SeeMe

An affordable, intelligent system to track elderly in their home and report/analyze possible issues

The team

I ended up moving to another country for my 4 month internship and had to find something to do with my time. Since this was a project that heavily depended on hardware it was difficult to find somebody I knew to work with me remotely. I was also interested in developing a project which had an architecture that spanned a variety of different technologies as a learning opportunity. The reason I picked this idea was because it seemed to have many interesting problems and it was something that I would want my own grandparents to use.

Person 1, University of Waterloo, Computer Engineering, 2020 - I have always been interested in making projects where hardware and software work together which is why I decided to go into Computer Engineering. I started making simple circuits in elementary school and began programming in Grade 10. Since then I have worked on many exciting projects, both personal (www.danielweisberg.com) , and professional as part of my internships.

Mentors:

- Grandmother -> My grandmother helped me understand how she would want to interact with technology and possible improvements I could make to my solution as I was building it. The overall message was that she was not interested in touching anything related to tech as to not make her life more difficult. This ultimately led the solution to not require any specific interaction from the person it is monitoring.
- Janet Hernandez -> Retirement Home Care Provider. Janet allowed me to talk to a few of the independent residents at the retirement home and get their opinions about the implementation. She also provided insight into some of the signs that the elderly may display when there might be something wrong (Early onset of dementia, depressions, etc).
- Many residents at the retirement home that Janet worked at.

The Concept

The purpose of the project is to be able to provide analytics and tracking into the way that an elderly person interacts with their home to determine possible issues that they may be having. Many independent elderly are deciding to live by themselves, especially as the Baby-Boomer group progresses into retirement. The problem is that these people are at risk of immediate issues (falling and unable to get up, unconsciousness) and problems that may worsen in the future yet might be difficult to spot in its initial stages (dementia, depression). Many need 24/7 monitoring without the cost of full time caretaker.

The SeeMe solution provides a proactive and reactive approach to these problems - 24/7 and on a budget. The reactive approach works by learning the habits of the person it is tracking that includes what room they go into, when, and for how long. It uses machine learning to construct a model from those data-points which then predicts for how long the person is expected to stay in a room given the room they entered and the time they entered at. If they spend far more then the predicted time, it can signal their loved ones or caregivers

via the app that something might be wrong. The pro-active solution works by monitoring the history of the persons movement and determining possible issues they might be experiencing (such as depression/insomnia) based on the way they move throughout the household (ex: not spending enough time in the bedroom sleeping) which is logged on the app. This allows caregivers or loved ones to provide appropriate changes before the condition worsens.

Target Audience or Market:

The target of the SeeMe solution can be described as elderly that either want to maintain independence or cannot afford care yet want something to keep them safe and healthy. For the purpose of specifying a more precise target it would be people 85+ as this is when many people begin displaying significant health issues such as dementia, depression/insomnia, or requiring immediate assistance when they are unable to reach help (69% of those 65+ develop disabilities before they die [https://www.caregiver.org/selected-long-term-care-statistics]). This provides a substantial market considering how there were 5.9 million people in the US 85+ which is expected to grow to 19.4 million by 2050 (https://www.caregiver.org/selected-long-term-care-statistics). In addition, the service would be most useful for those that live alone which account for 50% of those 85+ (https://www.merckmanuals.com/professional/geriatrics/social-issues-in-the-elderly/the-elderly-living-alone).

The geography of the demographic would be in North America as they have a large aging baby-boomer population that are becoming at risk from a variety of health issues from their age. There is also a very large amount of North Americans that would be able to afford the services of the SeeMe system (expected to be <$20/month). In 2012, only 15% of the 65+ population was under the poverty line which would make the SeeMe system affordable to many of them (https://www.caregiver.org/selected-long-term-care-statistics).

The targeted platform for the application which a caregiver or loved one would use is mobile phones (both iOS and Android) as almost everybody has one (within North America) and it is usually on their person. This would make analytics easy to check and a notification about a possible issue quickly addressed. The sensors that are within the house would have no targeted platform nor dependencies (not even WiFi as it would use the mobile network to send data) in order to make this system as versatile as possible.

Personas

Barbra is an 80 year old widow that lives 3 hours away from her children. She enjoys her independence and being able to do everything herself. She does not want a caretaker constantly monitoring her or to move in a restricting retirement home. She also does not get technology and doesn't have the time or patience to learn it. She wants an "out-of-site out-of-mind" system that will keep her safe in case something goes wrong.

Bill is a 65 year old suffering with a family history of dementia and low blood pressure. He wants to be able to have constant care but does not have the budget for a caretaker or to live in a retirement home. Bill needs a system on a budget that can tell him if he is starting to display an early onset of dementia or notify somebody if he loses consciousness from his low blood pressure.

Feedback

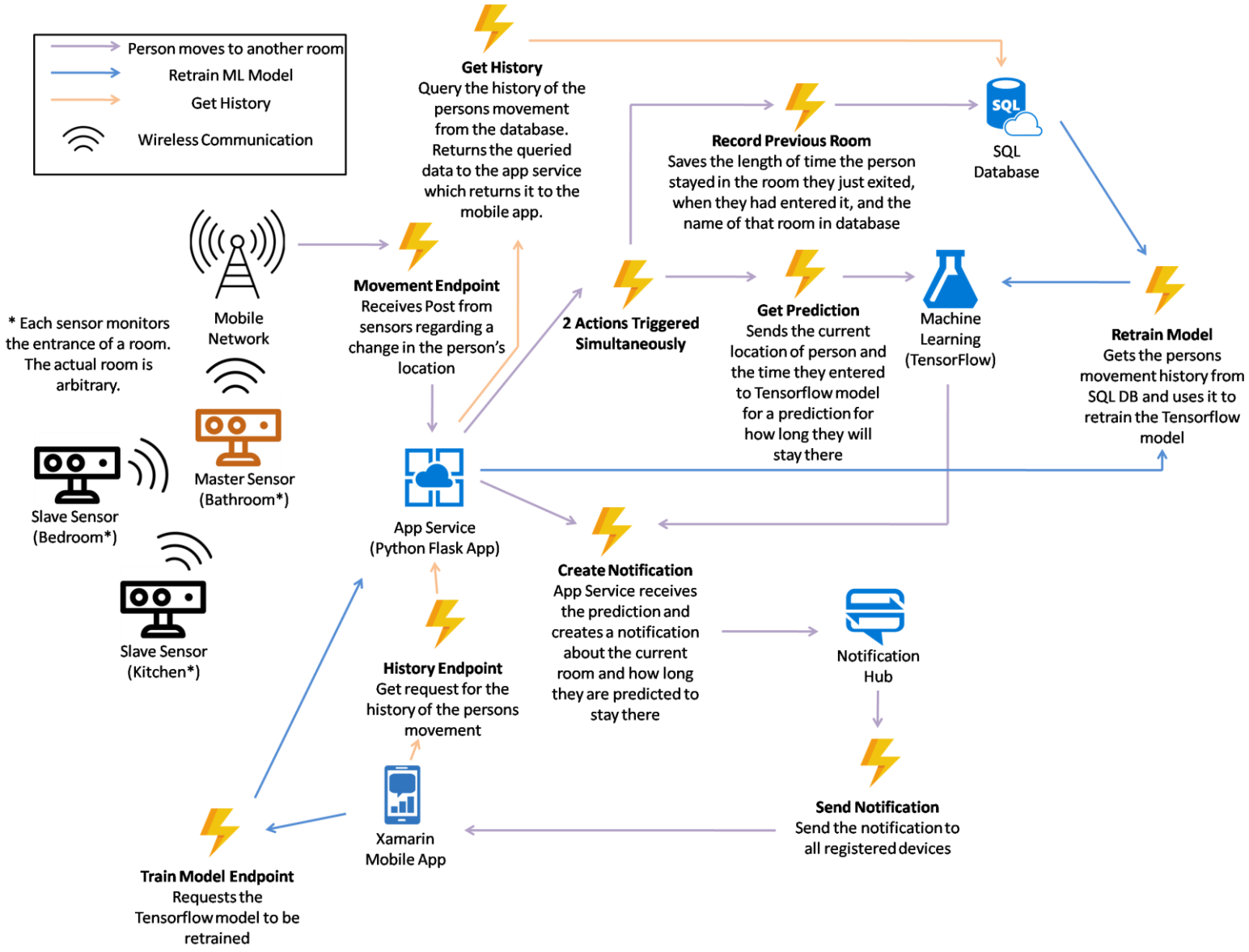
After working with my Grandmother, Janet Hernandez (professional in the elderly care industry), and a handful of the independent elderly living in the retirement home (although they were living in a home, they still provided valuable insight into what they wanted/needed before they were there) I was able to get important notes that helped me throughout the development of the project. The first is that they do not want to work with any kind of technology, regardless of how simple it is. Many expressed not wanting to have to remember to do something (such as keeping a device with them at all times to quickly contact help) and the best kind of solution would be something that they would not need to even touch.

The initial idea for SeeMe was to simply provide notifications whenever the person it was tracking stayed in a room for longer then it predicted them to be there. However, I learned that many elderly wanted for it to also measure their health as staying safe was just as important as staying healthy for them. With this feedback I was able to work with Janet in order to determine a system that would be able to monitor for 3 of the more common health related issues (depression/insomnia, UTI's, dementia) by using the way elderly interact with their home.

The feedback that I received from the elderly and caretakers was very invaluable and helped push this technology into its final form and something that they would actually use.

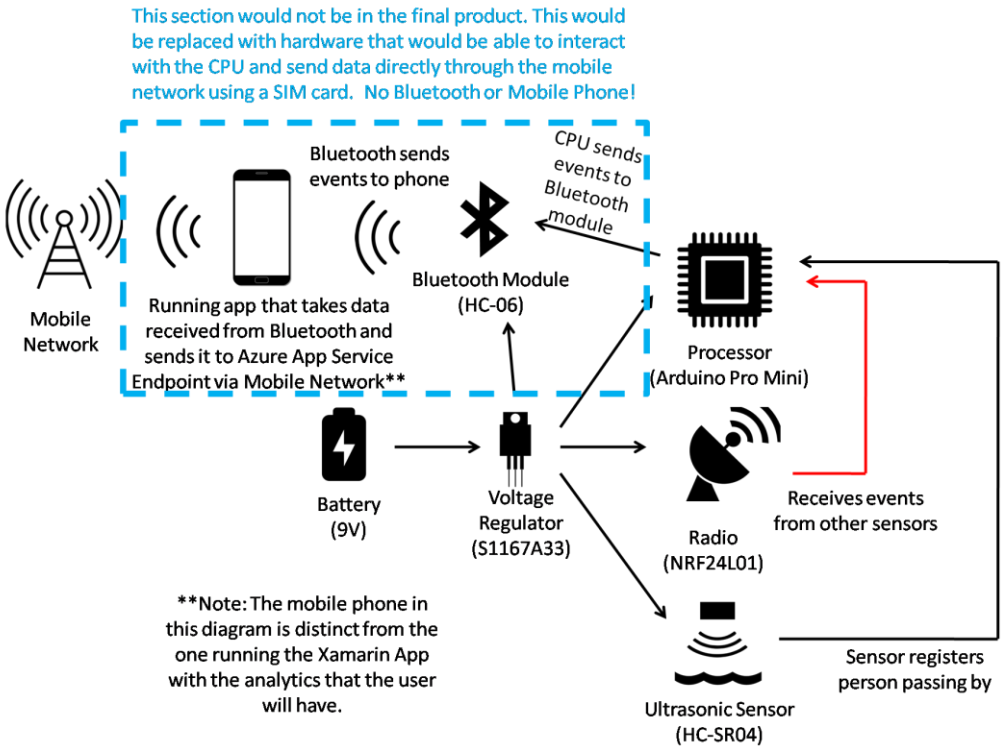
How it works:

Use this section to talk about how you built your product, how have Microsoft technologies made it feasible?



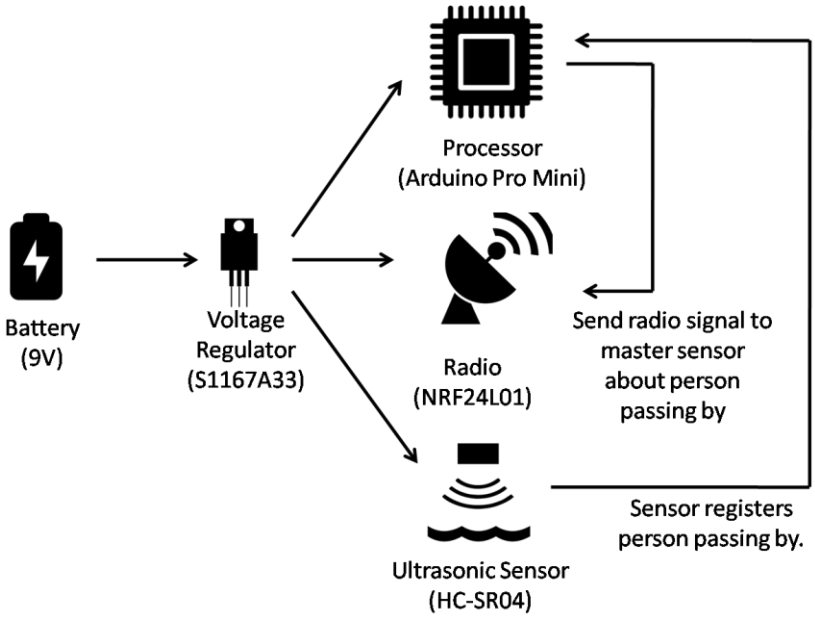
Master Sensor

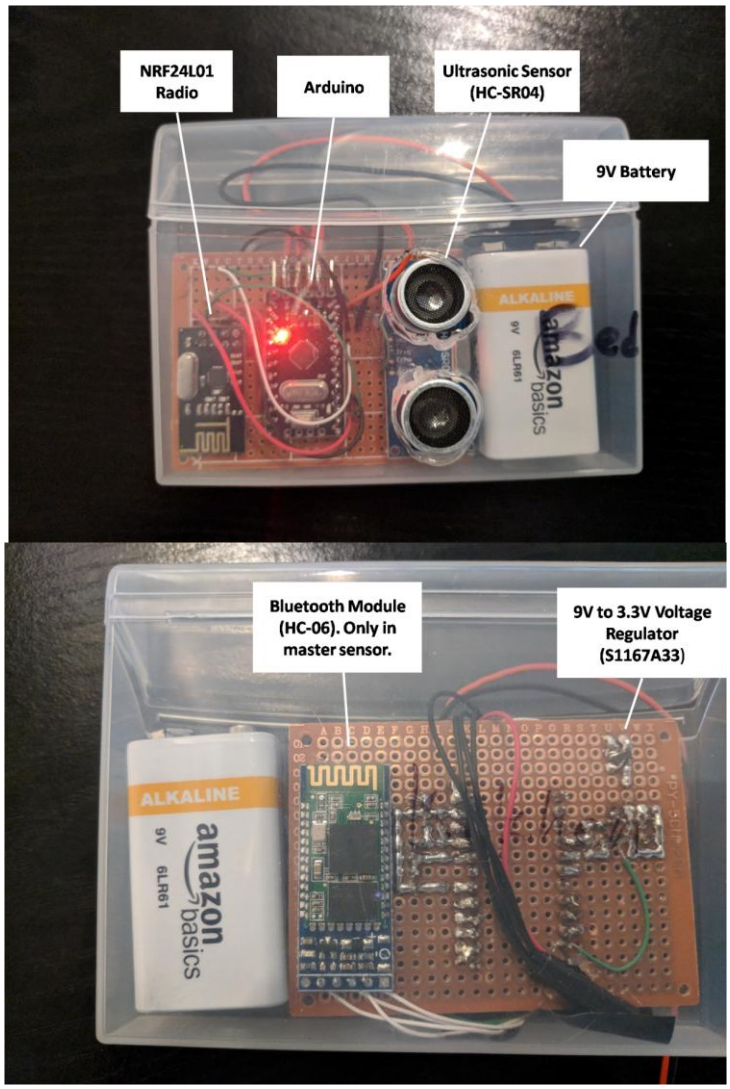
Everything in this diagram is encapsulated in the icon to the left when displayed in the main diagram



Slave Sensor

Everything in this diagram is encapsulated in the icon to the left when displayed in the main diagram





The system relies on two platforms- Microsoft Azure Platform and the Mobile Phone platform.

The mobile phone platform was chosen because of its inherit ability to always be accessible and at hand. This allows for faster responses from the loved one or caregiver that uses it. It also allows the app to get more access to the phones environment (vs a website) which allows it to create notifications about possible issues. Finally, apps provide the best user experience on the phone as they are native. All of these factors allowed for the creation of a very user friendly application with a professional degree of production as it runs natively and quickly.

The app was built using Xamarin to cover both platforms (iOS and Android). It was built on the example application created by Microsoft for receiving notification on mobile from the notification hub. From there, the UI was developed to be sleek and usable which included pie charts and an easy to access menu. Asynchronous calls to the endpoints (such as to get history) were developed to not lag the UI. All of the analytics performed were done directly on the mobile phone using the history data making the app much more

significantly. This was a part of the innovation in making the app very responsive by only requiring a single endpoint call to provide all of the data necessary to display without intermediate loading throughout the app.

The Microsoft Azure platform was chosen because of the multitude of tools that it provides in-house to develop this system which includes notifications, running scripts/hosting endpoint on the cloud, Machine Learning support, and an SQL database. This allowed for an easy-to-scale system which is all under the umbrella of a single Microsoft service.

Microsoft Azure app-services supported running a Python Flask Service which was then used to create the endpoints and to link all of the other Azure services used together. There were a few important endpoints created - Post Movement (data from sensors), Get History, Post Update Model. The Python application also leveraged the popular TensorFlow for Machine Learning in order to handle the creation of the model that would provide predictions for how long the person was supposed to stay in the room. An interesting innovation is that the ML model was stored in the App Service and was able to be directly retrained by hitting an endpoint within the Python app. The SQL database was made to contain 5 rows; a Unique ID, the name of the room, the time entered into the room (in seconds from midnight), the time stayed in the room, and the date-time entered into the time (every movement between rooms would have its own row). This data was used to get history for the mobile users, and also to train the model by putting the inputs (enter Time, name of Room) and expecting the output (time stayed in the room) which were both handled by the Flask application. The responsive nature of the Azure SQL Database made getting the entire contents of the table for ML training significantly faster than other database. An interesting innovation is that the data collected from the sensors was then able to be directly interpreted by Tensorflow during training without any type of changes making the whole process of collecting and learning from data completely automatic. The last section in Azure that was used was the notification hub which had a Microsoft made python app example for notifying mobile applications. The notification hub provided native support for notification by linking directly into Firebase for Android which allowed for the best user experience. The entire architecture was developed with performance in mind except for the Tensorflow model hosted within the Python app which was done for simplicity.

The one part that was not fully leverage was the capability of Azure's Machine Learning. Microsoft provides tools to develop and deploy models given training data which could have been taken advantage of in this project. A major bottle neck in the system is the time that it takes to re-train the model using Tensorflow within the Flask Application as the App Service was never specifically meant to support this. Using a system specifically meant for Machine Learning such as the Azure Machine Learning service could have mitigated this issue and greatly improved the performance of the app.

The hardware was developed with the intention that it should be affordable, easy to manufacture, and responsive. Each sensor costs less than $10 of small quantity purchases. The sensor contains a single breadboard which has the radio, ultrasonic sensor, voltage regulator, and processor soldered directly as well as most of their circuits to minimize costs. An interesting innovation was to make the sensors communicate in a star topology through cheap radio with only the central sensor sending the data to the endpoint using an expensive mobile network adapter in order to save on cost. This would also not cause issues with bandwidth as the data being sent is very limited. Another interesting innovation is that the sensors do not require any human intervention when being used compared to other devices in the industry of elderly care which require the person to remember to use/wear the device.

Core Technologies

Azure App Service, Notification Hub, SQL DB for reasons mentioned above

Mobile Platform for the best way to receive alerts

Google Firebase for Android Notification Support

Xamarin for rapid development on the mobile platform

Hardware components (radio, cpu, mobile network adapter, ultrasonic sensor) to make the sensor

The Business Plan:

You don't need to have a fully fleshed out business plan, we just want to know that you've put time into thinking about it.

Competition:

There are many competitors in the industry of making sure that the elderly remain safe. However, these devices are limited to smartwatches and wearable buttons to signal for help as well as GPS that shows their location. However, these wearables are required to be worn at all times for their protection. Considering how 55% of elderly are non-compliant with taking their medication with one of the main reasons being to have forgotten from memory loss (https://www.agingcare.com/articles/medication-problems-elderly-people-have-146111.htm), the same type of forgetting will likely occur with putting on a wearable. Many of these devices such as GPS monitors or watches require WiFi access to send their data.

The dominant products in the industry of elderly protection through tech are Life Alert, Alert1 and iTraq, all of which use wearables.

The SeeMe solution does indeed offer a meaningful innovation in requiring absolutely no commitment on the side of the elderly person to be protected at all times. Moreover, no infrastructure is need to set it up the system such as WiFi since it uses the mobile network. The SeeMe also provides exact information as to where in the house the person is located to a precision unlike any other device on the market. Finally, the SeeMe solution is able to provide analytics on mental conditions (ex: dementia) which no other system in the industry (even those that monitor vitals) is able to provide. SeeMe is unique enough to be in its own sub-industry in the huge elderly care industry. Our main selling point remains "out of sight, out of mind"!

Business Model

The SeeMe business model would be a rental and ongoing service. The rental would be for receiving the sensors in order to minimize or completely remove the upfront cost for setting up the system. The service would be in the form of maintaining the sensors as well as a monthly fee to keep the sensors online and reporting data. This will be sustainable as any elderly using the service will likely continue using it for their safety if they needed it in the first place. Therefore, the retention rate for those using the service would be very high and sustainable.

The expenditures would be developing the sensors, keeping the service online on Microsoft Azure, and paying mobile network companies to allow the sensors to report data via their network. The sensors are simple enough to where SeeMe would be able to work directly with offshore manufacturers in order to develop the hardware.

The plan to bring the SeeMe service to market would be multi-pronged. The most affordable method would be attempting a partnership with an existing company providing a service for the same demographics, such as Life Alert. The SeeMe solution would become a subset of the partnered company's services for customers to order. The other method to bring this service to market would be advertising through mediums that the elderly commonly use - television programming and newspaper. Television programming is commonly used in the industry to target elderly which would make it a proper starting point for advertising the system.

The specific target customer would be elderly 85+ living alone in North America.

The project is too early stage for any meaningful projected expenditures and costs.

Additional Information (The Makeshift Lab):