July 23, 2019

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

RE: ENSC 405W Project Proposal for Pulse Tracer

Dear Dr. Rawicz,

Please see attached the Project Proposal for Pulse Tracer, a patient monitoring system created by LumoAnalytics. Pulse Tracer uses photoplethysmography (PPG) to remotely measure the heart and respiratory rates of primarily immobile elderly patients who are often left unattended. Our goal for this device is to provide a way to accurately measure the heart and respiratory rates of patients and to detect significant variations from the average values in an attempt to alert caregivers of possible emerging health conditions. This technology will provide patients the ability to live in their own homes while still having a professional caregiver monitor their health.

The attached document will provide a high-level overview of Pulse Tracer. It will begin with a brief project overview providing a background and scope for Pulse Tracer, as well as outlining the risks and benefits associated with the project. It will then analyze the current market and competition for the device, followed by an estimated budget and schedule for the implementation of Pulse Tracer.

LumoAnalytics is comprised of a team of five engineering students: Winsey Chui, Wenpei Li, Huy Thong Bui, Corey Myrdal, and Brittany Hewitson. Our team members come from a range of engineering concentrations including electronics, biomedical, and computer engineering. We believe each member brings a particular skill set to the team that will contribute to the success of Pulse Tracer.

Thank you in advance for taking the time to review our project proposal. If you have any questions or concerns, please feel free to email our Chief Communications Officer, Huy Thong Bui, by email at htbui@sfu.ca

Sincerely,

Brittany Hewitson
Chief Executive Officer
LumoAnalytics

Project Proposal for
Pulse Tracer

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Executive Summary

Life expectancy in Canada is rising due to consistent improvement in healthcare technology [1]. Alongside this rise in life expectancy, healthcare services for the aging population are becoming increasingly important. There are challenges to providing healthcare for elderly and immobile patients that leave the healthcare system overwhelmed and patients at increased risk of harm. In addition, the comfort and quality of life of patients is just as important and patients losing their independence is a detriment to that quality.

Health monitoring equipment is ubiquitous and a necessary part of caring for at risk patients. However, it can become a burden and a restraint to those that require consistent monitoring, often keeping them out of their homes and less independent. In addition, equipment requiring contact with skin can quickly become uncomfortable and even cause damage to those with more sensitive skin. A multitude of research has been done on monitoring the health of elderly at home as this is a growing market in need of innovation [2–4]. Solutions are needed that offer flexible and comfortable monitoring of important vital signs such as heart rate or respiratory rate.

Our prototype, Pulse Tracer, is a remote vital sign monitoring solution that aims to provide independence and comfort to those that require or would benefit from consistent monitoring. The device is intended to be used by the elderly and their caregivers to monitor metrics such as heart rate, respiratory rate, and blood oxygenation. The novelty of the device comes from its ability to remotely monitor these vital signs through illuminating the patients face with near infrared (NIR) light and processing the light that is reflected.

Pulse Tracer can be divided into five main sections; NIR illumination, image acquisition, image processing, vital sign extraction, and a user interface. NIR LEDs are used to illuminate the patients face while an image is acquired by a camera capable of detecting this NIR light. The acquired image is processed on a micro controller to produce a number of regions of interest (ROIs) to be used by subsequent algorithms.

The average pixel intensity of each frame in the ROIs are used to create time series of data from the RGB sensors that are then sent to a cloud database for further processing. Algorithms to extract both the heart and respiratory rates are applied on this data, with algorithms for additional metrics such as blood oxygenation and heart rate variability included in the final prototype. The data is sent to a web application to display the patient's vital signs over time for both the patient and their health care provider.

The global market for remote patient monitoring devices is growing at an increased rate. There is greater demand for devices that can allow patients to remain independent. This demand equates to a market that is expected to reach $ 1.8 billion by 2026 and is driven by an aging population [5]. Along with the aging population there is an increased demand for caregivers that may not be met if innovation in this sector cannot keep up [6]. Pulse Tracer will reduce the need for caregiver attention as caregivers will be able to remotely monitor their patients.

LumoAnalytics is excited to provide Pulse Tracer as an effective solution to remote monitoring and retaining independence. As a team of five skilled and motivated engineering students with experience in medical device development, hardware and electronics design, and software development. Pulse Tracer will continue to improve and be made into a reality within the coming months, with our skills and dedication we hope the device will make a difference in the world of remote monitoring.

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1 Introduction

As healthcare technologies continue to improve, the life expectancy in Canada is on the rise [7]. However, with this increase comes the need to provide specialized health care services for the aging population. This can be a challenge as health care facilities can often become crowded and understaffed, leaving the elderly on wait lists or to live at home with little to no regular supervision from caregivers. Surveys also show elderly patients maintain a stance that independent living is important to their quality of life [8]. While they agree that having health issues may be an increased problem because of independent living, they tend to disagree with the need for constant supervision [8].

As a result, medical trends have moved towards wearable technologies [9]. However, wearable devices have also been disagreeable among seniors for several reasons, some having expressed devices being too harsh on delicate skin, forgetting to put on the device in the mornings, and feeling eyes on them for wearing a device that is clearly used for medical purposes as opposed to recreational [10]. However, seniors have shown a positive attitude towards monitoring devices that can be installed within their homes [11].

Therefore, LumoAnalytics is proud to present Pulse Tracer, a non-invasive, remote patient-monitoring system. Pulse Tracer is designed for elderly, mostly immobile patients who unable to be monitored constantly, relieving stress and time from family members and decreasing money needed to be spent on care aides. Data is collected remotely with videographic technology and sent to a database securely for accurate and efficient processing. Vital signs, both historic and real time, can be viewed with a simple user interface by both patients and caretakers alike.

The aim of Pulse Tracer is to remove the discomfort and obtrusiveness of wearable technology and move towards a more remote design, ensuring minimal changes in lifestyle. Caretakers will be able to monitor multiple patients from any location with internet connection, and are not required to be in the physical presence of the patient, but are still able to provide high quality care in a timely manner. Other health professionals are able to monitor vital signs as well, without the frustration of scheduling an appointment in office or at home.

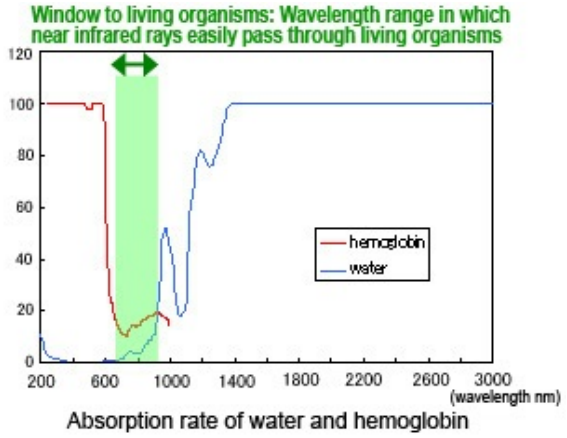
This document details the proposal for Pulse Tracer, including background, a high-level overview of the device, the scope, risks and benefits, as well as an analysis on the current marketing trends. Financial management will also be discussed, detailing the costs and sources of funding. This proposal will end with a Gantt chart that details the timeline for this project.

2 Project Overview

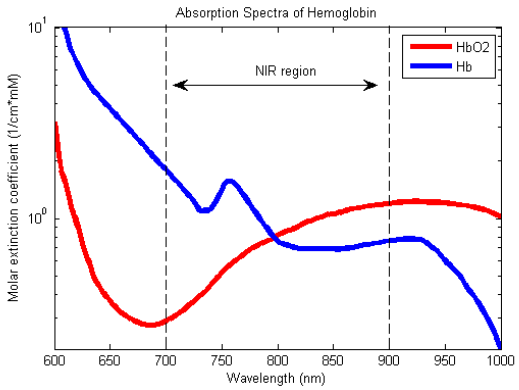
2.1 Background

Vital signs are measurements of the basic functions of the human body, including metrics such as heart rate, respiratory rate and blood oxygen levels. These measurements are often closely monitored in elderly patients by medical professionals to judge their overall health, as sudden changes in these signs may be early indicators of arising issues. Pulse Tracer provides a remote monitoring system to keep elderly, immobile patients out of the hospital and health care centers while still being constantly monitored by necessary health aids.

According to principles of biophotonics, light at wavelengths of 700nm to 900nm are absorbed, scattered and reflected by hemoglobin [12]. At these wavelengths, the absorption of blood is much higher in comparison to water, as seen in Figure 2.1a. In the adjacent figure (Figure 2.1b), within these set of wavelengths, it is clear that there is a boundary between the absorption levels for deoxygenated and oxygenated blood, where oxygenated blood has a greater absorption from approximately 800nm to 900nm, and deoxygenated blood on the lower end of usable wavelengths.



(a) Absorption of Light in Human Tissue [13]



(b) Hemoglobin Absorption Spectra [14]

Figure 2.1: Absorption of Light in Human Tissue vs Hemoglobin Absorption Spectra

These principles are most commonly found in pulse oximetry and photoplethysmography (PPG), concepts on which Pulse Tracer is derived from. By using near-infrared light, vital information can be obtained from patients in the form of videos, which is then processed to display real time and historic data.

2.2 Scope

The scope of Pulse Tracer details the design, assembly and testing of the prototype. The prototype will be able to collect and process real time and historic data because of the following:

- Shine and capture near-infrared light continuously
- Constantly detect facial features and extract regions of interest from incoming data

- Extract heart rate and respiratory rate information from the regions of interest signals in an efficient manner
- Save processed data for later viewing

Pulse Tracer's prototype will be able to do so in an efficient and accurate manner because of the following features:

- Shine and capture near-infrared light over the entire face
- Optimize facial detection algorithm to select regions of interest
- Move data to online database for faster extraction of vital signs
- Optimize algorithms for metric extraction that ensure proper filtering, smoothening and motion correction

The prototype has dimensions of approximately 40x40x20cm, and the final design will have significantly minimized this design. As Pulse Tracer moves through prototyping stages, its physical presence will become smaller and smaller to ensure minimal intrusion in the patient's home. The initial viewing of data in the prototype stage will be on a web app, securely and easily accessible to anyone with internet access. LumoAnalytics also has plans to expand this into a mobile app in the final design stages for ease of use and convenience.

In the final steps of prototyping, once the prototype has been assembled into a singular device, testing will occur. Data collected and processed will pass through testing using gold standard equipment to test accuracy and processing efficiency.

2.3 System Overview

Pulse Tracer is a remote patient monitoring device designed to monitor the heart and respiratory rates of immobile elderly patients. Through the use of near-infrared light, information is captured from the patient and subsequently processed by an analysis pipeline to determine heart and respiratory rates. The device can be divided into three major components: a hardware component for the collection of data, a software component for processing images and extracting necessary data, and an app for users to view the processed data. The following image shows the relationship between the components involved in Pulse Tracer.

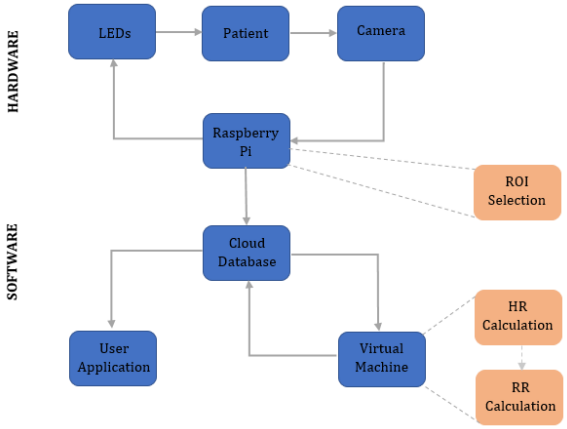


Figure 2.2: High-level system overview of Pulse Tracer.

2.3.1 Hardware Components

The hardware component of Pulse Tracer plays the essential role of data collection. Pulse Tracer uses near-infrared (NIR) LEDs with a central wavelength of 850nm set in a ring configuration to illuminate the patient's face, either from a frontal or profile view. Through the principles of blood absorption, scattering and reflection as discussed in the Background section, NIR light is reflected back and captured by a Raspberry Pi Camera Module with no IR filters. The captured videographic information is sent from the camera module to the Raspberry Pi 3B+ for processing and data extraction.

(a) NIR LED at peak wavelength of 850nm [15]

(b) Raspberry Pi NOIR Camera V2 [16]

Figure 2.3: LED and NOIR Camera

Figure 2.4: Raspberry Pi 3B+ [17].

2.3.2 Software Components

The software component is responsible for image processing and data extraction. By using Python, specified regions of interest are automatically selected from each frame of collected data. An algorithm then calculates the average pixel intensity of each frame in each of the RGB spectra to create three time series of data. The time series of data is sent to a cloud computing service for further processing.

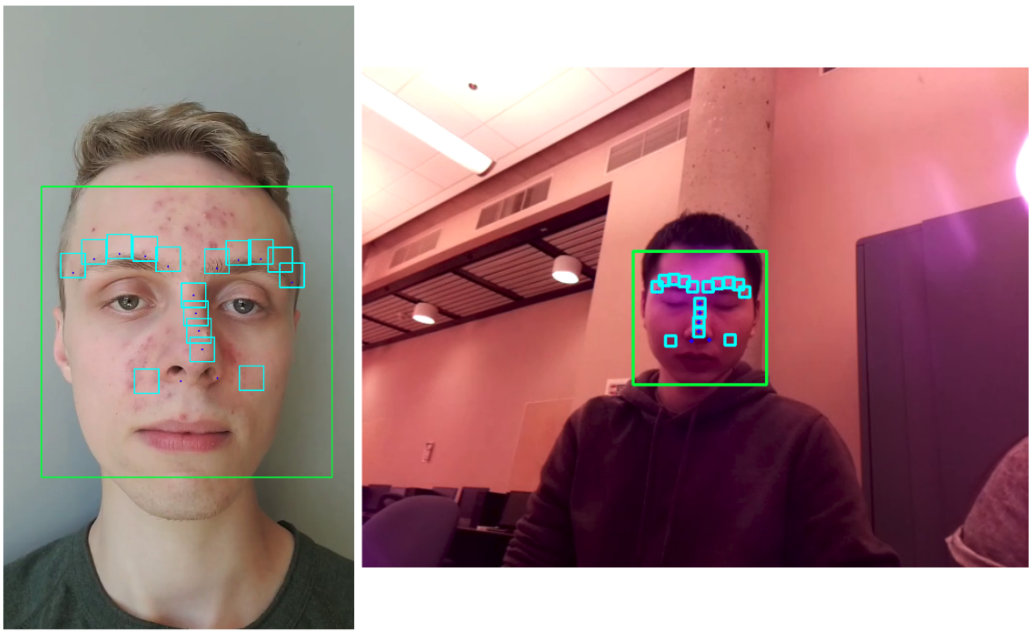


Figure 2.5: Region of interest selection results

In order to extract heart rate (HR) data, one of the time series RGB channels is selected. The selected channel is taken through pre-processing which includes normalization and filtering, before going through frequency analysis. The final result is the HR data. Respiratory rate can be extracted from the signal following this, where filters are applied to extract the maximum amplitude of the continuous wavelet transform within reasonable HR frequencies between 30-220beats per minute [insert ref from design specs]. This signal then goes through feature-based analysis to finally extract the RR signal.

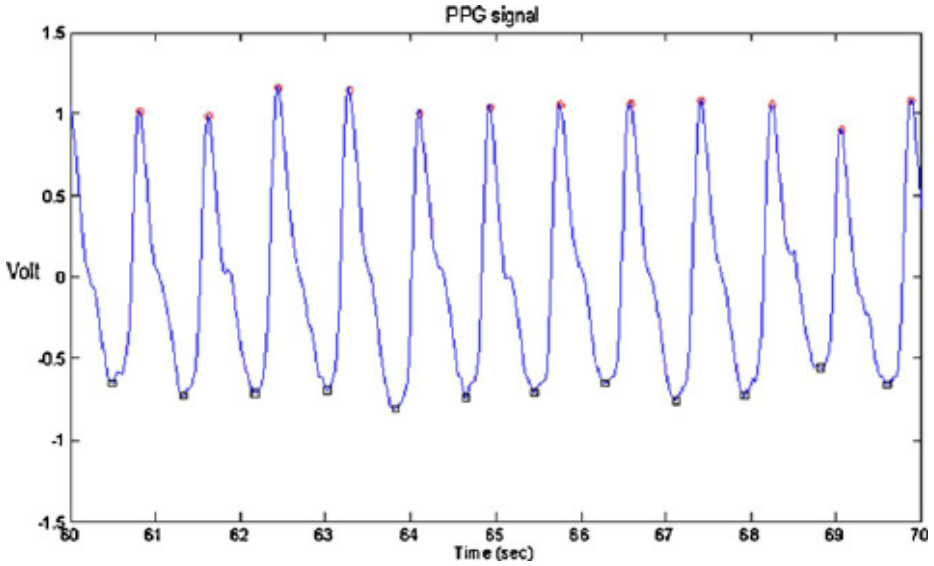


Figure 2.6: Extracted Heart Rate Signal [18]

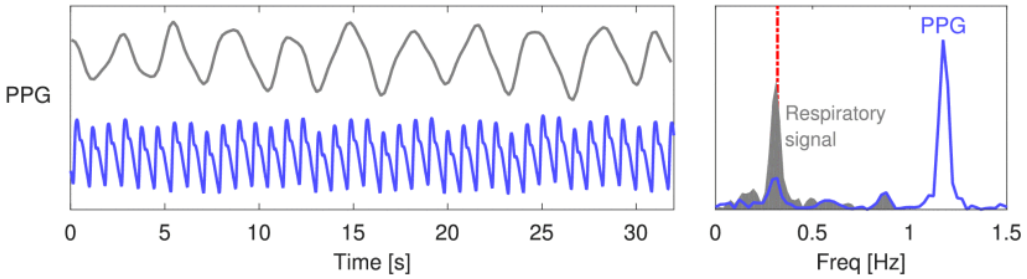


Figure 2.7: Extracted Respiratory Rate Signal [19]

2.3.3 Application

The initial prototype of Pulse Tracer consists of a web application as the user interface, and extends to a mobile application in later stages of development. The backend will be built using Django, which is a high-level Python web framework. Because Django is a high-level framework, it allows for rapid development while still providing sufficient features. The front end of the web application will make use of Bootstrap and Javascript alongside Djangos HTML templates. The Django backend will be connected to a PostgreSQL database, which will be hosted in the cloud as an AWS RDS. This will allow many Pulse Tracer devices to remotely send ROI data to the database. A VM will also access this database to process the ROI data into HR and RRs, and then store the results. The database itself will hold metadata about the patient and caregiver, raw ROI data for the patient, and the processed HR and RR data. Figure 2.8 shows the schema for the database.

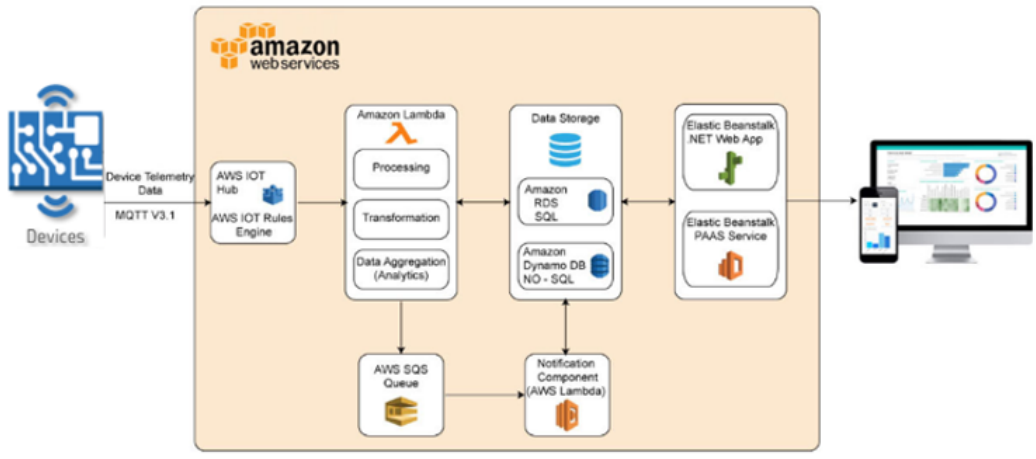


Figure 2.8: Overview of data flow [20]

2.4 Risks

While LumoAnalytics has done its best to minimize the risks associated with Pulse Tracer, is it undeniable that some may still exist. One of these risks is related to the accuracy of the processed data. While LumoAnalytics is dedicated to providing accurate results, unpredictable events may occur that lead to irregular and inaccurate data. This can cause a problems with doctors and caregivers when they analyze the data. However, in taking this into account, multiple regions of

interests are used in data processing, and both patients and caregivers have the capabilities to flag data.

There are also risks associated with possible current surges. Concerns associated with this involve overpowering the LEDs, which would lead to burn out, or photoaging in the patient due to an increase in power. The hardware team has future plans to install measures to prevent this or to shut down the system if prevention was not enough.

Another potential risk is possible data leakage. Seniors often express a concern about technology in the form of not knowing if their personal information is secure. To minimize this risk, on the front end, Pulse Tracer's user interface is equipped with a login and password, while in the backend, Amazon Web Services ensures the privacy and security of all information so long as LumoAnalytics continues to pay them.

2.5 Benefits

Pulse Tracer aims to improve the lives of elderly, immobile patients, their cargivers as well as the health care system as whole by relieving the need for constant supervision through the use of remote monitoring. In this section, LumoAnalytics provides a series of benefits that Pulse Tracer provides as a product that outweigh its current risks, and thereby justifying its production.

Stakeholders

This product does require an up-front cost for initial development stages, but through modifications and further research, Pulse Tracer is aimed to decrease significantly in production costs. From a competition point of view, there are currently no other devices on the market that employ remote-imaging PPG, ensuring the uniqueness of Pulse Tracer and lack of market competition.

Patients

From a patient perspective, Pulse Tracer provides multiple benefits. As discussed previously, independent living is a crucial aspect of a senior's quality of life [ref]. However, this is often unfeasible given the constant risk of issues flaring up, causing most family members to place their elderly relatives in senior homes or other places that provide constant supervision. With Pulse Tracer's remote monitoring capabilities, independent living without constant supervision is still possible, as caregivers can monitor their seniors from their own locations. In addition to this, unlike the growing trend of wearable products, because Pulse Tracer is non-contact, there is no fear of skin irritation or needing to remember to put the device on and take it off each night, problems which seniors often express. Furthermore, Pulse Tracer is highly intuitive and requires minimal physical presence. The device is packaged in a sealed enclosure with components made as small as possible, with openings only for powering the device, a charging station, the camera and all corresponding LEDs. All components are labelled clearly on the enclosure to provide ease of use, ensuring little to no misunderstanding. However, Pulse Tracer does allow for user interaction. In the user interface, users can view their data and flag points to increase understanding for other users. In doing this, patients can feel more in control of their own health and data, and caregivers can monitor multiple patients constantly. Finally, Pulse Tracer is capable of providing medical benefits. At certain irradiances, NIR light can reduce wrinkles, fine lines, skin roughness and cause an increase in intradermal collagen density.

Caregivers

Benefits for caregivers of patients using Pulse Tracer are immense. As mentioned previously, because this device is aimed towards cost reduction, Pulse Tracer is fairly inexpensive for anyone looking to buy the product. In relation to financial pressure, there is no longer a need for caregivers or family members to find constant human supervision for their seniors, as caregivers will be able to remotely monitor them from their web applications or mobile applications. This becomes a relief both financially and in terms of time.

Health Care System

The growing number of elderly patients is a strain on the health care system due to lacking numbers of senior homes and the financial burden of overnight hospital stays. Pulse Tracer reduces the need for both of these things. Because doctors can remotely monitor their patients, issues can be caught early before they build up into major issues that may result in overnight hospital stays. For example, common early signs of heart failure include irregular heart rate and dyspnea, both of which can be caught with Pulse Tracer.

World

LumoAnalytics is devoted to creating a green device by using the cradle-to-cradle design, which takes into consideration how each component of the device can be reused or discarded.

3 Market Analysis

Pulse Tracer is a remote patient monitoring device designed to be used by both the patient and their health care providers. The patients Pulse Trace is primarily aimed towards are immobile and elderly. The market analysis will be based on these factors along with some competitors in this area.

3.1 Market for Patient Monitoring System

Patient monitoring devices are used to observe the patient's heart rate, blood pressure and other important parameters. These devices, such as pulse oximeters, cardiograms and cardiac monitors, are increasingly used in small and large operations in hospitals, clinics and various outpatient centers, and are expected to simultaneously monitor the vital signs of multiple patients. In 2016, the global market value of patient monitoring equipment was US$2.112 billion, and is expected to reach US$3.235 billion by 2023, with a compound annual growth rate of 6.2% from 2017 to 2023. [21]

As a sub-project of the system, the revenue of remote monitoring devices will be affected by the overall patient monitoring market. This shows that remote patient monitoring systems, including Pulse Tracer, have good prospects in the global market.

3.2 Market for Remote Patient Monitoring System

Figure 3.1 below shows the estimated global remote patient monitoring devices market from the year 2012-2022. [5]

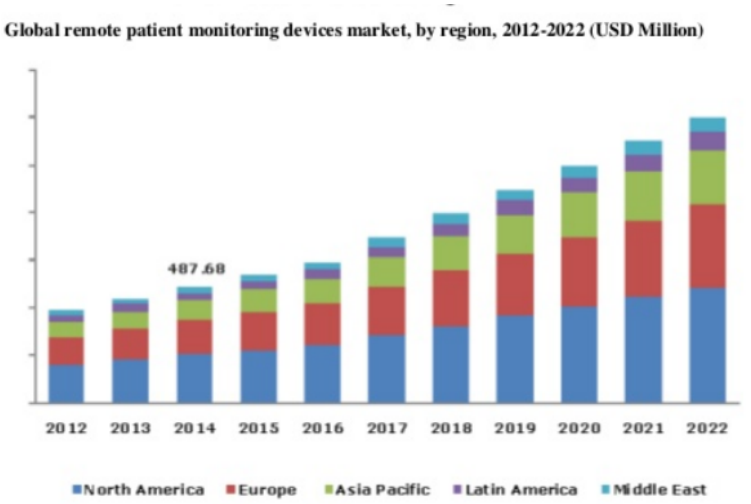


Figure 3.1: Estimated global remote patient monitoring devices market from the year 2012-2022

According to the report from the Grand View Research Inc., the global market for remote patient monitoring systems is expected to reach $1.8 billion by 2026 [22]. During the forecast period, the compound annual growth rate of the market is expected to reach 13.5% [22]. Telepatient surveillance systems are expected to increase significantly in demand for monitoring chronic diseases such as

diabetes, cardiovascular disease and cancer [22]. The increasing incidence of cardiovascular diseases, the increasing population of the elderly and the need for independent and healthy life are also far-reaching driving factors.

In addition, the improvement of medical infrastructure, post-emergency care management and the attention of major market participants to emerging economies are expected to promote the growth of the market for remote patient monitoring systems. It is expected that rapid technological advances will provide better choices for medical practitioners and patients, thus promoting growth. [22]

Like Pulse Tracer, the remote patient monitoring system includes a wide range of technologies designed to manage, evaluate, notify, intervene and modify treatment plans as needed. Remote patient monitoring systems are most commonly used to reduce the progress of chronic diseases and to enhance rehabilitation after discharge from the acute intensive care unit. These techniques also remind caregivers to intervene in a timely manner in any vulnerable situation. [22]

3.3 Market for Caregivers in US

Figure 3.2 shows the number of caregivers in the US who provided care to individuals over the age of 50. It shows that approximately 43.5 million caregivers have provided unpaid care to an adult or child in the last 12 months, with approximately 34.2 million of those patients being over the age of 50 [23]. This demonstrates that the number of individuals requiring care are mainly over the age of 50, showing a good prospect for a remote monitoring device for elderly patients.

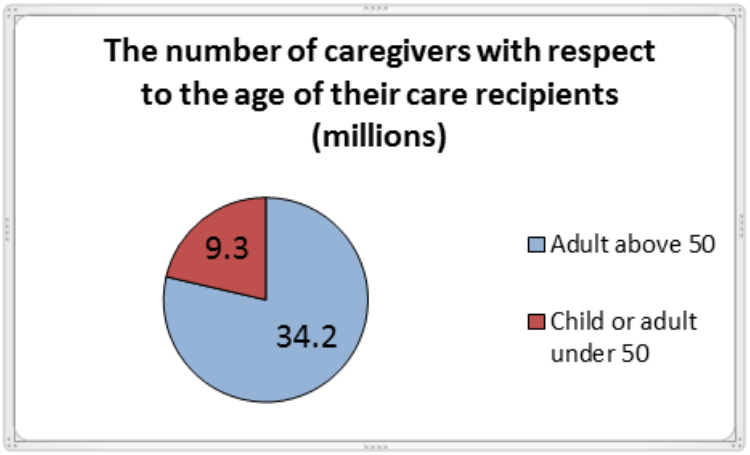


Figure 3.2: The number of caregivers with respect to the age of their care recipients

It is estimated that 641,000 adults over the age of 60 suffer from cognitive and other disabilities. By 2030, this figure is expected to double to 124,2794, which is consistent with the aging of the baby boom generation born between 1946 and 1964. Families are still the main caregivers for adults with developmental disabilities, and they themselves are getting older. About 76% of developmental disorders live at home. Among these families, 25% of family caregivers are over 60 years old. The average age of patients with developmental disorders was 38 years. [23]

Figure 3.3 shows that most of the recipients are disabled or ill, comprising 39.8 million out of the total 43.5 million individuals receiving care. These people are deprived of mobility for various reasons. Among them, the people who have Alzheimer's disease or other dementia constitute a high

proportion (15.7 million). [23] Statistics tells us that 46% of caregivers have performed medical and nursing tasks in the past 12 months. Among them, 57% of caregivers reported that they had no choice in carrying out clinical tasks, and the lack of such choice was self-imposed. [23]

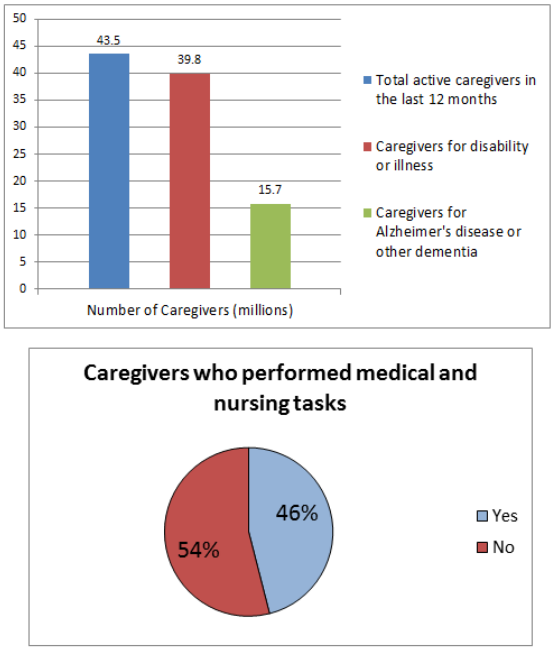


Figure 3.3: Tasks of caregivers

According to Figure 3.4, caregivers often have certain decision-making power in caring for patients, and they have different decision-making power depending on the situation. 66% of caregivers have the right to monitor and adjust patients, 63% of them can communicate with medical staff on behalf of patients, and 50% of caregivers can act as an advocate for the care recipient with care providers, community services, or government agencies. [6]

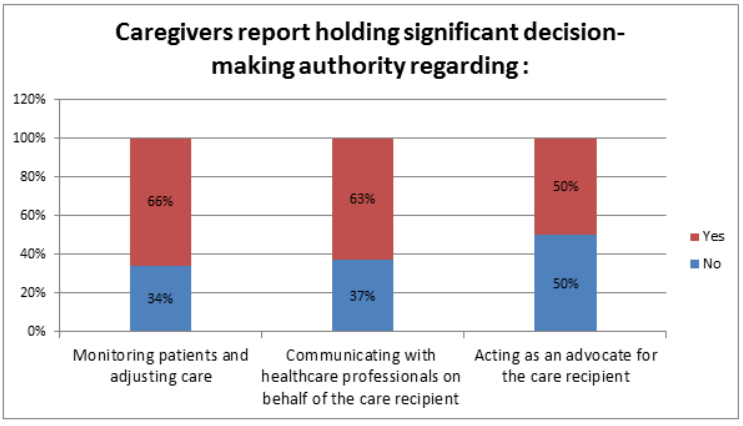


Figure 3.4: Decision making of caregivers

Pulse Tracer is a phone app based remote device. So caregivers can obtain information of patients remotely. And we find that the vast majority of caregivers (75%) reside within 20 minutes of their care recipient. 13% of caregivers reside between 20 minutes and an hour away from their care recipient. As the age of the caregiver increases, their distance from their recipient decreases. 84% of caregivers aged 75+ reside within 20 minutes of their care recipient, [6] compared to their caregiving peers in other age brackets. Thus this factor can also provide extra benefits to our product.

3.4 Competition

Welch Allyn are possibly the best-known manufacturer of diagnostic equipment in the world. Their diagnostic sets, otoscopes, ophthalmoscopes and Vital Signs monitors can be found in health centres and hospitals right across the globe. Welch Allyn's commitment to producing exceptional quality products and over 100 years of experience is apparent in every product they make. Reliable designed and packed with functionality, Welch Allyn diagnostic equipment is some of the best on the market.

Figure 3.5: Welch Allyn Home Blood Pressure Monitors

For example, Welch Allyn Home Blood Pressure Monitors [24] combine the clinical quality and accuracy, one-button operation for fast readings from the comfort of home. The free smartphone app lets patients store and track their readings, so they can monitor their progress. The app seamlessly connects to the blood pressure monitor using Bluetooth technology. This product allows users to read measured heart rate, blood pressure and SpO2 level remotely through the phone app. And it is also portable and rechargeable.

Many other companies in North America offer the similar products like **ZODORE, Suntech Medical, Contec, and Fencia.**

However, all of those products measure data by using the body contact method, the Pulse Tracer can record data, though an NIR camera remotely and it does not require any contact with the body. Therefore, our products have unique designs that are not available in the current market. This makes our products more powerful and competitive.

4 Cost Considerations

4.1 Cost Estimate

The tables below outline our estimated costs for both the proof of concept prototype as well as the final functional prototype. Parts used in the functional prototype that are from the proof of concept prototype are not included in the price as they do not need to be purchased again.

Component	Description	Total Cost (CAD)
Raspberry Pi 3 B+	Raspberry Pi kit containing components needed to make the pi functional	79
NIR LEDs	Near infrared emitting LEDs, variable power	6
NoIR Camera	Camera for raspberry pi that can detect IR light	86
Breadboards	Electronic breadboards for prototyping	10
Total		181

Table 4.1: Proof of Concept Prototype Estimated Cost

Component	Description	Total Cost (CAD)
NIR LEDs	Near infrared emitting LEDs, different wavelength	12
Visible LEDs	Visible light LEDs indicating system status	10
Custom PCB	Custom etched PCB replacing breadboard circuit	20
Switch	Electromechanical switch for powering on/off the device	8
Battery	Rechargeable battery pack and cables for recharging	50
Enclosure	Enclosure for device with mounting assembly	20
Total		120

Table 4.2: Functional Prototype Estimated Cost

4.2 Funding

4.2.1 Engineering Science Student Endowment Fund

The Engineering Science Student Endowment Fund (ESSEF) is a fund managed by the Engineering Science Student Society (ESSS). The ESSEF is given out for projects proposed by undergraduate engineering students which fall under 4 categories. The categories of interest for the Pulse Tracer is Category B (Entrepreneurial) and Category C (Class). Acquiring funding from the ESSEF should not pose a challenge as the Pulse Tracer meets the requirements and the project is relatively inexpensive so not much funding is required.

4.2.2 Wighton Development Fund

The Wighton Development Fund is administered by Dr. Andrew Rawicz. The fund is given to student projects satisfying Wighton's requirement of practicality with preferential treatment given to projects that benefit society. The Pulse Tracer was designed from the beginning to benefit society through the non invasive monitoring of less mobile patients. If funding from the ESSEF is insufficient, the Wighton fund will be a realistic additional source of funding.

5 Project Planning

Pulse Tracer will consist of a three stage design, with a separate prototype completed at the end of each stage. Table 5.1 below identifies the prototype produced at each of the three stages.

Phase Number	Prototype
I	Proof of Concept
II	Engineering Prototype
III	Final Product

Table 5.1: Design Stages

Phase I will be completed throughout ENSC 405W in the Summer 2019 semester. The prototype for this stage is intended to be a proof-of-concept prototype where there is limited functionality of the device. This includes:

- basic face detection and region of interest selection algorithm
- extraction of heart and respiratory rates from the video stream
- limited software user interface in the form of a web application
- Raspberry Pi requiring a wall outlet representing the physical Pulse Tracer device

An appearance prototype will accompany the proof-of-concept prototype to demonstrate the intended shape and size of the final product.

Phase II will be completed in the subsequent semester during ENSC 440. The engineering prototype will be completed at the end of this stage, which will provide more functionality and better accuracy than the previous proof-of-concept prototype. This will include:

- improvements to the facial detection and region of interest algorithms
- additional metrics such as blood oxygen levels and heart rate variability
- improvements to the security, appearance, and functionality of the web application
- introduction of a rechargeable battery to allow the Pulse Tracer device to be moved
- a customized PCB for the hardware components

Phase III will provide one more iteration on the design of Pulse Tracer and will be finished after the completion of ENSC 440. The main features new to the final prototype include further improvements on software algorithms, a mobile application to accompany the existing web application, and the miniaturization of the physical Pulse Tracer device.

Figures 5.1 and 5.2 below outline the schedule for Pulse Tracer over the first two phases of the design. Items in bold represent significant milestones in the project, while items beneath milestones represent the sub tasks required to complete the milestone.

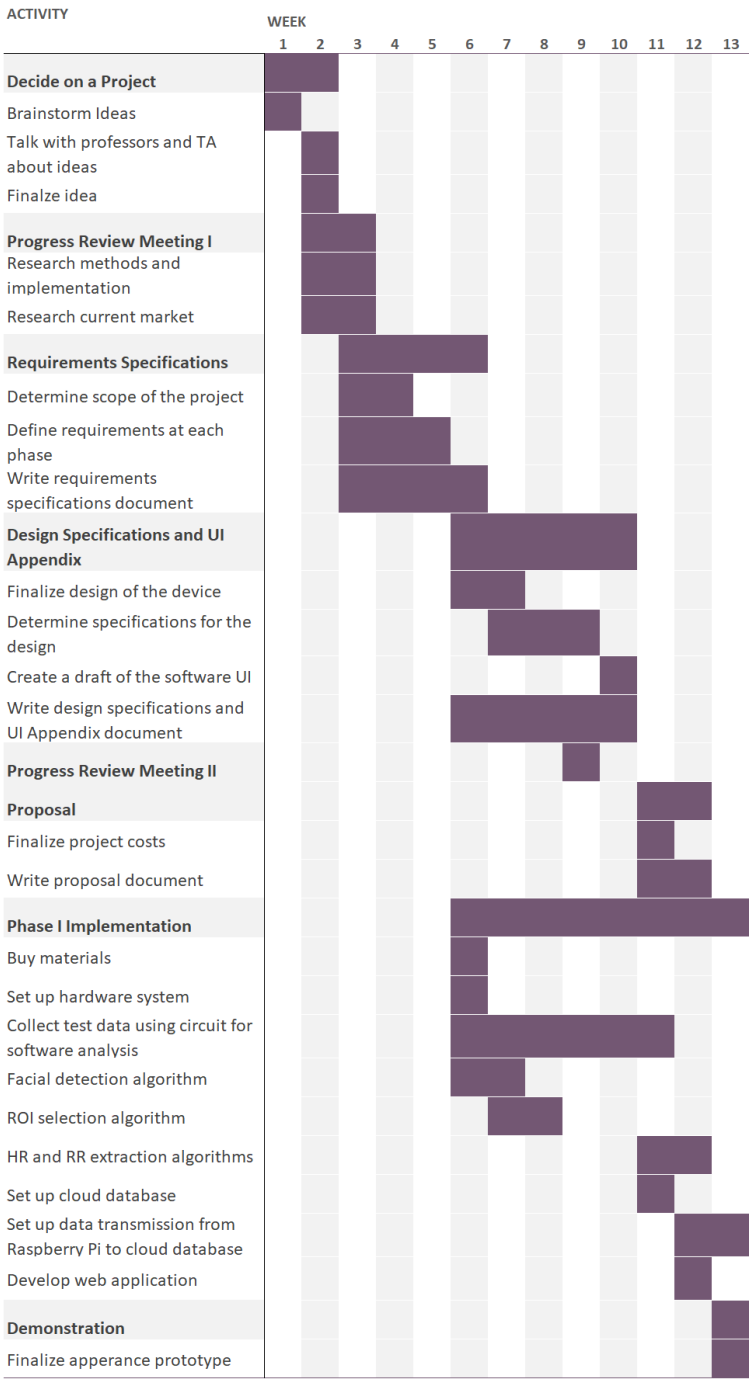


Figure 5.1: Gantt Chart for Semester 1 of the project

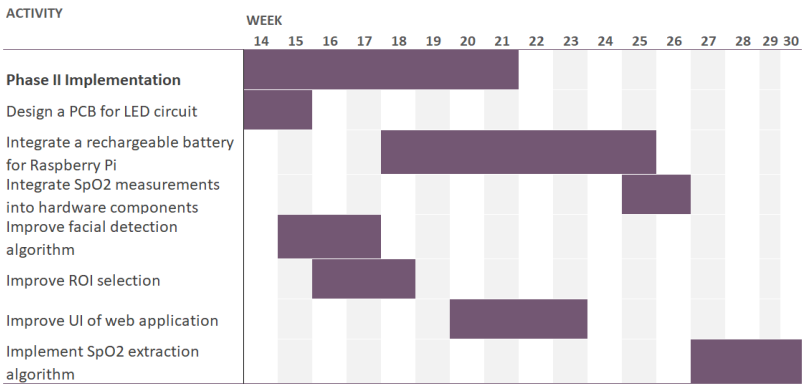


Figure 5.2: Gantt Chart for Semester 2 of the project

6 Company Details

6.1 Brittany Hewitson - CEO(Chief Executive Officer)

Brittany is a fifth-year Biomedical Engineering student with a strong interest in biomedical optics and medical imaging. Brittany has finished her co-op as a software developer, and as a scientific programmer at the BC Cancer Research Centre. At the center she took part in developing data analysis pipelines as well as leading the integration of cutting-edge analytic tools into the existing framework. With her extensive research and leadership experiences, Brittany is well suited to be in charge of implementing and planning the strategic orientation of LumoAnalytics.

6.2 Winsey Chui - CTO (Chief Technical Officer)

Winsey is a fifth-year Biomedical Engineering student whose primary interests are in the biomedical field such as biophotonics and medical image processing. She has accomplished internships as a Research Assistant at the Biomedical Optics Research Group (BORG) at SFU and at St. Paul's Hospital in Vancouver. Winsey will contribute to LumoAnalytics with her knowledge of programming and circuitry design to ensure that our products function as desired.

6.3 Corey Myrdal - CFO (Chief Financial Officer)

Corey is currently a fifth-year student pursuing a Biomedical Engineering degree with a passionate interest in medical device development. He has experience in mechanical design, software development and data analysis thanks to his industrial internship at a medical device development company. Therefore, he has skills sure to aid the LumoAnalytics team in the design of innovative and effective medical devices. Corey is also our companys incumbent CFO, in charge of managing and planning financial assets, and procurement.

6.4 Wenpei Li - CMO (Chief Marketing Officer)

Wenpei is a fifth-year Electronics Engineering student. His previous work experience was as a technical support and hardware assistance engineer at KSTAR, as well as a research assistant at SFU. His interests include microcontrollers, programming, and circuit design. Wenpei will apply his knowledge of microcontrollers and hardware design to ensure that hardware systems of the LumoAnalyticss product function as expected.

6.5 HuyThong Bui - CCO (Chief Communications Officer)

Thong is a fifth-year Computer Engineering student with an interest in Data Engineering and Analytics. His previous work experience include a research assistant at MENRVA Reseach Group at SFU, data engineer at Rogers Communications, and data analyst at Sierra Wireless. Thong will apply his knowledge of programming and database systems to ensure the data flow of PulseTracer is efficient and effective.

7 Conclusion

LumoAnalytics hopes to reduce the need for patients to live in hospitals and health care facilities by providing a means for professional health care providers to monitor patients from the comfort of the patient's home. Pulse Tracer is a patient monitoring system intended to realize this goal through the use of remote PPG. The device showcases the applications of remote PPG by detecting vital signs such as the heart and respiratory rates without the use of wearable technology, which often causes discomfort for patients, especially elderly [10]. The collected data is sent to a secure and easy-to-use web application to allow patients and caregivers the ability to view trends in the patient's data. With this information, the health care provider can determine whether the patient may have any emerging health care conditions.

This document has outlined Pulse Tracer as a whole, providing a background on the need for this device and a brief introduction of the suggested implementation. The current market for remote monitoring devices has been evaluated, showing that there are no comparable consumer products for Pulse Tracer exist. The document also outlines a cost analysis, showing the it will be relatively inexpensive to develop Pulse Tracer.

The engineers at LumoAnalytics involved in the design and implementation of Pulse Tracer hope to combine their diverse knowledge and skill sets to create a patient monitoring system aimed towards improving the early detection of health conditions related to the heart and respiratory rates.

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