we would need to find a problem first before finding a solution. After speaking to other friends, we had finally found a problem worth solving in the field of paramedicine. As we submerged ourselves into the problem, we realized much research and learning would be required. We realized we would have to delve into multiple technical domains in order to complete the task within the strict deadlines. As our prototypes evolved, so did my knowledge both technically and interpersonally.

During this project I have learned many skills from both my teammates and through my own accord. Having different specializations in the team allowed me to develop my skills in mechanical and PCB design, as well as increase my knowledge and interest in the field of medical devices and cash flow analysis. This project has allowed me to touch multiple branches related to electronic production. If I had to highlight my favorite technical experiences during this project, it would be being able to be part of the design and assembly of our own PCB. Additionally, I treasure the knowledge gained in this project relating to business cases, since I was most ignorant in this field.

Still, I must confess that the most valuable teaching in this course would have to be the skills learned related to teamwork and communication. Having such a large task to complete in such a narrow window of time has required all of us to communicate patiently and effectively. Despite having similar backgrounds, I found that at times there were knowledge gaps between team members. Personally, some software and medical terminology originally seemed foreign to me; it was here where patience was required most from all team members. Moreover, when meeting after task divisions, it was necessary for the team to communicate only the relevant progress. Though I was tempted to communicate my entire reasonings and changes, I learned that it is important to communicate only what is necessary in order to efficiently work through the project.

If I were to partake in a project with a similar magnitude in the future, I would hope to have more available time to dedicate to the project. Having taken courses in parallel with Capstone, I found it difficult to juggle the team's schedules (who had work and other courses as well) in order to find times that best suited all members.

After much hard work, I am proud of our VitalTag prototype and am most grateful for having worked with such great team. I truly believe that it is only through the efficient and fun team environment created by ETA that we were able to complete this difficult task in such short time.

8.2 Jeetinder Ghataurah – Chief Executive Officer, ETA

Our Capstone project has been a discussion topic for years amongst my team members. We first started casually meeting in the summer of 2015 as we wanted a head start. Myself, along with my teammates, wanted to create a project that pushed the boundaries of our education and be the highlight of our undergraduate degrees at Simon Fraser University. We spent months brainstorming ideas for a project that would be ambitious and highlight each of our engineering disciplines.

After much deliberation we decided to create VitalTAG, a continuous, wireless vital-measuring and logging device for all first responders to use. The aim of VitalTAG is to decrease the time paramedics need to capture the essential vitals such as Heart Rate, SpO_2, and Blood Pressure. I personally love this project because of its biomedical application along with its possibility to save lives. Additionally, all team members wanted to create as close to a finished product as possible.

Building VitalTAG has allowed us to use the knowledge we have gained throughout our education along with supplementing it. I was very skeptical at first if we would truly have a near finished product due to the sheer amount of work required. Through hard yet smart work, we have all been able to strengthen our skills in PCB design, PCB manufacturing, 3D modeling, 3D printing, biopotenial measurement, biopotential analysis, software coding and documentation.

With each member being a specialist we were able to learn the supplementary material and teach our teammates. Being the Biomedical Engineer and with my experience and education in Biomedical Engineering Technology it was crucial, for me to convey the biopotential measurement analysis properly to my teammates in order for us to properly process the signal with our hardware and software. Additionally, with my work experience at Neovasc, I headed documentation. In creating VitalTAG and working with my teammates I have been able to strengthen my coding, 3D design and printing, and PCB design and manufacturing. Having created VitalTAG, I feel as if anything I envision could be created.

Although we have copious amounts of experience working together I found communication regarding deadlines and individual work were the only weak points. Luckily, for most communication gaps, at least one of the teammates stepped up and set deadlines. Looking back, I believe for future projects I should accommodate the work styles of my teammates. Several nights our meetings would end at 2 to 4 am, which severely shortened my sleep for school or work.

This project would not have been possible without my amazing team members Andre Chang, Richard Chen, and Tony Yuen. Throughout my undergraduate career I am ecstatic to have had numerous classes, projects, employment and my Capstone with my team members. I will always be proud of what we have accomplished in four months. I cannot wait to continue working on VitalTAG and see where it takes the team and I.

8.3 Richard Chen – Chief Technology Officer, ETA

For our Capstone project, we wanted to explore an end-to-end project where we could apply everything we've learned here at SFU. I am extremely proud of our final product as we've really pushed the boundaries of what can be achieved in these short, four months. During this project, we were able to develop the software, firmware, PCB design and 3D print the final enclosure. Not only so, we were able to do our own literature review and tackle an innovative method for obtaining blood pressure.

Having done research at the MENRVA lab, I was able to apply my experience in rapid prototyping, signal acquisition and signal processing to this project. What made our project outstanding was the fact that we were able to have a working final product and collect our own data to validate the findings in another research paper. The entire R&D and startup process was encapsulated in these short months and we were able to come up with 5 revisions for the PCB design, and 4 revisions for the enclosure design.

Due to the diversity of our backgrounds, we were all able to bring something to the table from our past experiences. Mainly, the development workflow used by each of our team members became a nice blend of what we experienced in our previous co-ops or jobs. Although I've designed PCBs in the past, I felt that this was the first time I took the lead on a full design. I learned everything from sourcing components, placing and routing, electrical and design rule checks and ordering PCBs.

All in all, I think I learned a lot about myself as well as working in a group environment under pressure. I feel I still have a lot to learn about communication and getting my ideas across. In future projects, I would better delegate the tasks and allow more room for team members to work in parallel.

This project was a team effort and we've surprised ourselves in what we could accomplish. We've exhausted every experience and knowledge we've obtained in the past and learned so much from each other. This could not have been done without this team and I would like to thank the team of ETA for this amazing experience. This Capstone has really given us a taste of a startup company and I hope we will work together on more projects in the future.

8.4 Tony Yuen – Chief Financial Officer, ETA

This project is one of the most meaningful and important experiences throughout my engineering undergraduate degree. It provided me with an experience similar to a start-up engineering company. In addition, I have also learnt a lot from this project ranging from product market research to technical documentation to real-time signal processing.

The product our team, ETA, envisioned would help paramedics and other first responders to increase the survivability of victims. Having this goal in mind, I truly felt that we have put everything we have got into the past four months to create a working prototype of our vision, VitalTAG. The project was segmented into hardware, software, signal analysis and industrial product design. This allowed us to work on the project in parallel, efficiently as a group, helping us meet the tight deadlines set at the beginning of the semester. The group dynamic was great as all team members of ETA were friends since first year. Weekly meetings/updates were productive and enjoyable. Roadblocks and challenges were overcome together with constructive discussions and arguments.

This project has helped improve my professional portfolio greatly. I have started this project with no prior experience with firmware development, signal processing and HUD applications. During the course of the past 4 months, I have been given the opportunity to learn and develop signal-processing techniques on PPG. In addition, I also gained experience implementing algorithms into firmware to run on the Atmega328P microprocessor. Furthermore, creating an application for a HUD has given me a glimpse to one of the newest consumer-grade technology existing.

At the end, I wanted to thank my fellow ETA team members for the great experience and knowledge throughout the development of VitalTAG.

9. Conclusion & Future Work

9.1 Conclusion

The team of ETA learned a great deal in successfully building VitalTAG. Throughout the journey we have fortified many skills such as circuit design, 3D modeling, biopotential measurements, Bluetooth communication, and multi-platform coding. The team pushed the boundaries of our educational experience with new skills such as PCB manufacturing, 3D printing, and app-based software development. Through each iteration the ETA team solved all issues while improving functionality. To mitigate schedule delays expedited shipping methods, multiple processing paths, and extended working hours were enforced. The final version boasts a comfortable and adapting VitalTAG capable of measuring Heart Rate, SpO_2, and Blood Pressure.

The VitalTAG stores the data onboard while transmitting to the smart eyewear that displays the vitals in a custom GUI.

9.2 Future Work

The ETA Team is extremely proud of VitalTAG and its rapid development from concept to functional product. As complete as our final product is, additional features and enhancements should be made prior to production.

Enclosure

Several 3D prints were created throughout the enclosure development that also changed in material composition between PLA and ABSplus. 3D printing is affordable and ideal for rapid prototyping but the final product would utilize injection molding to mass-produce the enclosure. Future designs of the enclosure should; provide a more secure structure between the upper and lower halves, have a rounded end for larger finger nails, and slimmer design for the future compact components.

Smart Eyewear

The smart eyewear, or more specifically the GUI, performs all the functions we desired. Future work would allow different types of smart eyewear to use the VitalTAG app. The app's versatility would allow users more choice in eyewear apparel and allow VitalTAG to be compatible with future eyewear technology and advancements.

Circuitry

The circuit design and PCB has gone through several revisions, each enhancing the capabilities of VitalTAG. Future PCB designs would use the Intel Curie microprocessor, as it would be available by the end of Q1 2016. The Bluetooth module can be removed as the Intel Curie has on-chip BLE capability [1]. Lastly, future PCBs would have an inductance battery charging circuit.

10. References

[1]"Intel® Curie™ Module: Unleashing Wearable Computing Innovation", Intel, 2016. [Online]. Available: http://www.intel.com/content/www/us/en/wearables/wearable-soc.html. [Accessed: 06- Apr- 2016].

Appendix: Meeting Minutes and Agenda

ENSC 440 Meeting Agenda

16-01-08

Agenda

- Discuss Andre's interview results from Ryan Haluk (paramedic graduate), and Adam Gotkin (lifeguard)

ENSC 440 Meeting Minutes

16-01-08

Meeting commenced at 2:00pm

Interview Results

- Stay away from gloves because they need their hands all the time, can become dirty or broken
- EMR -> PCB -> ACP -> CCP
- Still measure heart-rate with watches and pulse from wrist, if a device could do all of them, could save them 2-3 minutes when there are more victims
- Speed and reliable
- Most important vital signs
    1. Glasgow coma scale (eyes, verbal, motor)
    2. Heart Rate
    3. Blood Pressure
    4. Respiratory
    5. SPO2
    6. Blood Glucose
    7. Pupils
    8. Temperature (not priority)
    9. Pain (not priority)

Action Items

- Research more about measuring blood pressure
- Come up with an idea for the design of the product
    - Band
    - Glove
    - Features

Next Meeting

- Confirmation of the design

ENSC 440 Meeting Agenda

16-01-12

Agenda

- Identification of problem
- Finalize product features
- ESSS funding request
- Start ordering parts
- General discussion
- Branding

ENSC 440 Meeting Minutes

16-01-12

Meeting commenced at 9:00pm

Identification of Problem

- Current paramedic technology for circulatory assessment is slow and inaccurate, or accurate and bulky/expensive
- Current technology only allows one patient to be assessed at a time
- Paramedics must use their hand (both) to diagnose
- Data collected by first responders are not reliable/usable to paramedics unless recorded by an instrument

Finalize Product Features

Core Features

1. Hands-free (attach to victim)
2. Accurately log heart rate and SPO2 of victim for use by paramedics/hospital
3. Heads up display on smart eyewear to visualize data

Feature Roadmap

1. Blood pressure measurements
2. Attach to multiple victims
3. Relay data log through BLE to generate a report

ESSS Funding Request

- Features finalized and budget pending
- PowerPoint presentation needs to be constructed
- Emphasize time saved with use of device
- Emphasize our market research with paramedics and firefighters

Start Ordering Parts

- Chip – Intel Curie (Arduino Genuino 101 for prototyping)
- Heart Rate Sensor – Pulse Sensor Amped

General Discussion

- Request for confidentiality
- Break down of first responder to paramedic procedure and what information is most important
    - For both parties: device frees up their hands when checking vitals
    - First Responder: don the device on victim to initiate logging but priority is fixed on saving people and containing the situation

- Paramedic: device reduces time needed to measure vitals and data relayed can be viewed to see vital history. Data can be extracted and exported for diagnostic purposes. We will further the market research for report format and the best representation of the data.

Branding

- Theme: emergency related, medical, wearable, vital
- Company name ideas: ETA (Emergency Technical Applications), Aceso (goddess of healing process)
- Product name ideas: Mital, Vitaltap, Vitaltag, Vitalink, Vitaleyes, Pulse-link

Action Items

- Work on funding PowerPoint
- Work on Wighton Fund
- Find method of obtaining blood pressure

Next Meeting

- Wednesday, January 13th, 2016

ENSC 440 Meeting Agenda

16-01-22

Agenda

- Team Updates
- Parts Arrival
- ESSEF Funding Results
- Proposal

ENSC 440 Meeting Minutes

16-01-22

Meeting commenced at 10:30 am

Team Updates

- Everyone expressed their current work loads and schedules
- Set next meeting time
- Everyone collected more research papers

Parts Arrival

- Pulse Oximeter x 1

ESSEF Funding

- Received $513.00

Proposal

- Collection of everyone's contribution to the proposal
    - Andre –Marketing, Introduction, Team Description (self)
    - Richard – Background, Images (Logos & 3D Design), Team Description (self)
    - Tony – Budget, Timeline, Team Description (self)
    - Jeet – Scope/Benefits/Risks, Team Description (self)
- Everyone must peer review each other's sections for Sunday January 24th, 2016
- Meet Monday January 25th, 2016 to complete Proposal

Action Items

- Work on extracting data from Pulse Oximeter
- Proof-of-concept to extract blood pressure from heart rate timing
- Complete Proposal

Next Meeting

- Sunday, January 31th, 2016

ENSC 440 Meeting Agenda

16-01-31

Agenda

- Team Update
- Arrival of Parts
- Blood Pressure Measurement Verification
- Blood Pressure (Preliminary Results)

ENSC 440 Meeting Minutes

16-01-31

Meeting commenced at 9:00pm

Team Update

- Everyone updated their current timelines and workloads
    - Richard and Tony have multiple interviews this upcoming week

Arrival of Parts

- Genuino x 3
- Pulse Sensor x 2
- MAX30100 x 4

Blood Pressure Measurement Verification

- Use home Blood Pressure Monitoring device with multiple trials and compare with our measurements
- Questions to be answered
    - Use on different hands at the same time or successively?
    - "White Coat" Effect?
        - Use average of multiple repetitions
    - How many repetitions to accurately represent data?
        - 5 per age group
    - Does age make a difference?
        - Research shows it can, we shall measure the difference
    - Is the error consistent?
        - Will analyze data

Blood Pressure (preliminary results)

- Extracted data from Pulse Oximeter into Laptop
    - Pulse Oximeter outputs Excel file
    - Import Excel into MATLAB
    - Data processing and analysis
- 60 Hz sampling rate
- Ensured all team members understood pulse waveform
    - SpO_2 fundamentals
    - Heart Rate, Blood Pressure, and timing relation

Action Items

- Tony will start Genuino and Pulse Sensor connection
- Richard will continue to extract Blood Pressure from Pulse Oximeter Data

- Andre will investigate datasheets for all hardware devices & solder wires on MAX30100
- Jeet will start the Functional Specifications

Next Meeting

- Sunday, February 7th, 2016

ENSC 440 Meeting Agenda

16-02-12

Agenda

- Team updates
- Heart Rate measurement v1.0
- Order of new parts
- Friends & family funding
- Functional Specifications update
- Task Division
- Next Meeting

ENSC 440 Meeting Minutes

16-02-12

Meeting commenced at 8:30pm

Team Update

- Everyone expressed their current workloads and schedules
- Set next meeting time
- Breakout board required for Max-30100 device

Heart Rate Measurement v1.0

- First heart rate measurement prototype built
- Utilizes low cost pulse sensor (amped) and genuino
- Adaptive calculations implemented to find half point between minimum and maximum peaks of PPG signal
- Heart rate estimated by calculating interbeat interval (IBI) at half points between peaks
- Heart rate calculation of first prototype are comparable to CMS50D+ pulse oximeter values

Order of new parts

-

Friends and Family Funding

- $180 received from Meghan Lui

Functional Specifications

- Due February 15th, 2016
- Base of presentation completed

Division of Tasks

- Tony- advance recon-jet interface with heart rate measurement
- Richard- Eagle Files and electronic design
- Jeetinder- Blood pressure measurement research
- Andre- Casing design and implementation

Next Meeting

- Thursday, February 18th, 2016

ENSC 440 Meeting Agenda

16-02-18

Agenda

- Team updates
- MAX30100 mount
- Design review presentation
- Next meeting

ENSC 440 Meeting Minutes

16-02-18

Meeting commenced at 7:30pm

Team Update

- Everyone expressed their current workloads and schedules
- Set next meeting time
- Progress report on individual tasks

MAX30100 mount

- MAX30100 attached to breakout board without heat gun
- Pins connected to breakout board

Design Review presentation

- PPT created
- Review on schedules, budge and design changes

Next Meeting

- Thursday, February 24th 2016

ENSC 440 Meeting Agenda

16-02-24

Agenda

- Team updates
- Completion and order of PCB design
- Part measurement for casing
- Verification of heart rate values
- Blood Pressure acquisition
- Next meeting

ENSC 440 Meeting Minutes

16-02-24

Meeting commenced at 4:30pm

Team Updates

- Early PCB design completed
- Max 30100 traditional soldering techniques unsuccessful
- Due to mismatch in breakout board, unable to solder Max 30100
- Visual identification of peaks using Genuino complete

Completion and order of PCB design

- PCB design completed using Eagle software.
- PCB design verified and compared to Genuino configuration
- PBC ordered from Oshpark delivery should be in a week's time

Part measurement for casing

- Tallest components of PCB are measured and logged in order to begin casing development
- Battery is largest component (H: 5.5 mm)
- Bluetooth component will go on upper chamber of Vital-Tag, while PCB and battery will be placed on bottom chamber of device

Verification of heart rate values

- Pulse-sensor values obtained from Genuino is compared to smart watch and pulse oximeter values
- Values obtained are within +-2 BPM range from compared device. Data observed from pulse sensor are consistent.
- Pulse sensor values continue to fluctuate on pressure applied by finger

Blood pressure acquisition

- First blood pressure measurements obtained
- Values are within +- 10 mmHg when compared to those measured by off-the-shelf blood pressure monitor

Next Meeting

- Wednesday, March 2th 2016

ENSC 440 Meeting Agenda

16-03-02

Agenda

- Team updates
- Order of new parts
- Case design
- Design Specification task division
- Next meeting

ENSC 440 Meeting Minutes

16-03-02

Meeting commenced at 5:45pm

Team Update

- PCB should arrive following day (March 3, 2016)
- Material for casing investigated
- Advancements on design specifications

Ordering New Parts

- Order new parts from Lee's electronics store
- Parts include different battery pack sizes which might change case design
- Must pick- up parts following day to solder PCB parts once received

Case Design

- Upper and lower chamber should hold Bluetooth module and PCB separately to condense device design.
- U- shaped lid considered having access to upper and lower chamber as well as wiring.
- Two materials should be used inside inner compartment: rigid silicon for PCB side (for support) and a soft spongy material on top for (consistent pressure on finger)
- Materials considered for inside: Thermoplastic elastomer (TPE), Silicone rubber and Silicone foam.
- 3D printing of case will be obtained from www.3dubs.com

Design Specification Task Division

- Andre: Enclosure and User Manual
- Richard: Circuitry and Sensors
- Jeet: Design Spec base, Test Plan and Conclusion
- Tony: Software and Recon Jet

Next Meeting

- Monday, March 6th 2016

ENSC 440 Meeting Agenda

16-03-08

Agenda

- Team updates
- Design Specifications
- Casing
- Hardware updates
- Division of tasks
- Next Meeting

ENSC 440 Meeting Minutes

16-03-08

Meeting commenced at 6:30 PM

Team Updates

- Extension for Design Specifications was taken, extending due date to Mar 10, 2016
- Components soldered onto PCB board

Design Specifications

- Early draft complete by comparing new design selections to function specifications written
- Casing, hardware and software write-ups to be completed

Casing

- First SolidWorks design completed
- Simple 4 compartment design due to modulation capabilities
- 2-piece design for first prototype selected
- Need to request printing from school

Hardware

- All components soldered onto PCB board, including Max 30100 chip
- ATmega chip booted by using a capacitor to begin clock oscillation
- Future design must include larger pins for easier attachment of Max 30100

Division of Tasks

- Tony - Software portion of Design Specifications and early testing on Max 30100 development board
- Richard - Complete Hardware Design Specifications
- Jeetinder - Blood Pressure measurement research using Max 30100 development board
- Andre - Casing design and implementation

Next Meeting

- Thursday, March 17th, 2016

ENSC 440 Meeting Agenda

16-03-17

Agenda

- Team updates
- PCB modifications
- Case design
- Early Blood pressure testing
- Division of tasks
- Next Meeting

ENSC 440 Meeting Minutes

16-03-17

Meeting commenced at 6:25 PM

Team Updates

- Eagle design modified
- Solder paste bought to attach Max30100 sensor
- Raw signals extracted and processed obtained from Max30100 developing board

PCB Modifications

- Capacitor added to oscillate external clock, to ease programming of Atmega32AP
- Larger pads added to facilitate soldering of Max30100 sensor onto PCB
- LED leads added to design
- Through-holes added for better connection and esthetics of wiring

Case design

- Printing requested from School, pricing estimated to be under $30.00

Early Blood pressure testing

- Use research paper algorithm to test blood pressure, using PPG signals.
- Values obtained from development board are compared to CMS50D+ pulse oximeter values

Division of Tasks

- Tony- Peak detection of PPG using Max30100 development board and Recon Jet app development
- Richard- Ordering of new hardware components and mounting of new parts
- Jeetinder- Blood Pressure measurement research using Max 30100 development board
- Andre- Obtain 3D printing and start developing new case design

Next Meeting

- Thursday, March 23rd, 2016

ENSC 440 Meeting Agenda

16-03-23

Agenda

- Team updates
- Mounting of PCB components
- New case design
- Blood pressure signal processing
- Division of tasks
- Next Meeting

ENSC 440 Meeting Minutes

16-03-23

Meeting commenced at 6:00 PM

Team Updates

- Received PCB from Omni circuits
- Requested more PCB from 3PCB overseas
- 3D printing of case completed but components unable to fit without sanding of parts
- Two part case design looks bulky and is difficult to work with

Mounting of PCB components

- Components successfully mounted onto PCB, new design proves to have easier programming and mounting of components
- Major components (Max30100, Atmega32AP and Bluetooth) successfully communicate
- Raw Bluetooth signals from Max30100 are successfully obtained from PCB

Blood Pressure signal processing

- Peak to peak detection completed by analyzing maximum and minimum amplitude
- DC offset leads to reset of programming, requires more robust algorithm

New case design

- 6 piece design created using Solid Works, modular teeth added allow VitalTag to customize to children sized fingers
- New design is highly modular and fits electrical components well
- 3D printing done by 3D hub for quick prototyping and to save on costs
- VitalTag logo added to case and will use LEDs for back lighting
- Case accounts for battery and Bluetooth wiring
- Case is visually more appealing than previous case

Division of Tasks

- Tony- Signal processing of heart rate and blood pressure, as well as Recon Jet app development
- Richard- Signal processing of SPO2 and Blood pressure research
- Jeetinder- Early development of Post- mortem
- Andre- Obtain 3D printing and complete changes accordingly, LED resistor selections for color appeal.

Next Meeting

- Thursday, March 29th, 2016

ENSC 440 Meeting Agenda

16-03-29

Meeting commenced at 6:00 PM

Agenda

- Team updates
- Signal Processing
- Final case design
- Software Update
- Division of tasks
- Next Meeting

ENSC 440 Meeting Minutes

16-03-29

Meeting commenced at 6:00 PM

Team Updates

- Received PCB from Omni circuits are requested more from 3PCB overseas
- Hardware complete
- 3D printed case obtained shows minor warping and does not have enough space for added LED.
- 3PCB boards received
- Resistors selected for appealing LED colors

Signal Processing

- Using Matlab more robust algorithm determined to detect points of interest in both IR and Red LED readings

Case design

- Removed through holes and pins due to printer limitations
- Extra lip added to prevent upper case shifting
- Larger crevices added for wiring
- Edge rounded inside upper component to reduce lid tilt while wearing device
- 3D printing done by 3DHub and SFU.

Software Update

- Recon Jet app complete (able to display data sent by BLU), GUI esthetic appeal still requires further development
- SPO2 and Heart rate algorithm improved. Algorithm is more robust and is able to detect peaks more reliably
- Matlab algorithm transferred to C++ for Atmega32AP programming

Division of Tasks

- Tony- Implement real-time signal processing from Matlab into C++
- Richard- Signal processing of SPO2 and Blood pressure research
- Jeetinder- Early script development for video
- Andre- Obtain 3D printing and complete changes accordingly

Next Meeting

- Thursday, April 2, 2016