Capstone Proposal - Parachute

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1 Introduction

Information is a vital resource, especially in the context of Healthcare. When a patient's health is at risk, their medical history becomes the most important piece of information in providing them with appropriate care [1].

At present, there exists no secure, lifetime record of ones health history [2]. When faced with a problem, healthcare providers are left without details, and often fumble for generic solutions, instead of catering care to each individual. In Ontario, the government is addressing this problem through a new initiative called eHealth Ontario; a group focused on researching how to best connect patients and providers through digital technology and information [1]. The initiative has developed a framework for building the future of "interoperable electronic health records (EHR) for Ontarians", which outlines and defines how a comprehensive EHR may be developed [3].

Among technical details, the blueprint defines how "information access portals" may be used to distribute and present information to stakeholders, ensuring patients and providers are presented with the information most relevant to them. The blueprint further identifies key areas that may require unique access portals, such as hospitals, community care facilities and pharmacies [2].

Emergency First Responders (EFRs)are just one stakeholder identified as requiring an information access portal. Today, EFRs respond to emergencies knowing little or nothing about the people in their care. This results in a noticeable information gap that reduces the effectiveness of EFRs, and the negatively impacts the outcomes of their patients.

The objective of this capstone is to therefore develop "information access portal" (IAP) software, that can be used by EFRs to obtain and create patient health records while responding to a call. In addition to software, hardware will be developed to provide EFRs with a means to track and store a patients vitals (i.e. Heart Rate) in real-time. Such information can be useful in determining the status of a patient, and in the case of a large-scale event, allow responders to allocate their resources and time to the people that need it most. Vitals information can be stored and displayed through the information access portal, functioning as a proof-of-concept for a more comprehensive emergency response event tracking system in the future. The ideal system would then consist of an information access portal that allows responders to not only access medical information, but work in conjunction with hardware to create a record of the emergency for use by other medical professionals.

2 Background

2.1 eHealth Ontario

Throughout Ontario, there is a clear desire to bring healthcare into the digital age by using software to improve access to medical information. The province of Ontario intends to use a service-oriented architecture to allow for the development of components (i.e. IAP's) that distribute information between systems using a standard protocol known as the Health Information Access Layer (HIAL). HIAL will act as "the broker and mediator for information exchange, ensuring that all [software] abide[s] by a common set of rules" [3]. The intention of the government is to have a comprehensive and secure electronic health record, that may be accessed by HIAL-supporting software. This software (i.e. IAPs) may be developed by any vendor to support any patient or healthcare professional as the vendor sees fit. A systems diagram of Ontario's future eHealth infrastructure can be seen in figure 1 below.

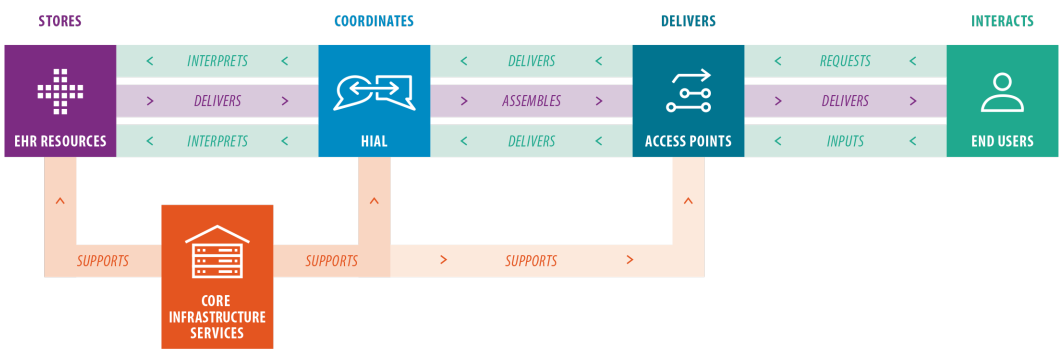

Figure 1: A systems view of Ontario's planned eHealth infrastructure, showing "how EHR resources and services [will be] integrated and deployed." [3]

2.2 Talking with Paramedics

In regards to software and hardware for EFRs, we talked to a number of paramedics about how technology can support and improve the care they provide. Currently, EFRs use software such as the system seen in figure 2 on page 3, to guide them through collecting data that may be important to a patients health. These systems are cumbersome, require time to fill, and are only as helpful as the information the paramedics manage to collect. Throughout our discussions, there was overwhelming interest in a system that could provide paramedics with a patient's medical history. Our findings can be summarized with the following quote from paramedic Matt Sartor:

Nursing homes carry [transfer documents] that contain updated information on [a patient] such as: medications, allergies and diagnosed disorders; including if they [have] had a stroke, or have dementia, and what level of cognition or communication is normal for them. This kind of information gives us as paramedics a tipping point for how we assess our patients, or how we expect to communicate with them or have them do the same with us. [This information] would be very helpful for anyone we meet. Even if it's only [medication] history and allergies, we can decipher a lot from that. Even recent visits to hospital gives us a pattern of problems with a patient.

Currently the hospital can scan their card and get all prior hospital visits and diagnoses on discharges, but it's not available or compact enough for [paramedics] to get. If somehow our laptop forms, which we have to manually input all information we can attain, could get the aforementioned information, it would largely influence our practice.

Matt went on to explain how there are several different documenting systems used by Paramedics in Ontario, and that none are standardized. A standard system, like the one we are developing, would improve the ability of professionals to work together, and provide patients with care.

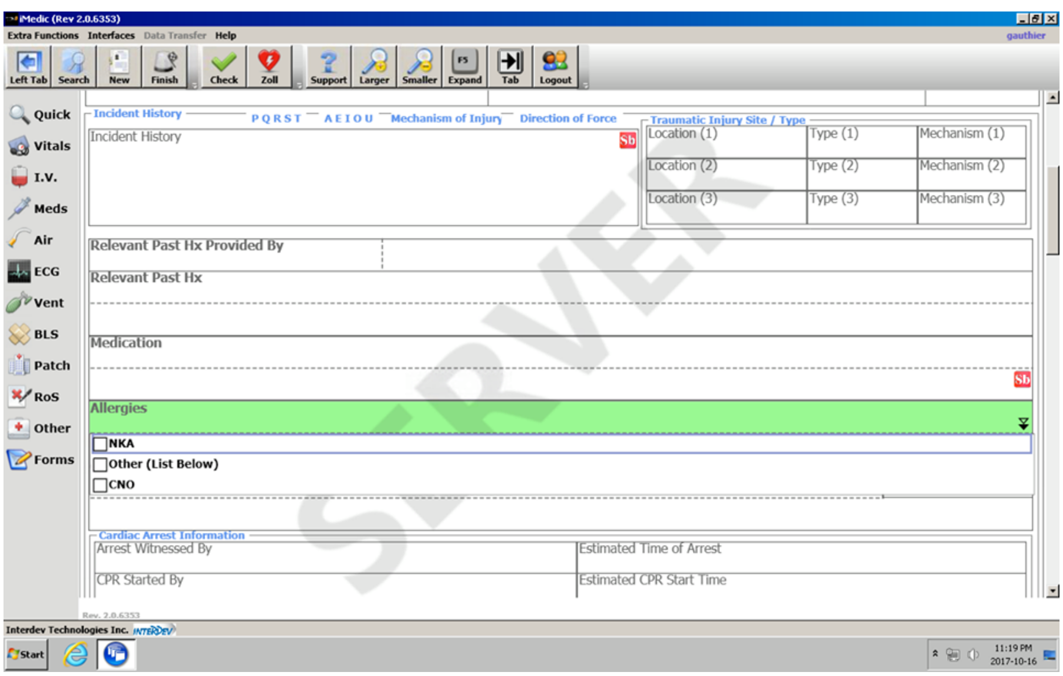

Figure 2: A screenshot of the current software, iMedic, used by paramedics when responding to a call.

As discussed, there currently exists no cumulative EHR in Ontario, and we are developing software based on the assumption that in the future an EHR will exist. The software we develop will be focused on handling, storing and presenting medical information, rather than how it will be acquired.

2.3 Alternative Electronic Health Records

In 2003 the World Health Organization (WHO) released a document outlining the possibility of implementing a medical information system using smart cards. They described how information stored on a card could be carried by patients, that when scanned, would allow professionals to see the patients medical history [4]. This method of information retrieval has the medical history being stored on the card itself, which is incompatible with Ontario's future EHR infrastructure. Instead of storing medical information, we will be using health cards to identify patients and provide authentication to access a particular medical record.

3 Software Design Component

The software system we are designing will function as an information access portal (IAP) to Ontario's Electronic Health Record infrastructure. The main user of the system will be paramedics. Specifically, we plan to develop an application for use on both iOS and Android devices, that will allow paramedics to view a patients medical information. The information provided includes data such as allergies, medications and conditions that are useful to know in the case of an emergency. In the future, we hope the app can be extended to all areas of the medical profession as well as the general public.

It is important to note that we are not focused on acquiring medical information, as it will be available and stored by the province through the future EHR system. The focus of our software will be to access, process and present this information to a user.

3.1 Software Technology

In regards to application software, we will use the React Native Javascript framework to develop an Android, and iOS application concurrently. Additionally, the app will require a database to store patient information. For this, we plan on using Node.js to develop software that can access and process data from a MongoDB document database. The system will be modifiable, and compatible with accessing and retrieving information from Ontario's future EHR system.

3.2 Functional Design

There are a number of requirements the app is expected to meet in order to be useful to an EFR. Most importantly, the app should be compatible with the planned protocols and standards outlined in Ontario's eHealth blueprint, allowing it to be used in the future. These protocols include the HIAL and Health Level 7, an international standard for the exchange and handling of medical information.

From a user perspective, the app will require a secure log-in for paramedics, a health card scanning system and screens to display and annotate electronic health record information. Additionally, it will need the ability to connect to a vitals-monitoring hardware device. An basic prototype of the app can be seen in figure 3.

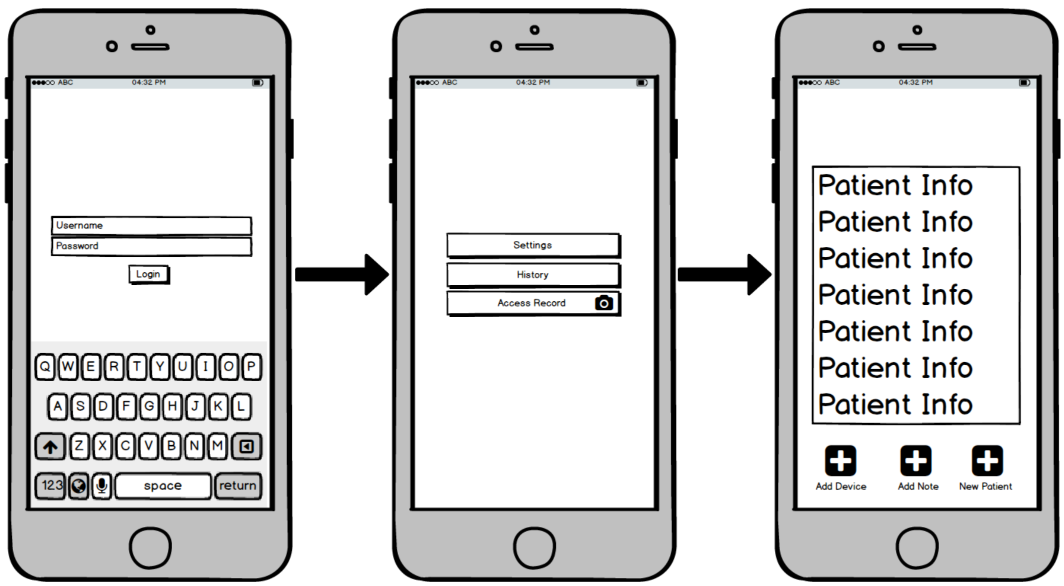

Figure 3: A prototype of the information access portal application with the basic functional requirements, features and layout.

As seen above, if a paramedic is using the app, they will be required to enter a username and password, which will then bring them to a screen with access to the camera, call history, and settings. Accessing a record will require them to scan a health-card using the camera, or to enter the ID information manually. This will then bring them to the patients EMR, with information organized based on importance. The importance of information, and order in which it is presented will be determined in the future, most likely by discussing the app with EMRs. While responding to a call, the EMR will also have the ability to pair the app with a vitals tracker, logging important vitals information. This vitals information can be viewed in real-time, and stored for later use. If one or more patient's are present on the app the EMR will be able to see them all through different views and screens. The history screen will simply show what patients the paramedic has treated but will not allow the paramedic more access to their information once the paramedic has closed the patient's EHR.

3.3 Non-Functional Design

The app must have secure information storage and transmission by the standards outlined in the eHealth Blueprint. The app must have a cohesive look, including size and colour scheme in order to be easy to navigate. The app must be available in English and French. The app will be made so that the average paramedic is able to use it (assuming paramedics are males and females adults with above secondary education) and will use terms that are familiar to them. The app must be able to run on Android and iOS devices that still receive updates from their providers. The app must not have harsh colouring or flashing lights in order to prevent harm to the paramedics.

4 Hardware Design Component

To adequately track the vitals of a patient, there are 2 main hardware components required; the receiver, the transmitter and the sensor.

4.1 Sensor

As this is a preliminary design, only one vital will be tracked as proof of modality so the focus will be on heart rate and blood oxygen saturation. A simple heart rate sensor will be constructed consisting of an infrared and red wavelength emitter and receiver as well as an amplification circuit. The 2 LEDS are pulsed on the skin of the patient and the reflectance of both wavelengths is measured by detectors. IR and red light scatter differently depending on the amount of blood in the skin at that time and the detectors pick up the reflected light from both and output the corresponding current and voltage. This is then amplified and is sent to a microcontroller.

To decrease the size of the overall sensor, an ATmega microcontroller can be used with the appropriate capacitors, oscillators, and power source to avoid the use of a full Arduino board. This chip will receive signals in from the pulse oximetry circuit and can calculate the heart rate, blood oxygen concentration and will create a pulse wave to show heart activity. These signals can then be sent out through a Wi-Fi Transceiver module to the users mobile device.

4.2 Transmitter

All modern communication devices, such as tablets and mobile phones, can connect to auxiliary devices via Bluetooth and Wi-Fi. Bluetooth communication has limitations on how many devices can be connected to a parent device at any given time with the ideal number being 4. [5] As the primary use for this device will be for mass accidents, being limited to 4 patients per device is impractical. Wireless internet networks such as Wi-Fi are less limited and allow for 10 devices to be connected at a time when using a mobile hotspot source. When a paramedic is out in the field, a mobile internet source will be provided from a mobile hotspot and will have the ability to have 10 devices actively communicating with it at a time. This also allows for information to be sent to the hospital in real time whereas Bluetooth communication would be limited to when the patient has already reached the hospital. Because of this we have chosen to connect to our sensors through Wi-Fi with the receiver being the devices own internal Wi-Fi receiver. To transmit the data from the pulse oximetry sensor to the mobile device, a serial Wi-Fi transceiver module will be used. With both devices connected to the same wireless network, data will able to be sent serially from the sensor to the host device.

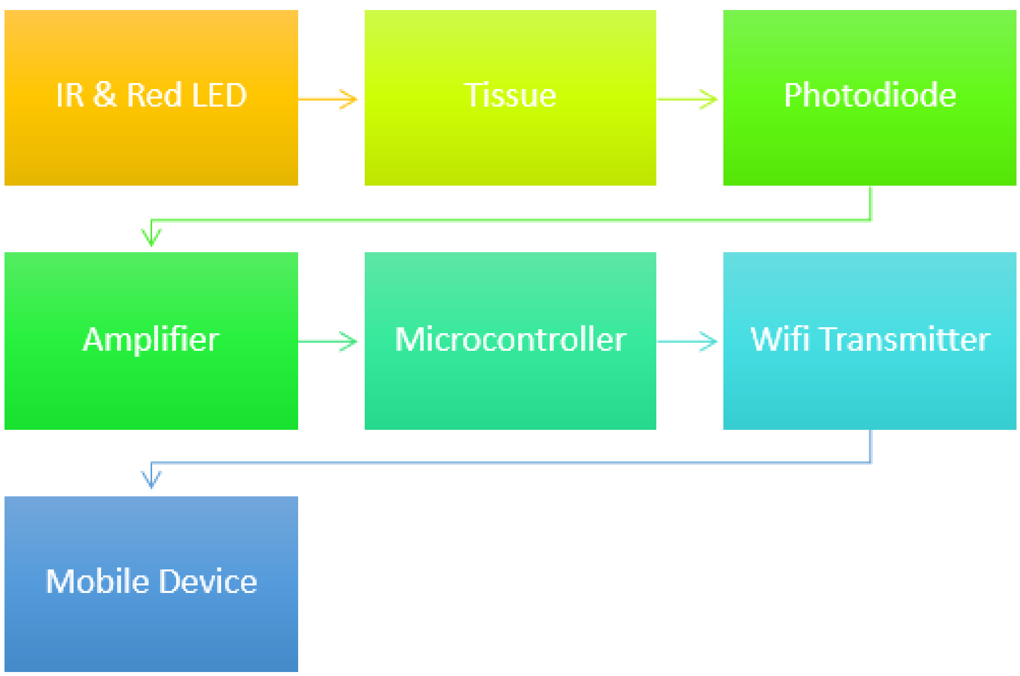

Figure 4: Block Diagram of Hardware Components

5 Conclusion

Throughout the development process, both the software and hardware will be tested to ensure it meets design requirements. In terms of software, each module will be verified using test cases that have known outcomes to ensure functionality.

The hardware will be tested in a similar way, using test cases to verify the hardware meets specification. The pulse oximetry circuit can be tested on a group member that has had their pulse calculated with a 3rd party device i.e. FitBit. The pulse rate from the FitBit and the circuit can be compared to test if pulse if being sensed correctly.

The ability to transfer data from the sensor to a mobile device can be tested through a simplistic mobile application that will display the information on the users screen.

References

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