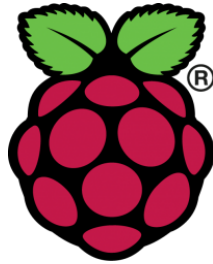# Institute of Technology Carlow, Kilkenny Road, Carlow
Bsc (Hons) Software Development

Home SecuriPi

Functional Specification

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Abstract

The purpose of this document is to provide an account of the functionality of the project. The document will outline the need for Home Security systems, the functionality flows, and the project iterations throughout development.

Some of the material documented may not be included in the final project, as the project adopted an agile approach to development.

Table of Contents

1. Introduction

This project is a Home Security solution that can be used to monitor a person's home remotely through the use of a Raspberry Pi, motion sensors and cameras. By providing this functionality along with the ability to take action once activity is detected, by either mimicking internal movement by turning on/off appliances, or by communicating verbally with the individual, the product aims to become the first line of defence should an intruder be found lurking on the end user's property.

The document will be discussed under five headings; Problem Statement, Scenarios, Project Description, Functional Requirements and Project Iterations.

The Problem Statement will outline the need for a Home Security system in Ireland, by providing some insight into what convicts look for when surveying a potential target.

Described under the Scenarios heading are six different situations a person might find themselves in, and how the system will help those in the scenario to gain a desirable outcome.

Documented under the Project Description heading is a detailed view of how the system will operate, including the hardware components necessary and the eventual user interaction.

The Functional Requirements section outlines the core features of the project, with the additional "nice to have" fringe features.

Each iteration in the project will be summarised under the Project Iterations heading.

2. Problem Statement

When people in Ireland are away from their homes for an extended period of time, a common concern is the security of their home. For people living in rural Ireland, this concern is exacerbated. Often times an individual's only defense is a burglar alarm, which comes in as number 13 on the list of things that deter a burglar. Even in the event that a burglar alarm is monitored by a third party, as witnessed by myself, the response time of the Gardai can be up to 20 minutes. Most burglars will know this, and will simply hasten their thievery of your cherished possessions.

Among the things most likely to deter an intruder are, CCTV, a TV being turned, a vehicle in the driveway, and notably, a smart connected home as stated by over 90% of ex-convicts [1].

The main function of the application will be a live video stream, to provide a means to remotely monitor your home. A motion sensor will notify the device of activity, and the application will provide a notification through email/SMS, to the end user, who will then be able to login to the application and view who or what set off the motion detector. If within a given time frame there is no response to the notification, the camera will take a series of pictures and store them for later viewing.

Upon viewing the live stream from the camera the user can decide what step to take next. If the user finds an unwanted guest, they will be able to turn on/off their TV or a light, to mimic movement or activity within the house, or communicate verbally with the individual through the use of a speaker.

Alternatively, if it is a friendly person who set off the motion detector, the user will be able to open the front door, or ask them to call back later.

All of the interactivity will be provided through a web application, allowing everything to be controlled remotely, from anywhere in the world.

The need for a sense of security of an individual's personal space and property is paramount amongst today's population. The application could give a son/daughter peace of mind, by being able to respond to their elderly parents security needs, if living far away. Often times a person can feel helpless when something happens around their home, and this application will give the user a means to defend their own, or their loved ones property.

3. Scenarios

The following will provide some scenarios where our product would come in useful. By providing these scenarios, the reader of this document will gain valuable insights into the need for our product.

3.1 Scenario 1, The Bad Guy

A "bad guy" is scoping out your property, and you are not home. In a rural area there may be no one else around to notice the activity, and the only deterrents are the flimsy door locks, the mild indifferent traffic on the main road, and the distant barking dog. The bad guy is alone. Taking his time to survey the weak spots of your home, peering in windows to take stock of valuables, and totting up how much money he can make from your possessions, he (or she) rub their hands together.

But wait, a T.V. just turned on inside the house, maybe they are not alone after all. The bad guy scarpers, startled by the sudden activity. As referenced in the Problem Statement, a T.V. turning on is one of the main deterrents reported by convicts.

Notifications of movement around your home through the use of motion sensors, along with providing the necessary means to control your appliances, our application will become your first line of defence with regards to protecting your home.

3.2 Scenario 2, The Con Artist

The door to door con artist. While we now live in a digital age where most con artists focus their devious intentions on eMail and SMS, there still exists the old-school conman. Knocking on your elderly parents front door, under the ruse of offering some service, the friendly individual is entertained by your well-mannered parent. Peeking inside the home from the welcoming front doorstep, the conman gains intelligence.

A third voice coming from a speaker mounted beside the door, asks the question, "Is everything ok?". After introducing yourself, and in the process alerting the conman of a home surveillance system, the conman drops the ruse and moves on.

Providing a means to communicate with individuals remotely, which our application aims to achieve, will inform individuals that this is a "Smart Home", one of the top reasons for convicts to dismiss an invasion.

3.3 Scenario 3, The Vandal

Damage to property is a major concern for homeowners. Be it your car, your windows, or your flowerbed, these possessions are often targeted by the neighbour kids or, more sinister individuals. By placing a motion sensor in proximity to anything you value around your home, our application will alert you to movement in that area.

Taking pictures and storing them for later viewing, as well as live streaming video, will provide the necessary evidence to successfully identify any culprits, and allow the homeowner to pursue matters as they deem necessary.

3.4 Scenario 4, The UPS Guy

Not all guests are unwanted. That thing you wanted from Amazon has finally arrived. The UPS man knocks the door but gets no response, forcing him to leave the parcel at the nearest, dreaded, Post Office. Everyone knows what this means; the only way for you to retrieve your parcel is to take time from your busy schedule to pick up the parcel, because, the parcel collection service of our country's vintage Post Office only opens Monday to Friday, as nobody ever wants to pick anything up on a Saturday….

Through utilizing our application, the scenario described above is completely transitioned. The motion sensor has alert you to movement at the front door, and the brief conversation through our voice communication functionality would follow something similar to,

"Excuse me mate! Would you mind leaving that parcel in the shed behind you, please?", "No problem, sunshine!". That's it, Post Office avoided.

Our system will provide a means for communication with both wanted and unwanted guests.

3.5 Scenario 5, The Offspring

You're in a meeting and get a text from one of your children, or your spouse, saying they have locked themselves out of the house, again. Click a button on your mobile phone and "hey presto", the front door opens.

You will never have to hide a key under the flower pot, nor will you have to leave the bedroom window ajar for your teenage children to gain entry, as our application will provide the functionality of opening the front door, from your mobile phone.

3.6 Scenario 6, Holiday Woes

It can happen to anyone. Sunning yourself on the beaches of Barbados with not a care in the world, you suddenly get a bad feeling. Checking in on your home using the livestream video

from the strategically placed cameras around your home, you see water. Panic sets in. I need a plumber and quick, and I've secured my house so completely that it's impossible for someone to get in without damaging my home, and I've forgotten to leave a key with my relatives…. Nightmare.

Not to worry, the initial threat has been established by utilizing the live streaming video functionality of our application, and the issue of not having left a key out becomes irrelevant also, as you can allow the plumber entry through the front door by the simple click of a button.

4. Project Description

4.1 Overview

The Home SecuriPi product is a system which can be installed in any home with an internet connection, and a Personal Computer. The main function of the system will be to monitor motion around different points of the home, take still images once motion has been detected, and provide notifications to end users with the images attached. The system will store the images for later viewing. The product will also allow end users to mimic movement around the home, by controlling appliances remotely, thus providing a means to deter intruders. Live stream video will be included on the home page, to allow users to check in on their home at any time, from anywhere around the globe. Also included in the project will be the functional ability to remotely communicate, verbally, with guests (wanted or unwanted) at the home. A final objective for the project is to possibly provide the functionality of opening the front door for family and welcome guests.

The systems functionality will be provided through a web application. Once the users have successfully logged in to the application, using any device capable of running a web browser, all of the functionality will be available to them.

4.2 System Description

This system will be comprised of hardware devices, including motion sensors, cameras, speakers, and microphones, which are all controlled by software running on a Raspberry Pi. The interaction with the system will be provided through a web application running on the users' PC, which will in turn be communicating bi-directionally with the Raspberry Pi.

4.2.1 Hardware Devices

The Raspberry Pi - As mentioned in the Research Document (section 3.2), the Raspberry Pi is a credit card sized computer originally designed for education. Boasting the capability to run a Linux based operating system, with the ability to run several different processes, the Pi is the central component to the entire project. The Pi will provide the ability to listen to the motion sensors, and push notifications to the server (the users' PC) upon motion detection. The Pi will also provide the capability of controlling the cameras, the speakers, and the provide the additional possibility of opening the front door.
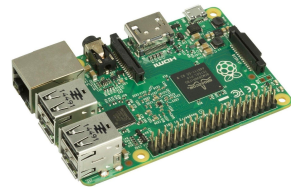
Motion Sensors – The motion sensors provide the functionality of detecting motion. Upon detection, the signal being received by the Raspberry Pi will change, ushering the Pi to notify the server.
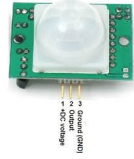
Cameras – The camera will provide the functionality of taking pictures, and also provide live streaming video. This capability will allow the users to view who is at their home, upon notification or at any time the feel the need, and respond by opening the front door, asking the individual who set off the sensor to leave the property or call back later, or mimic movement by turning on/off appliances in an effort to deter the intruders.

4.2.2 System Interaction

The frontend of the system will provide user interaction through the use of a graphical user interface (GUI), provided on a web application. The GUI will allow users to access all of the functionalities of the system, including scrolling through any pictures stored on the server. A proposed GUI is provided in the figure below:
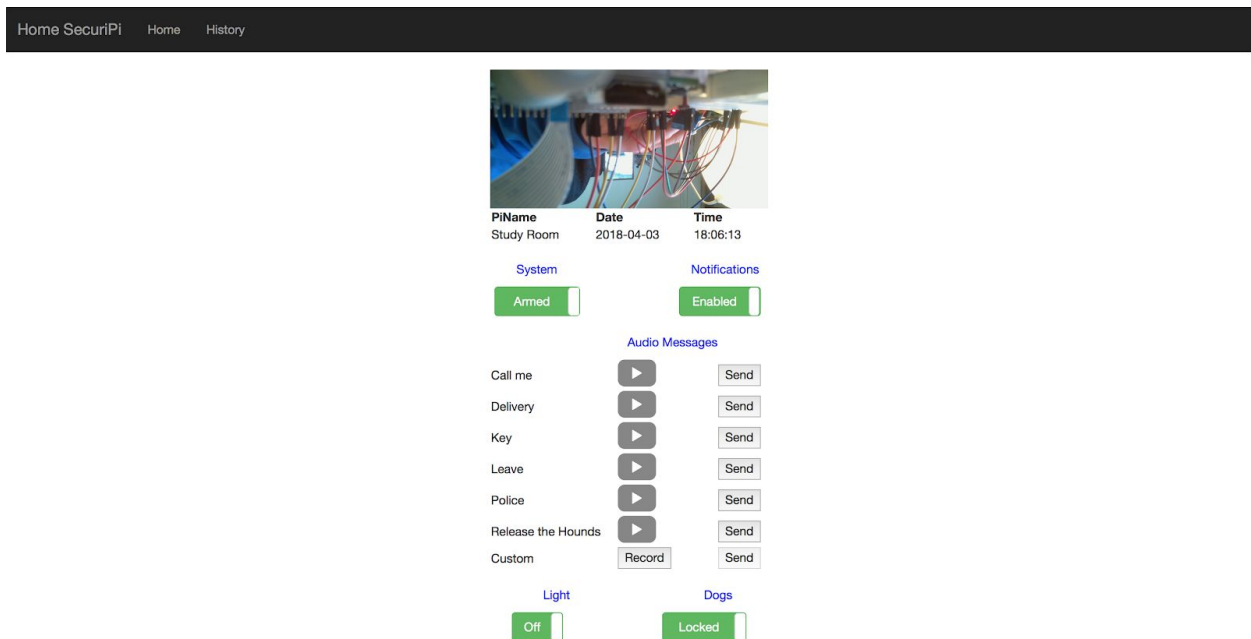
4.2.3 System Architecture
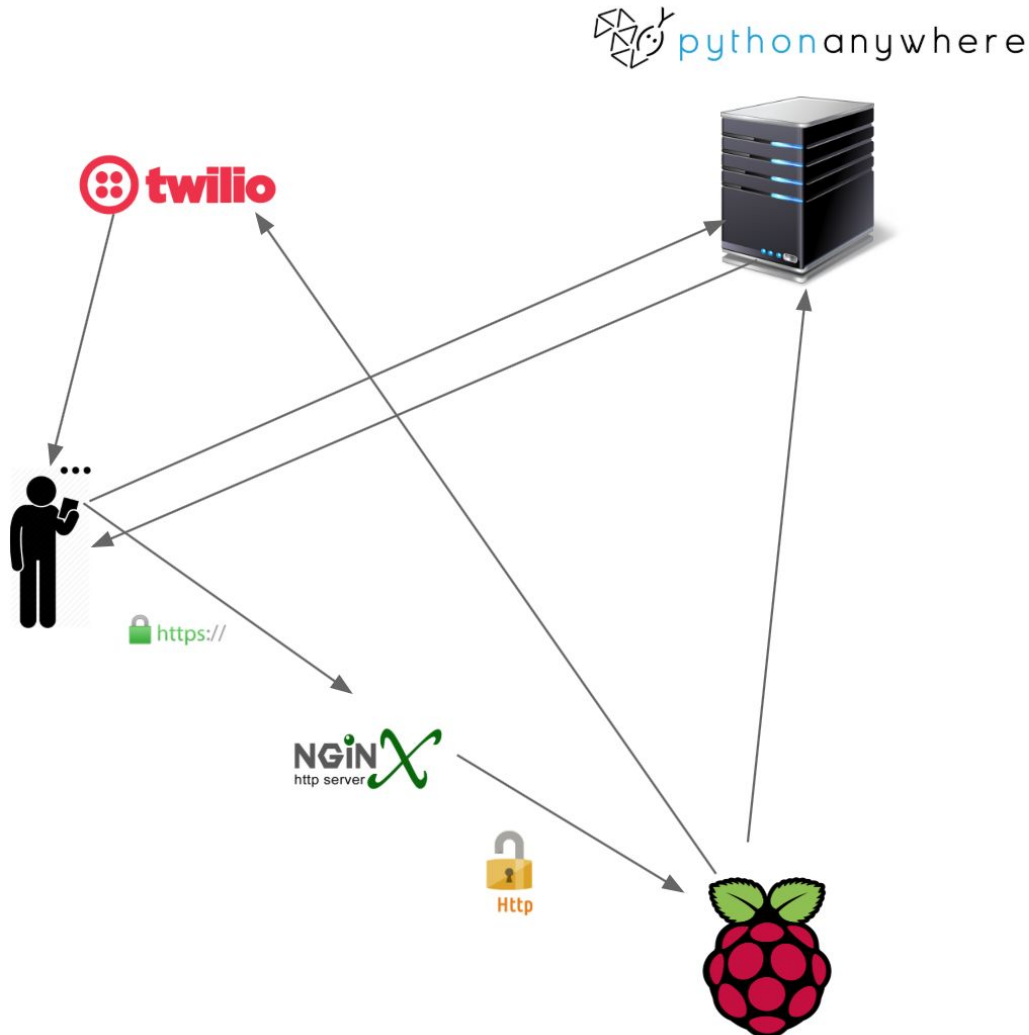
The system will consists of two Flask servers, one on the Raspberry Pi which will be located at the users home, the other will be living on pythonanywhere. Once the Raspberry Pi detects motion, it will take a picture and send it to pythonanywhere. Pythonanywhere will then store the image and, upon successful completion, send an SMS message to the user. The user will be a able to interact with the web application on pythonanywhere, and can view the most recent images that the Pi has taken from the home page of the app. The user will then be able to tell the Pi to play a pre recorded voice message of their choice, or, the user will be able to customise a message to be sent on the spot, according to what they see has set off the motion sensor.

5. Functional Requirements

5.1 Core Features

The following will outline the core functionalities of our application, and we will also offer some possible fringe functionalities.

5.1.1 Motion Detection and Notification

The most important feature of the application will be the ability to detect motion around the home, and send notifications to an end user. The desired recipients of the notification can be set in the application. When motion is detected by a sensor, a series of pictures will be taken from a relative camera, and an eMail/SMS will be sent to the desired recipients. The pictures will be attached to the message body, so the user can instantly view what set off the motion sensor. These images will be stored locally for later viewing, and backed up in the cloud daily.

5.1.2 Live Stream Video

Another important feature of the application will be the ability to view a live stream from the camera(s). This feature will be accessible at any time, allowing the user to monitor what's going on around their home, whenever they desire.

5.1.3 Voice Communication

Our system will provide a means to communicate verbally with a person at your house, be they friend or foe. If the visitor found at the home is considered unwanted, they can be asked to leave, or informed that the Gardai are on their way, likewise if the visitor found is friendly, they can be asked to call back later.

5.1.4 Mimic Internal Movement

While video streaming and notifications are an essential part of the application, they are trivial without the ability to somehow react to what is visible. If the user views an unwanted guest, the application will provide a means to mimic movement inside their home. By allowing the user to turn on/off lights or appliances such as their television, an intruder can be led to believe that there is someone in the house.

5.1.5 View Pictures

The user of our application may not always be in a position to view the images sent through the notification immediately. The user may also want to show the Gardai the images of an intruder. Because of these reasons, our application will provide a means to scroll through any images stored in their database. The data and time that the images were taken will also be displayed.

## 5.2 Fringe Features

5.2.1 Open Door

While the main functionalities of our system are focused on protecting the home from intruders, one additional feature will be the ability to welcome a guest. If the user finds that a delivery man or family member needs access to the house, the application will provide a feature that allows the user to open the front door.

5.3 User Interaction

All of the functionality will be provided through a web application accessible from any device capable of hosting a web browser. As the system may be set up for an elderly loved one, the ability to set the recipients of notifications will be provided to our admin, meaning our loved one is shielded from the nuisance of notifications. However, all other functionality will be offered to every user.

5.4 Use Case Diagram

The use cases described below outline the initial concept for this project. This project will adopt an agile approach to development, thus some if the use cases might change as the project progresses.
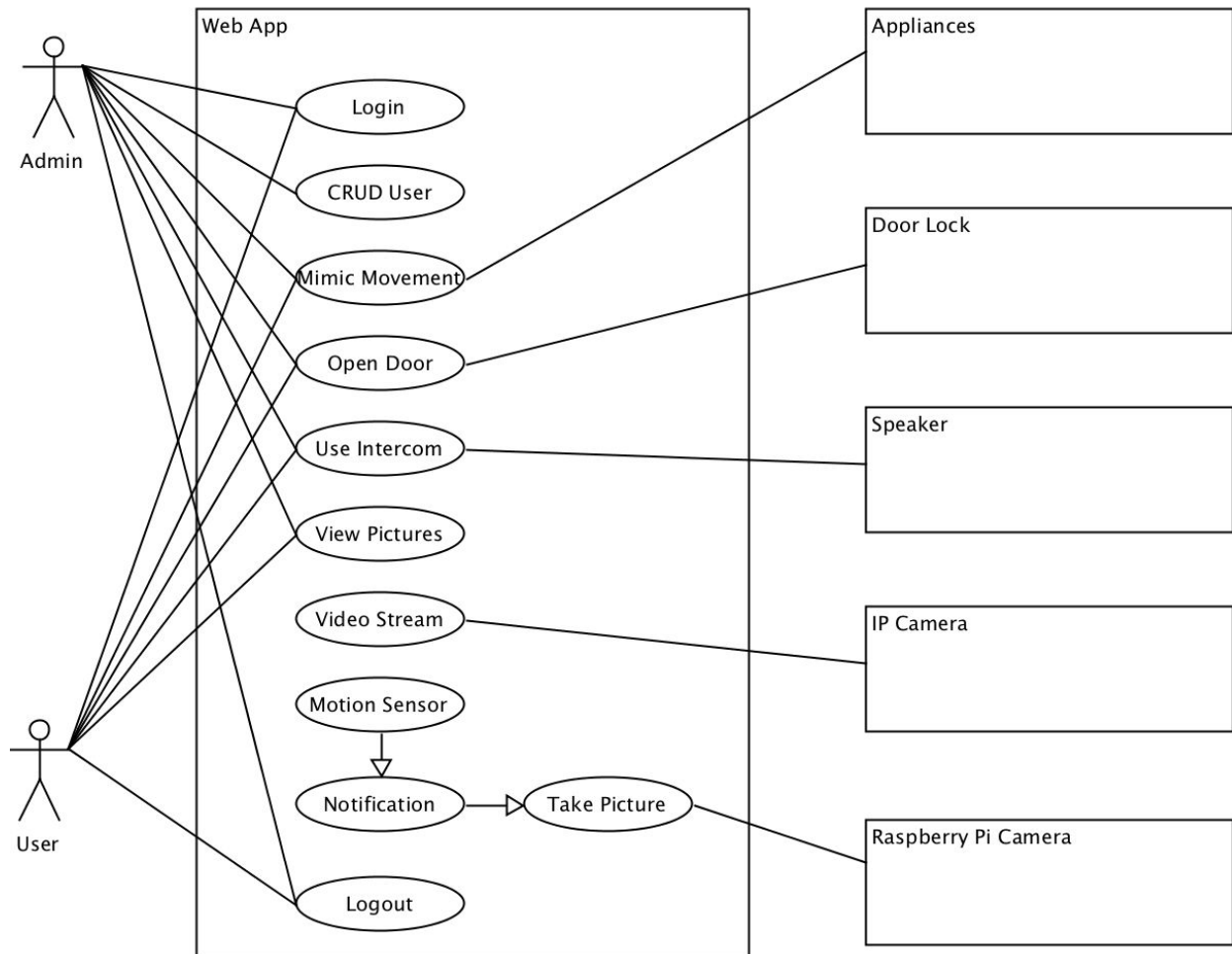
5.5 Brief Use Cases

In the following Use Cases CRUD refers to Create, Read, Update or Delete. The description provided will refer to the "Create" aspect of CRUD.

5.5.1 Login

Actors involved: Admin, User, Web App

Description: This use case begins when an **Admin** or **User** wish to log into the **Web App**. The **Admin** or **Client** will enter their details, which will include their Username and Password. Upon completion the **Web App** will verify the details. This use case ends when the user has successfully logged in.

5.5.2 CRUD User

Actors involved: Admin, Web App

Description: This use case begins when an **Admin** uses the **Web App** to CRUD a user in the system. The **Admin** will enter the details of the user, which will include the user's name, their mobile phone number, their eMail address and their access rights(Admin or User). Upon completion the details will be verified by the **Web App,** which will then store the data. This use case ends when the user's details are successfully stored.

5.5.3 Mimic Movement

Actors involved: Admin, User, Web App, Appliances

Description: This use case begins when an **Admin** or **User** uses the **Web App** to turn on/off **Appliances**. The **Admin** or **User** will select which appliance to turn on/off. The application will then turn on/off the appliance. This use case ends when the appliance successfully changes state.

5.5.4 Open Door

Actors involved: Admin, User, Web App, Door Lock

Description: This use case begins when an **Admin** or **User** uses the **Web App** to open the **Door Lock**. The **Admin** or **User** will press the "Open Door" button. The **Web App** will then open the door. This use case ends when the door successfully opens.

5.5.5 Use Intercom

Actors involved: Admin, User, Web App, Speaker

Description: This use case begins when an **Admin** or **User** uses the **Web App** to communicate verbally through the **Speaker**. The **Admin** or **User** will press the "Intercom" button. The **Web App** will then allow the **Admin** or **User** to start speaking. This use case ends when the **Admin** or **User** finishes speaking.

5.5.6 View Pictures

Actors involved: Admin, User, Web App

Description: This use case begins when an **Admin** or **User** uses the **Web App** to look at any pictures stored in the database. The **Admin** or **User** will press the "View Pictures" button. The **Web App** will then allow the **Admin** or **User** to scroll through any pictures stored. The **Web App** will also display the time and date stored for the relative picture. This use case ends when the **Admin** or **User** finishes viewing the gallery.

5.5.7 Video Stream

Actors involved: Admin, User, Web App, IP Camera

Description: This use case begins when an **Admin** or **User** has logged into the **Web App**. The **Web App** home page will assert a connection to the IP camera. The **Web App** will display the video stream received, on the home page. This use case ends when the **Admin** or **User** navigates away from the home page.

5.5.8 Motion Sensor

Actors involved: Motion Sensor, Web App

Description: The **Motion Sensor** will constantly be searching for any movement. Once motion is detected, the **Web App** will be notified.

5.5.9 Notification

Actors involved: Motion Sensor, Web App

Description: This use case begins when a **Motion Sensor** is triggered. Once motion is detected, the **Web App** will take a picture with the relative camera. The **Web App** will then attach the image(s) to a message body, and retrieve the desired address of the Admin users from the database. The **Web App** will send a notification to the Admin users. This use case ends when the notification has been sent.

5.5.9 Take Picture

Actors involved: Web App, Camera

Description: This use case begins when the the **Web App** needs to take a picture. The relative **Camera** will open a stream, and a snapshot will be taken.

6. Project Iterations

The project timeline is projected to run over three iterations or "sprints". The following will document what the plan for each iteration was, and how closely we adhered to the plan.

6.1 Iteration One

For the first iteration we want to explore what is possible with the Raspberry Pi. Specific investigation will take place into the setting up and programming of the motion sensor, setting up Flask servers on both the Raspberry Pi and another local machine which will act as a development server for testing our notification upon motion detection. We wanted to start our documentation in this iteration, mainly the Research Document and this Functional Specification. We also want to set up a means for remote access to the Raspberry Pi, as when devices such as the motion sensor are added and wired up, transportation of the project becomes a huge obstacle. An additional investigation will takk place into taking a picture and how we are going to provide access remotely to the pictures.

6.1.1 Motion Sensor

As previously stated the motion sensor is a core component of the project and is the most crucial aspect. During this iteration we will investigate how to wire and configure the motion sensor, and figure out what signals are coming from the motion sensor which will be utilised to make our further decisions.

6.1.2 Flask Server

We need to set up a Flask server on a local machine which will be used to test our endpoint calls, with the server eventually living on pythonanywhere. When motion is detected we need to send information to a server which will store details of the event for later viewing by the end user.

6.1.3 Remote Access

Means of remote access will be investigated to provide us with a way to develop the application while on campus or otherwise not beside the Raspberry Pi.

6.1.4 Take Pictures

Using the hardware of the Pi to take a picture is another core component that needs to be asserted as early on in development as possible, as this will provide the end users with the knowledge of what has caused the motion sensor to be activated.

6.1.5 Store Pictures

Taking pictures and sending them to a web application is one thing, but we need a way to store the images persistently. It will be investigated as to how we can ensure that the remote server is successfully storing the images sent to it from the Pi.

6.1.6 Alert

When motion is detected, we are planning on taking a picture and sending it to an end user as an alert message. Third party software will be investigated see can we integrate this functionality.

6.2 Iteration Two

This iteration will be focused mainly on coding and getting the functionalities from Iteration One working in conjunction. Additional features will be investigated also. This iteration will be heavily focused on documentation.

6.2.1 Development

This iteration will involve getting the motion sensor to detect motion, take a picture and send it to the local server. By the end of this iteration the server should be successfully storing the picture and displaying them from a web application hosted on pythonanywhere.

6.2.2 Voice Communication

We will use this iteration to investigate ways to record and send voice messages, with the ultimate goal being that the Raspberry Pi will play the voice message out of a speaker connected to its audio jack.

6.2.3 SMS Alert

By the end of this iteration we hope to be successfully alerting our end user of motion detection, via sms messaging.

6.3 Iteration Three

This last iteration will be focused on pulling it all together with the addition of adding the functionality of allowing users to pre record voices messages that will be played out of the speaker of the Raspberry Pi. Focus on the front end development will take place also.

8. References

- [1] The Guardian(Aug 2017). Former burglars say barking dogs and CCTV are best deterrent [online],
  available:https://www.theguardian.com/business/2017/aug/18/former-burglars-barking-dogs-cctv-best-deterrent [accessed 2 Nov, 2017].