National College of Ireland
BSc in Computing 2017 / 2018

Final Report

Encapsulate

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EXECUTIVE SUMMARY

For my software project, I decided to make something similar to a smart pill bottle. The aim of the idea is to alert and remind the user to take their medication or supplement through an alarm.

1 INTRODUCTION

Encapsulate is a device that allows individuals to manage their daily intake of medication. It reminds the user by alerting them and uses sensors to detect when the bottle is being opened, helping to monitor time patterns in their routine. This would benefit doctors and medical services when examining the patient.

1.1 BACKGROUND

My original idea was to have LED lights synced with music. However, due to the difficulty of the AI recognising voice, I was advised to convert the audio file into text so that the accuracy will be much better. It will also make linking it to the LED lights much simpler as it will be reading words instead of the frequency.

However, displaying text through LED lights proved to be difficult to implement as well, since I would also need to know some basic engineering skills in order to solder the LED lights together, due to the amount of LED I would need to display a row of text. Also, if I end up choosing to use an Arduino instead of the Raspberry Pi, I would need to purchase extra equipment like breadboard and jumperwires.

To solve my problem, I have decided to change my project into bottle that reminds the user by alarm to take their medication or supplement. The idea was established by the female contraceptive pill, as women are likely to forget to take it when they are on it. To prevent this, I believed that my device could help missed pills.

1.2 AIMS

My overall aims and objectives are as follows

1. Create an alarm that a user can control and set their own time
2. Link the alarm to a pill bottle
3. Pill bottle detects if lid is closed or not to monitor time the pill is taken
4. Reduce the amount of missed medication or supplement by the user

1.3 TECHNOLOGIES

The two technologies that I am using are the Raspberry Pi and the Grove Pi+.

The Raspberry Pi is a portable computer that can be connected to a monitor and uses a mouse to move around and a keyboard type with. It is mostly used to build practical and fun projects at home or in courses. It runs on Raspbian OS.

The Grove Pi+ is basically a bridge between the original Grove Pi and Raspberry Pi. It is an add on board that can be connected to the Raspberry Pi to prevent soldering and the use of a breadboard. The board comes with 15 four-pin hubs, as well as pin headers.

These two components work hand in hand and makes things so easy when building my project and coding it. Furthermore, the Grove Pi+ comes with multiple sensors that can be worked with and I am using majority of the sensors to build my alarm. I am writing my code in Python, which is advisable when using the Raspberry Pi.

1.4 STRUCTURE

The structure of this project is simple and can be broken down into four parts.

1. Set an alarm
2. Turn off alarm when it rings
3. Open bottle lid to take medication or supplement
4. Close lid bottle

The Grove Pi+ sensors that I will be using are that are connected to the Pi are as follows:

- LCD RGB Backlight
- Buzzer
- Button
- Rotary
- LED Bulb
- Ultrasonic Ranger

I will also be using a small bottle to demonstrate how it will be like if the ultrasonic is wireless and can be attached to the lid of the bottle.

2 SYSTEM

2.1 REQUIREMENTS

2.1.1 Functional Requirements

- Choosing which sensors are compatible
- Setting up alarm to preferred time
- Being able to turn on and off alarm
- Bottle can detect when lid is opened or closed

2.1.2 Non-functional Requirements

Performance/Response Time

This is very important t This is one of the most important and vital requirement in my system as the alarm should be running the way it should. Response time should be immediate and there should be little to no delay when the user is controlling the features. Since the system is running based on the user's commands, the alarm must ring at the time it is set and respond quickly to alert the user.

Reliability

Just like any other application or device, it must be reliable during difficult situations and should not influence the performance of the system. Ideally, users want an application that can run without any issues therefore the system must be capable of handling any obstacles in the way while maintaining its quality.

Extendibility

Extendibility refers to how well the system digests new features and functionalities during updates. Every application always needs improving, even if it's a small change, thus every update it undergoes should be accepted without any difficulties. The performance should always be increasing when the system is restored with new information, and errors and bugs should be lessened with every update.

User Requirements

I would need to know what the target audience wants and try implement their demands in my project. By doing this, I am increasing audience satisfaction as well as their interest for the device.
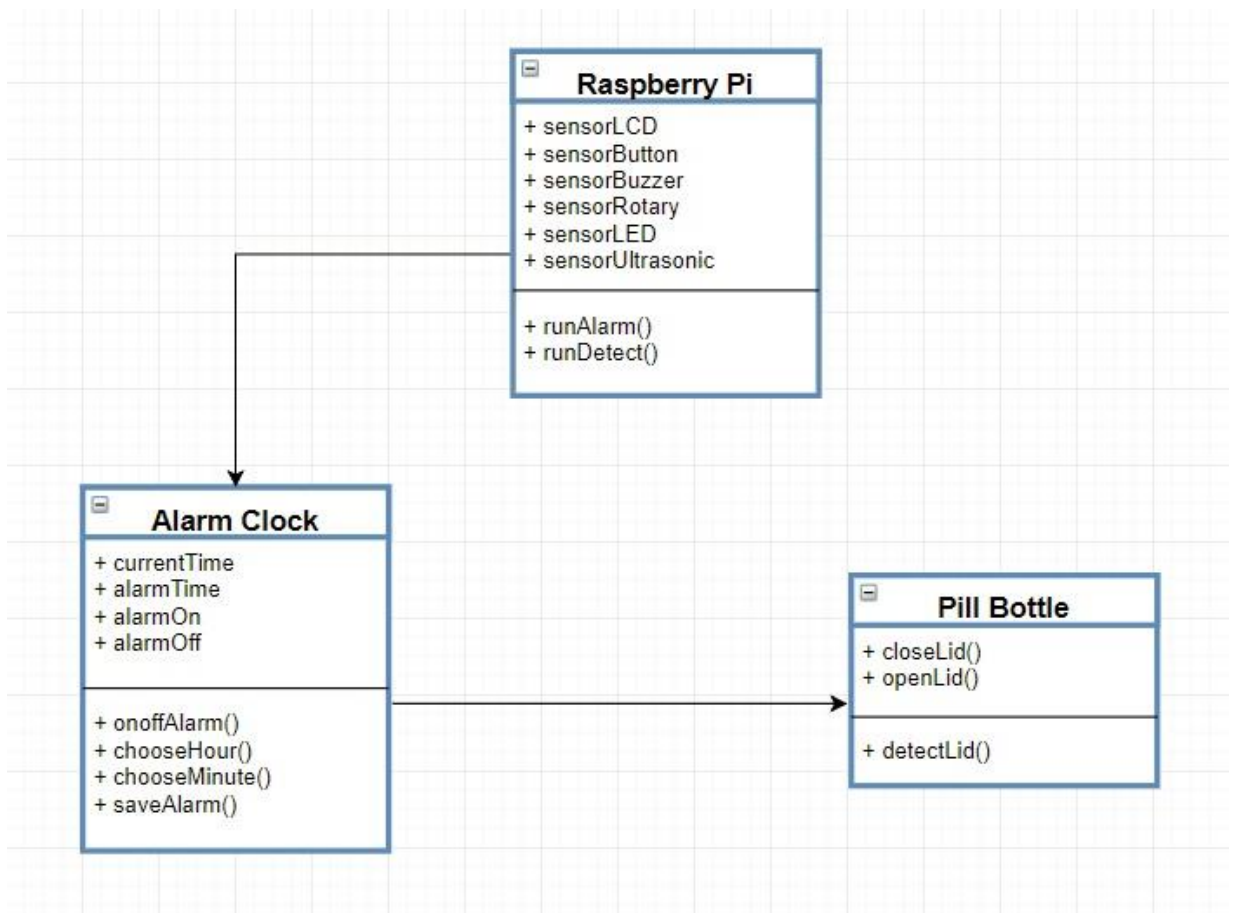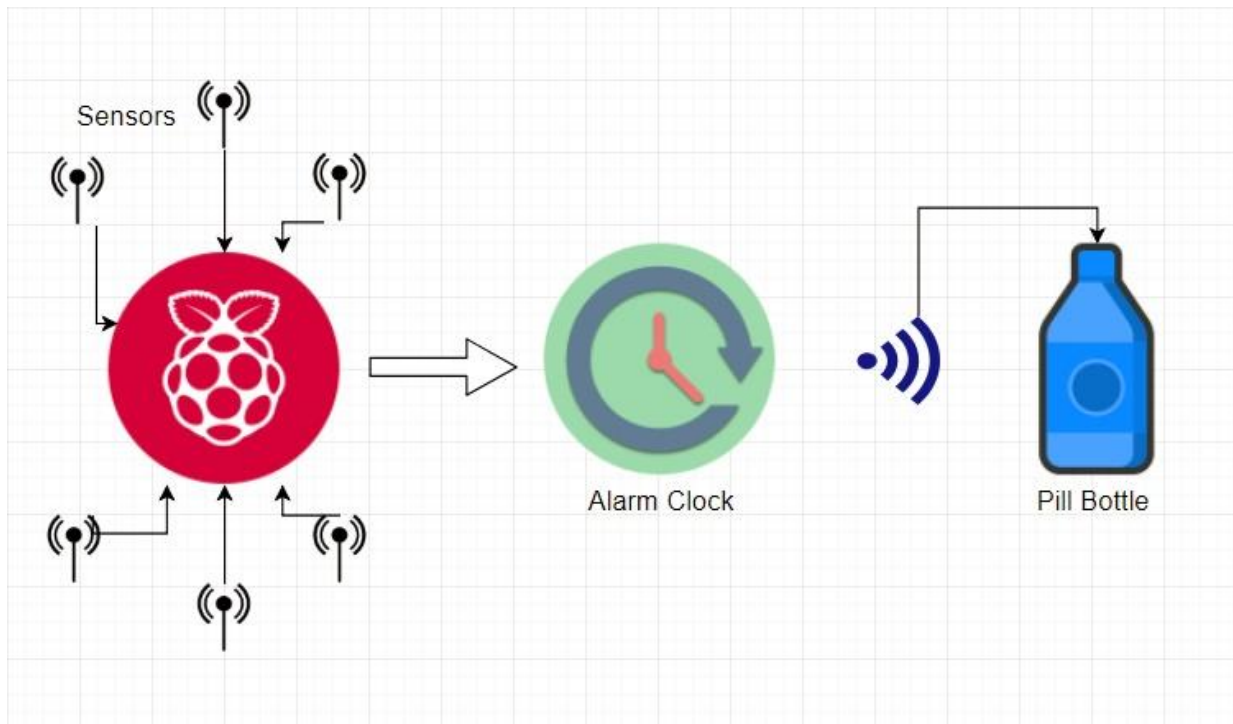
For the volunteers that would like to participate, I have added a consent form as well as interview questions for them to be asked. (*See Appendix*) This would give me multiple feedbacks on my product and various constructive criticism to improve and make my product better.

Usability Requirements

Encapsulate can be used by anyone taking any medication or supplement daily. Although it is aimed at users that take any form of pill, it can still be very flexible, and it can even be used to remind the user to drink water if they are using a water bottle and not taking any form of supplement or prescription.

It may appeal to anyone that easily forgets to take things on a regular basis. Encapsulate will help reduce the number of missed doses.

2.2 DESIGN AND ARCHITECTURE
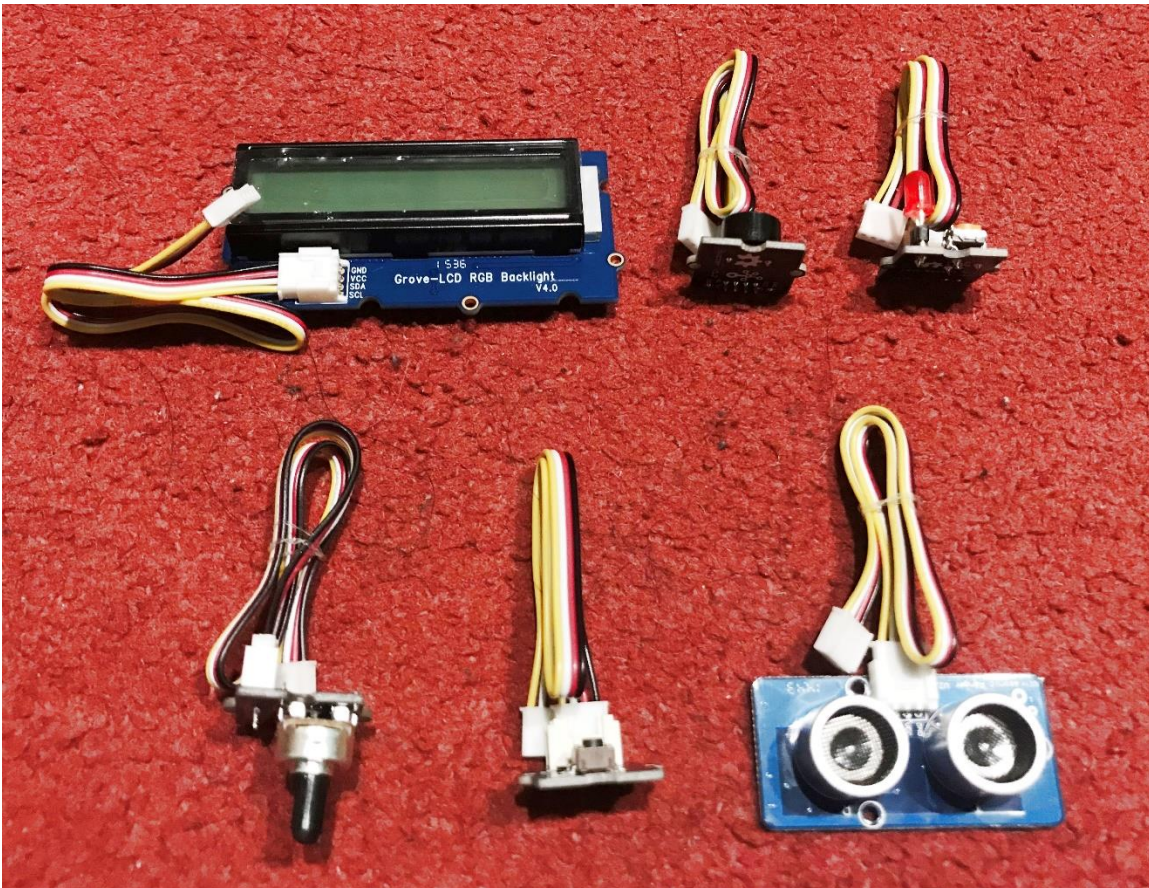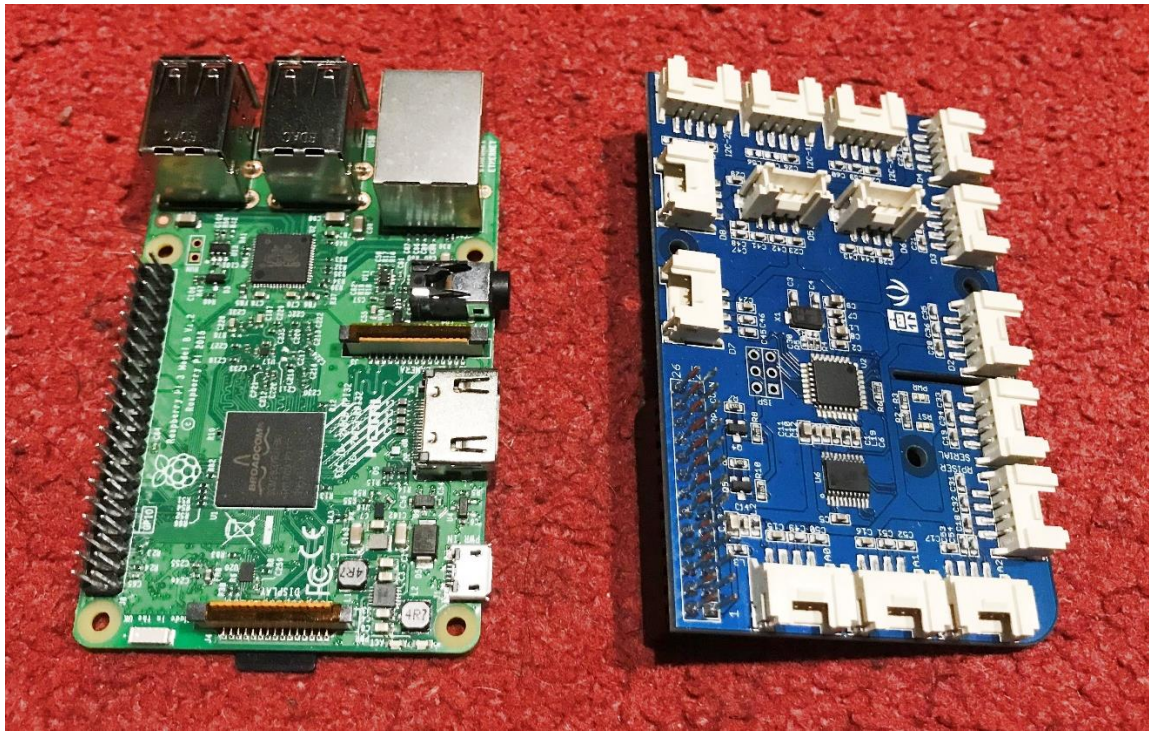
2.3 IMPLEMENTATION

The main components that I will be building is the alarm. This is vital to the project since this is the main feature of my product and it will no work without it. The alarm clock is composed of the Raspberry Pi and Grove Pi + stacked together, and multiple sensors connected to it. I have written a python code for each sensor so when the code is run, each sensor does its own function and purpose.

I have also used a medication bottle for example purposes to demonstrate how the bottle cap detects when it is closed or opened. The sensor in charge of this is the ultrasonic sensor which measures the distance of the cap. An LED will turn on when the bottle cap is opened and turns off when it is closed.

Sensors that I have used are:

- LCD RGB Backlight

  This displays the menu for setting up the alarm and turning it off. It also displays messages of the alarm.

- Buzzer

  This is used for the ringing sound of the alarm

- Button

  The button is pressed to select an option in the menu

- Rotary

  This is used to choose between the options in the menu and works like a left and right arrow keys, except the user will be able to turn it right or left to move around

- LED Bulb

  The LED bulb is the indicator whether or the not the bottle cap is open or closed

- Ultrasonic Ranger

  This detects the distance of the cap to the bottle

2.4 HARDWARE COMPONENTS

2.5 TESTING

At the beginning, most of the testing would be done by myself as I would be the one building and implementing it. I would also be more aware and knowledgeable about the device and how it works, therefore I will spot all the sections that are faulty and not working the way they are supposed to. It would also benefit me in learning from my mistakes in future projects.

When I do have my basic functionalities running and working, I would let family and friends test it out to get feedback and comments about the application. It will also be interesting to see if it will display differently and if they will have complications running it. This would be beneficial to improve and enhance the system further.

2.6 EVALUATION

I monitored and evaluated my program by running a few tests with the alarm. I've noticed that the alarm does not give an option to be repetitive so that it loops until the next day. This can cause a big issue if brought out to the real world to be sold as competitors that are more skilled in coding will have already implemented this function with ease. This is a matter that I will need to try and find a solution for.

Secondly, my ultrasonic sensor isn't wireless, therefore it cannot be attached to the bottle cap as I would have preferred. This is only a minor point as I am working with the sensors compatible with the Raspberry Pi and Grove Pi, therefore it can easily be replaced if I used another hardware to develop it.

Lastly, I do not have it connected or linked to a mobile device, therefore users can only use my device as I have built it. I believe this lowers the flexibility of my product in terms of mobility but once again, that is another feature that can be added for feature updates.

3 CONCLUSIONS

Overall, I believe that this project can be enhanced and improved greatly as there are many functionalities that can make it better. Researching about it has definitely gave me insight in the medical industry regarding prescription and how tedious it can be to organise and monitor everything.

As a 4th year student, my main aim right now is to fulfil my main objectives and make it as fun & interesting as possible when developing and building my project.

Just like all ideas, there will be disadvantages and advantages that come with it. I have listed the benefits and circumstances below.

ADVANTAGES

- Alerts user to take their pill or supplement
- Flexible in terms of usage
- Since it is a working project, it has potential to grow
- Extra functionalities can be added if hardware is expanded

DISADVANTAGES

- High competitors
- Functionality is simple and scarce
- Risk of unproven operations
- Individuals may prefer branded and original way of taking medication or supplements

4 FURTHER DEVELOPMENT OR RESEARCH

With more resources, this project can be developed further and have a wide range of capabilities. So far, what I have are the basic components, but more complex and unique functionalities can be added to improve the system better. For example, since my sensors need to be linked with the Grove Pi in order to work, it would be ideal for the sensor that detects distance to be attached to the cap of the bottle wirelessly, instead of being connected to the alarm. By doing this, it will be more mobile and flexible.

If I had more resources and knowledge about the hardware, I can expand it to any type of item that uses bottles as their main component. This can be important for companies that want to check the peak of when their bottled products are sold, helping monitor and reduce wastage in producing.

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6 APPENDIX

6.1 PROJECT PLAN

Encapsulate

TASKS	SEPT	OCT	NOV	DEC
Project Initiation	● ● ● ●			
Project Planning		● ● ● ● ● ●		
Market Analysis			● ● ● ●	
Design & Analysis				● ● ● ●
Build Project				● ●

Encapsulate

TASKS	JAN	FEB	MAR	APR
Implementation	● ● ● ●			
Build Project	● ● ● ● ● ● ● ● ● ●			
Create Prototype		● ● ● ● ●		
Testing			● ● ● ● ● ●	
Evaluation				● ● ● ●

6.2 CONSENT FORM

I ___(participants name)___ declare and agree in partaking in this project. I comply to the following terms:

- *I am 18 years old or older*
- *I am not under any medical or clinical treatment that influences this project*

I give my consent and acknowledge that this is a voluntary participation and that I can withdraw at any time. I have fully read the description that was provided in the email and I understand everything that the project involves.

Participants Signature: _____   Date: _____

6.3 INTERVIEW QUESTIONS FOR VOLUNTEERS

1. *Are you a:*
   Female   Male

2. *Did Encapsulate help you in remembering to take your medication/supplement?*
   Yes   No

3. *Did Encapsulate alert you at the time you set it as?*
   Yes   No

4. *Have you missed a day when using Encapsulate?*
   Yes. (If yes, please explain: _____)   No

5. *Was it easy to use?*
   Yes   No

6. *Is there any other feature you would like to include to improve the device?*
   Yes (If yes, please explain: _____)   No

7. *Would you recommend Encapsulate to someone else?*
   Yes   No (If no, please explain: _____)

8. *Any other comments or observations?*

6.4 Monthly Journals

6.4.1 September - October

The start of this month was a challenge as coming up with the idea was very difficult as I could not think of something that I would enjoy building as well as be unique. During the project pitch, my idea was rejected.

The feedback I got was that the idea is either too simple to be considered as a 4th year project and that it can also be too difficult to develop and implement as I am working on this alone, therefore my idea was shut down and was encouraged to look at the list if ever I do not come up with something.

The project proposal was also due on October so I had to come up with an idea quickly. I decided to choose the "Smart Home" idea from the list, however, after talking to my supervisor, I was advised to change it as I was unsure of what it was asking in the brief. It was best to know how I was going to build it instead of having a vague idea, so once again, my idea changed. I ended up deciding on making an application that syncs lights with music. My supervisor gave me the go-ahead with the idea, also suggesting adding speech recognition to it to make it unique and original.

6.4.2 November

November was a very busy month as I've had a lot of things to get done in such a short amount of time. The requirements specification was the document that was due this month. I still had a lot of questions regarding the idea I choose and started second guessing the idea once again. I decided to meet up with my supervisor to help me with the requirements specification as well as advice for the project. Unfortunately, the meeting was unsuccessful, and I left feeling even more confused and worried about my project.

Nonetheless, I managed to finish the document, despite it being not the way I hoped for. As the weeks went on, I struggled even more with how I am going to start building it, so I made an appointment with the computing support of the college to guide me. The meeting went

on for about half an hour and during that time, I have been told to modify my idea to make it simpler and easier to do.

In the end, I eventually choose the easier route and change my idea slightly to make it simpler, in time for the mid-point presentation. However, due to how late the changes were made, I had to ask for an extension on my technical report since I am not going through with my initial idea anymore.

6.4.3 January

This month, I researched my new idea, looked up components needed to build it as well as applications that are compatible to control my device. For my mid-point presentation, I showcased a website.

This demo website was going to be connected to my device and be the control hub for it as well. Hopefully, I am able to accomplish the connection between the two applications by the end of this deliverable. I will admit that after my presentation, I did take a break for my project to focus on exams and other continuous assessments in my module, therefore there was little work done for this month.

6.4.4 February

As the weeks went on, I played around with the Google API, text to speech. However, I had problems when installing it, therefore I found another website that does a similarly, which was VoiceBase. I used this as a back up as I learn how to use the Google Speech API.

I also tried coding the application to control the LED. I started off with basics, like making the LED blink, turn on and off, different intervals in waiting time etc. I did this so I am familiar with it before getting heavy with adding other functionalities to it.

I also researched alternate ways of building my device instead of using a Raspberry Pi. Using an Arduino Uno was my top choice if I was to pick an alternate way of creating my device, however, I will need to learn how to run it and its components.

6.4.5 March

For this month, I've started having complications with my project. Things weren't working out and the building progress was slower than I would have liked. I still had issues with linking the Pi to the website, hence, I could not test whether or not the text will be displayed through the LED.

At this point, I started panicking and feeling hopeless about the project, as the deadline is in two months and I have other projects apart from this to start on. Regardless of the stress of starting over, I decided to once again change my project idea. I felt like it would have been for the best as I was not getting anywhere with my current project despite trying again and again.

So once again, I was back to square one with researching for a suitable project as well as checking hardware to create, build and implement my new idea.

6.4.6 April

This month could be what you call "my super productive month". I have set my new project idea on a smart bottle, alerting its user when it's time to take their supplement or medication. I came up with the idea when thinking about female contraceptive pills and how easily they can be forgotten when taken, so building a device to help monitor and alarm the user seems very useful.

Due to the difficulties I faced, I had to be productive every single day and would need to at least add to my project a few hours a day. I decided that taking it one step at a time and focusing on one functionality first would be more ideal than creating the bigger picture straightaway.

I also ended up not straying too far away from hardware I am not too familiar with, so the Raspberry Pi and Grove Pi are the main technologies I will be using for my project.