



Faculty of Computer Science and Information Technology

***DEVELOPING AN INTELLIGENT ASSISTANT EMBEDDED IN A  
SMART MIRROR PROTOTYPE***

Hui Chen Hao

Bachelor of Computer Science with Honors

(Software Engineering)

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**DEVELOPING AN INTELLIGENT ASSISTANT EMBEDDED IN A SMART  
MIRROR PROTOTYPE**

HUI CHEN HAO

This project is submitted in partial fulfilment of the  
requirements for the degree of  
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**PEMBINAAN PEMBANTU PERIBADI PINTAR TERBENAM DI DALAM  
PROTOTAIP CERMIN PINTAR**

HUI CHEN HAO

Projek ini merupakan salah satu keperluan untuk  
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## ABSTRACT

*A mirror is a very important tool in our daily life. We spend a decent amount of time every day to stand in front of a mirror, whether it is to put on makeup, set a hairstyle or adjust outfit. However, we are unable to check our phone for news and weather when we are adjusting our looks in front of the mirror. In a busy daily schedule, it would be time-consuming to do both consecutively. Therefore, efficiency and productivity will be lowered. The purpose of this project is to explore and search for a possible solution to the problem statement. This project is the development of an intelligent personal assistant embedded in a Smart Mirror prototype. The prototype can reflect the image of the users like a normal mirror while displaying various information on the mirror. Users can carry voice interaction with the system. In this way, the users can interact with the system while getting themselves ready for the day. As a result, there will be an increase in the efficiency and productivity of users.*

## **ABSTRAK**

Cermin ialah alat yang sangat penting dalam kehidupan seharian kita. Kami meluangkan masa setiap hari untuk berdiri di depan cermin, sama ada untuk memakai solek, menetapkan gaya rambut atau menyesuaikan pakaian. Walau bagaimanapun, kami tidak dapat menyemak telefon kami untuk berita dan cuaca apabila kami menyesuaikan penampilan kami di hadapan cermin. Dalam jadual harian yang sibuk, banyak masa akan digunakan untuk melakukan kedua-dua berturut-turut. Oleh itu, kecekapan dan produktiviti akan diturunkan. Tujuan projek ini adalah untuk meneroka dan mencari penyelesaian untuk menyelesaikan masalah tersebut. Projek ini adalah pembinaan pembantu peribadi pintar yang terbenam di dalam prototaip Cermin Pintar. Prototaip ini boleh mencerminkan imej pengguna seperti cermin biasa ketika memaparkan pelbagai maklumat di cermin. Pengguna sistem boleh melakukan interaksi suara dengan sistem. Dengan cara ini, pengguna sistem boleh berinteraksi dengan sistem semasa mereka bersiap sedia sebelum keluar. Akibatnya, kecekapan dan produktiviti pengguna dapat dipertingkatkan.

## TABLE OF CONTENTS

Declaration .....	i
Acknowledgement .....	ii
Abstract .....	iii
Abstrak .....	iv
Table of Contents .....	v
List of Tables .....	viii
List of Figures .....	ix
Chapter 1: Introduction.....	1
1.1 Introduction.....	1
1.2 Problem Statement .....	2
1.3 Objectives .....	2
1.4 Brief Methodology .....	3
1.4.1 Requirements Planning .....	3
1.4.2 User Design (Prototyping, Test, Refine).....	4
1.4.3 Construction .....	4
1.4.4 Cutover.....	4
1.5 Scope .....	4
1.6 Significance of Project .....	5
1.7 Expected Outcome .....	5
1.8 Project Schedule.....	6
1.9 Project Outline .....	8
1.9.1 Chapter 1: Introduction .....	8
1.9.2 Chapter 2: Literature Review .....	8
1.9.3 Chapter 3: Methodology .....	8
1.9.4 Chapter 4: Implementation and Testing .....	8
1.9.5 Chapter 5: Conclusion and Future Work .....	9
1.10 Summary.....	9
Chapter 2: Literature review .....	10
2.1 Introduction.....	10
2.2 Technologies in Personal Assistant.....	10
2.3 Reviews on Possible Platform to be Adopted.....	13

2.3.1 Open-Source.....	13
2.3.2 Closed-Source .....	17
2.3.3 Comparison between the platforms .....	22
2.4 Review of Tools .....	24
2.4.1 Arduino .....	24
2.4.2 Raspberry Pi .....	25
2.4.3 Arduino vs Raspberry Pi.....	26
2.5 Summary.....	26
Chapter 3: Methodology .....	27
3.1 Introduction.....	27
3.2 Rapid Application Development.....	27
3.3 Requirement Planning .....	29
3.3.1 Requirement Elicitation (Questionnaire) .....	29
3.3.2 Requirement Analysis .....	32
3.4 Software Requirement .....	33
3.5 Hardware Requirement.....	34
3.6 Proposed System Design .....	35
3.6.1 Hardware Design .....	35
3.6.2 System Interface Design .....	37
3.6.3 Use Case.....	38
3.6.4 Activity Diagram .....	46
3.7 Summary.....	47
Chapter 4: Implementation and Testing .....	48
4.1 Introduction.....	48
4.2 Hardware Implementation .....	48
4.3 Software Implementation .....	54
4.3.1 Integration .....	54
4.3.2 Main Interface .....	55
4.3.3 GPS module.....	56
4.3.4 Journey Planner Module .....	58
4.3.5 Voice Interaction Modules .....	59
4.4 Testing .....	60
4.4.1 Functional Testing .....	60
4.4.2 Performance Testing .....	67

4.4.3 User Acceptance Testing .....	69
4.5 Summary.....	70
Chapter 5: Conclusion and Future Work .....	71
5.1 Introduction.....	71
5.2 Project Achievement .....	71
5.3 Project Limitations .....	72
5.4 Future Works .....	72
5.5 Conclusion .....	73
References .....	74
Appendix A.....	75
Appendix B .....	77

## LIST OF TABLES

Table 2.1: Comparisons between the possible platforms to be adopted and proposed system.....	22
Table 3.1: Software Requirement .....	33
Table 3.2: Hardware Requirement .....	34
Table 3.3: Use Case 1 .....	39
Table 3.4: Use Case 2 .....	40
Table 3.5: <i>Use Case 3</i> .....	41
Table 3.6: Use Case 4 .....	42
Table 3.7: Use Case 5 .....	43
Table 3.8: Use Case 6 .....	44
Table 3.9: Use Case 7 .....	45
Table 4.1: Connection of pins between Raspberry Pi and GPS module .....	49
Table 4.2: Hotwords and their corresponding actions .....	60
Table 4.3: Test Case 1 - Turn on the prototype .....	61
Table 4.4: Test Case 2 - GPS module .....	61
Table 4.5: Test Case 3 – Weather modules .....	62
Table 4.6: Test Case 4 – Calendar module.....	63
Table 4.7: Test Case 5 – Trigger Hotwords to check events .....	64
Table 4.8: Test Case 6 - Journey Planner module .....	65
Table 4.9: Test Case 7 - Trigger Hotwords to turn off Journey Planner .....	66
Table 4.10: Performance testing on the GPS module .....	67
Table 4.11: Performance testing on the voice capturing function .....	68
Table 4.12: Summary of the result for the questionnaire .....	69
Table 5.1: Tabulation of objectives and achievements .....	71

## LIST OF FIGURES

Figure 1.1: Rapid Application Development (RAD) Model .....	3
Figure 1.2: The Gantt Chart of the Development of the Project (FYP1) .....	6
Figure 1.3: The Gantt Chart of the Development of the Project (FYP2) .....	7
Figure 2.1 : Mycroft Mark 1.....	14
Figure 2.2: LinTO Logo.....	15
Figure 2.3: Echo (3rd Gen) - Twilight Blue.....	18
Figure 2.4: Google Home.....	19
Figure 2.5: Apple HomePod.....	21
Figure 2.6: Arduino Uno.....	24
Figure 2.7: Raspberry Pi 3 Model B+ .....	25
Figure 3.1: Rapid Application Development (RAD) Model .....	27
Figure 3.2: Result from questionnaire question 1 .....	29
Figure 3.3: Result from questionnaire question 2 .....	30
Figure 3.4: Result from questionnaire question 3 .....	30
Figure 3.5: Result from questionnaire question 4 .....	31
Figure 3.6: Result from questionnaire question 5 .....	32
Figure 3.7: Hardware Design of the system .....	35
Figure 3.8: Setup behind the mirror .....	36
Figure 3.9: Mock up Interface .....	37
Figure 3.10: Use case diagram .....	38
Figure 3.11: Activity diagram .....	46
Figure 4.1: Raspberry Pi 3 Model B+ .....	48
Figure 4.2: GY-NEO6MV2 with NEO-6M GPS Module.....	49
Figure 4.3: Picture of setup of Raspberry Pi and GPS module .....	50
Figure 4.4: Pin diagram of the connection of Raspberry Pi and GPS module .....	50
Figure 4.5: 7" touchscreen monitor for Raspberry Pi .....	51
Figure 4.6: Microphone.....	51
Figure 4.7: Speakers .....	52
Figure 4.8: Hardware inside the prototype.....	52
Figure 4.9: Front view of the prototype .....	53
Figure 4.10: Main interface of the prototype.....	55
Figure 4.11: Code Snippet of GPS module .....	56
Figure 4.12: Main interface before GPS signal is obtained.....	57
Figure 4.13: Notification when location is detected .....	57
Figure 4.14: “Upcoming events” updated according to Google calendar .....	58
Figure 4.15: Google map of the Journey Planner module.....	59

# CHAPTER 1: INTRODUCTION

## 1.1 Introduction

It is often shown in a scene in a movie where there is an Intelligent Assistant carrying out its master's commands and controlling the lighting and electrical appliances in the home. In this advanced digital era, such technology is no longer a work of fiction. In Internet of Things, environmental and daily life items, also known as "things", "objects", or "machines", are upgraded with computing and communication technologies to join the communication framework, satisfying a variety of services based on person-to-person, person-to-machine, machine-to-person, and machine-to-machine interactions using wired or wireless communication (Chaouchi, 2010). Thus, the devices in the home can be connected to the Internet and able to share information among each other. An Intelligent Personal Assistant is a software designed that uses natural language to aid human to carry out simple tasks, mostly granting results or responding a user's questions regarding specific fields using online resources (Bael, n.d.). Therefore, by embedding an Intelligent Assistant to an IoT system, the Assistant can process the gathered information from the Internet and perform tasks according to a user's queries.

A vanity mirror is a crucial personal grooming mirror in daily life. It is used to check appearance, set hairstyle, apply makeup and help people to look the best. People often spend a lot of time in front of a vanity mirror to prepare themselves for the day, especially women as they take longer time to apply makeup. After people finishing with their appearances, they usually need to scroll through their mobile phones to update themselves with latest information.

A smart mirror is a device that functions as a mirror with an electronic display behind the mirror that can display different kinds of information. This project aims to create a Smart Mirror prototype that allows users to set up their appearances and catch up with any important information at the same time. The prototype can display weather conditions, news, time, personal schedule via audio-based A.I intelligent assistant.

## **1.2 Problem Statement**

People spend a decent amount of time every day to be in front of a mirror, whether it is to apply makeup, set a hairstyle or adjust outfit. When it comes to working days, the time spent for preparing the day in the morning becomes much more important, especially for working adult. However, people are unable to check their mobile phones for news and weather when we are adjusting our looks in front of the mirror. In a busy daily schedule, it would be time consuming to do both consecutively. Therefore, the efficiency and productivity will be lowered.

## **1.3 Objectives**

- i. To build a Smart Mirror Prototype using the Raspberry Pi.
- ii. To design an IOT based Smart Mirror embedded with the capabilities of an A.I intelligent assistant.
- iii. To implement the Smart Mirror system along with the A.I intelligent assistant that can carry out simple voice-activated commands.

## 1.4 Brief Methodology

Rapid Application Development (RAD), a form of Agile software development methodology is selected to develop the prototype of this project. This is because RAD is a development model that puts less emphasis on planning and more emphasis on adaptive process which includes rapid prototyping and gathering feedback from users. As a result, requirements changes can be accommodated throughout multiple iterations without needing to start a development schedule from scratch each time. Figure 1.1 shows the processes in RAD.

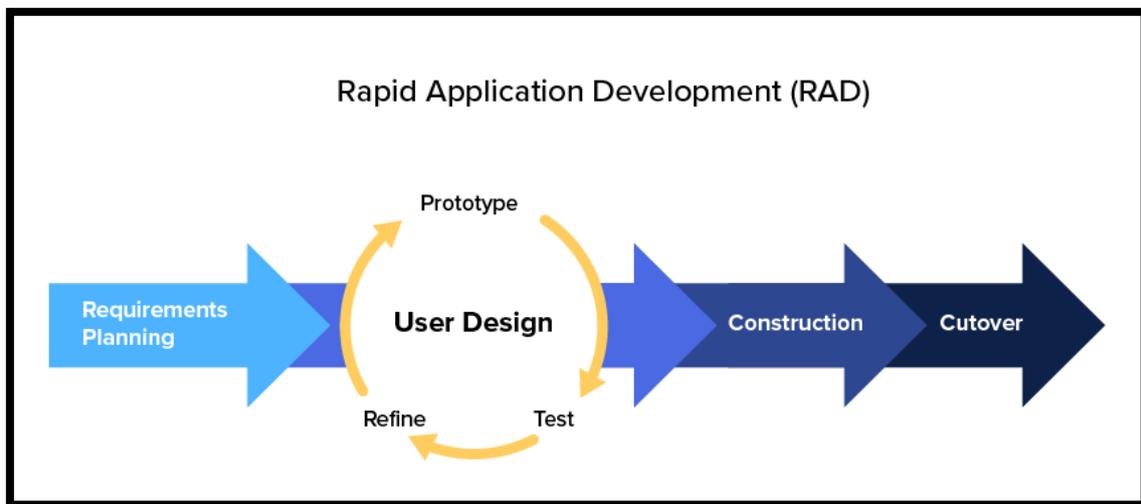


Figure 1.1: Rapid Application Development (RAD) Model

(Image source: <https://kissflow.com/rad/rapid-application-development/>)

### 1.4.1 Requirements Planning

The first step is to understand and identify user base, which is working adults. Surveys will be distributed to a group of working adults to evaluate their interests, requirements and suggestions towards the project. Meeting will be held between the developer and stakeholder(supervisor) to communicate to determine the goals and expectations of the project.

### **1.4.2 User Design (Prototyping, Test, Refine)**

This phase is an iterative process. A prototype is designed. Different features and functions will be built in the prototype based on requirements and feedback obtained. Then the stakeholder tests it and communicate with developer to decide what features and functions to stay or to be removed. Bugs and problems also can be detected and fixed earlier before they pile up. The prototype is then refined based on feedback and suggestions accordingly. This phase iterates until stakeholder and developer obtain a satisfactory design.

### **1.4.3 Construction**

This phase is where the prototype is turned into working model. The developer can build the working model more quickly as majority of the problems are solved on the previous phase. However, stakeholders might still suggest new requirements or changes. At the end of this phase, all the expectations and objectives of stakeholders must be met.

### **1.4.4 Cutover**

This phase includes all the final changes and testing to make sure the new system is ready. This phase includes performance testing of final product.

## **1.5 Scope**

This project primarily targets working adults. While they are preparing to go to work, they can perform multitasking by dressing in front of the mirror and updating themselves with the latest information at the same time. While maintaining an aesthetic mirror look, the system can

display information via audio-based A.I intelligent assistant such as weather conditions, time, news, and personal daily schedule. The product of this project can also be used by people other than working adults, however, they do not fully benefit from the functions such as the personal daily schedule and journey planner.

## **1.6 Significance of Project**

This project aims to help users to increase their productivity and efficiency in the morning while preparing the day. It allows users to perform multitasking tasks by preparing their appearances while interacting with the Intelligent Assistant embedded thus reducing their time and energy in manually performing these tasks one after another.

## **1.7 Expected Outcome**

The expected outcome of this project is an IOT based system which is WiFi-enabled and user-oriented. It accesses the Internet to get the latest news and weather then displaying them. The intelligent assistance can carry out simple commands. This allows the users of the prototype to multitask while preparing to go to work at the same time. The expected functions of the prototype are as following:

- Carry out speech-to-text function to receive voice commands from the user
- Carry out text-to-speech function to read out the information to the user
- Read out time and weather
- Read out daily schedule
- Perform journey planning

## 1.8 Project Schedule

The proposed project schedule spans two semesters, with first semester doing Final Year Project 1 (FYP1) and second semester doing Final Year Project 2 (FYP2). FYP1 started at 9<sup>th</sup> September 2019 and ends at 11<sup>th</sup> January 2020. For first semester, the project prototype with limited functionality will be released to collect feedback for the first iteration. Then, the improvement of second iteration will be carried out in the next semester. Figure 1.2 and 1.3 show Gantt chart for FYP1 and FYP2 respectively.

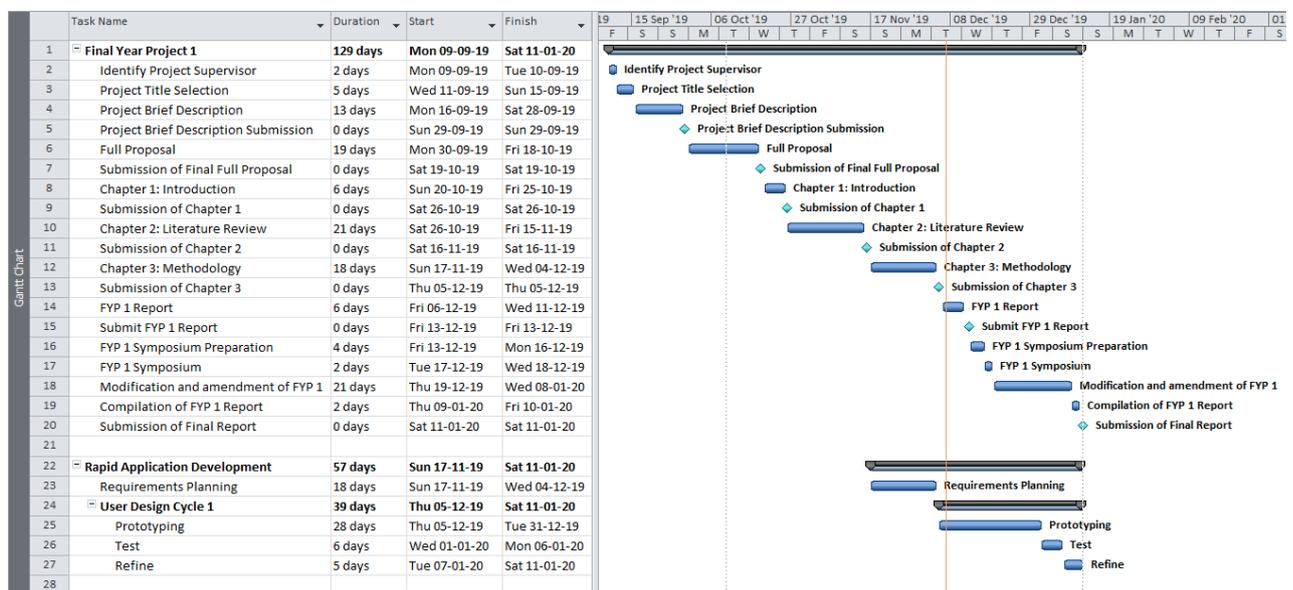


Figure 1.2: The Gantt Chart of the Development of the Project (FYP1)

FYP2 will start at 28<sup>th</sup> January 2020 and end at 29<sup>th</sup> June 2020. The prototype will be refined in two cycles and should be finished by 14<sup>th</sup> April 2020.

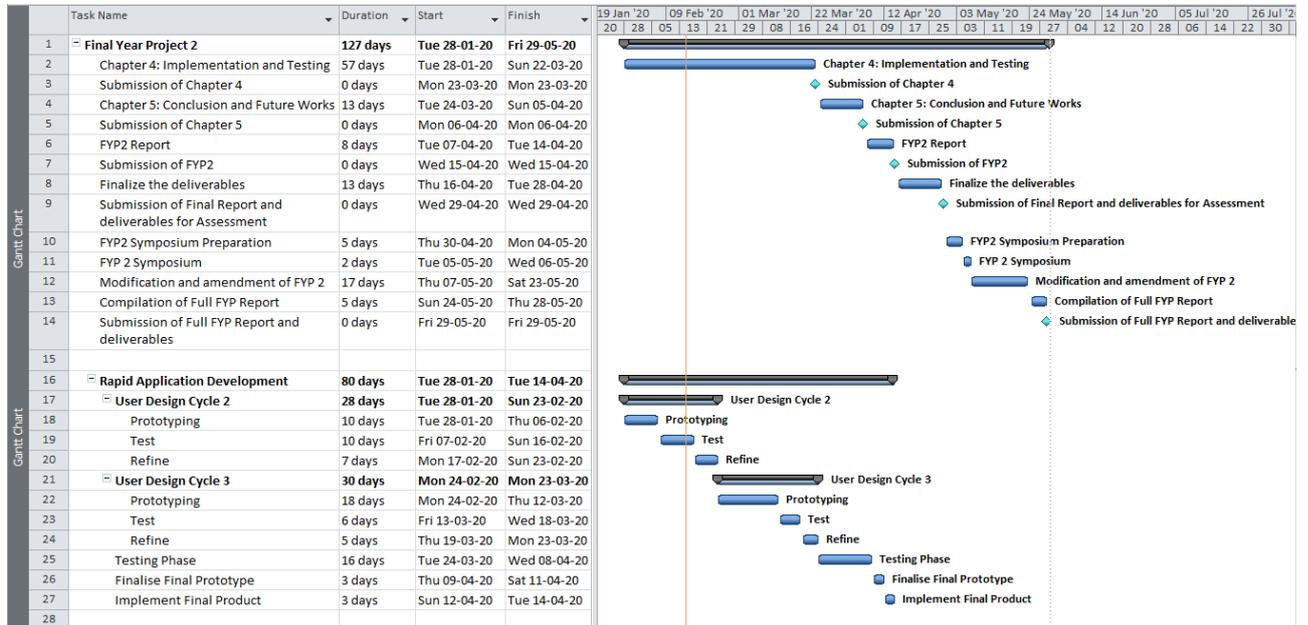


Figure 1.3: The Gantt Chart of the Development of the Project (FYP2)

## **1.9 Project Outline**

This project report will consist of five chapters, with each chapter summarized as below:

### **1.9.1 Chapter 1: Introduction**

Chapter 1 describes the background of the project, which focuses on the problems that the projects are trying to solve (problem statement). Chapter 1 also includes the objectives of the project, methodology used to develop the project, the scope of the project, significance of the project and the expected outcome for the project. Finally, the timeline of the project is schedule so that we can keep track of the progress.

### **1.9.2 Chapter 2: Literature Review**

Chapter 2 reviews on technologies and existing platforms to gain a comprehensive understanding on how they work, their pros and cons. This chapter will also review the tool that is going to be used in this project.

### **1.9.3 Chapter 3: Methodology**

This chapter will discuss two main parts of the project which are the methodology and requirement analysis and design. The first part will discuss the methodology chosen for this project, which is Rapid Application Development (RAD). For the second part, the requirement gathering process will be done and the result will be analyzed to come out with the user's requirement specification. The requirement part is including the software and hardware requirements. This will specify the type of hardware and software that is being used.

### **1.9.4 Chapter 4: Implementation and Testing**

Chapter 4 will be emphasizing on the implementation of the project, which involve in building a prototype for the project. The prototype will be tested to ensure verification and validation take place.

### **1.9.5 Chapter 5: Conclusion and Future Work**

This final chapter concludes the project and documenting the results from this project. A list of future works is outlined to pave a way for future projects to benefit from this project.

### **1.10 Summary**

Chapter 1 discusses the inception of the project, which is why this project is necessary and why the development of this project would help us to solve some daily problems we face. This project is more than developing a merely IoT system; it is about challenging the status quo and questioning the beliefs we have towards existing standards and figuring a better, sustainable and easier way to solve, or at least, be part of the solution that dive humanity forward.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.1 Introduction**

In this chapter, the technologies used in personal assistant is discussed. This aims to allow us to understand and gain background knowledge about the related topic. Next, possible platforms that may be adopted into this project are discussed and reviewed. The review will be conducted based on functionalities, usability, pros and cons of the platforms. A comparison table is made to show the overall review and details of these platforms. Furthermore, this chapter will discuss the tools used to build the proposed system.

### **2.2 Technologies in Personal Assistant**

These are the main technologies used in creating a Personal Assistant.

- i. Speech Recognition or also known as voice recognition
- ii. Natural Language Processing (NLP)
- iii. Application Programming Interface (API)
- iv. Machine Learning

At first, speech recognition allows the computers to capture and convert human voice into its corresponding textual form. Then once it is in textual form, the NLP algorithms are run. The NLP is a branch of artificial intelligence technology that enables the interaction between computers and humans using the natural language (Garbade, 2018). The goal of the NLP is to make the computers to learn and understand the human language in a valuable way. So, the computers can react or perform the corresponding actions according to humans' request. For

any required information, the system gathers corresponding information through various API. An API helps two programs or applications to communicate with each other by providing them with the necessary tools and functions (Kumawat, 2019). The users send their requests to the service provider through API and then the result generated from the service provider is sent to the desired user. Finally, machine learning comes in place to allow most of NLP techniques to train themselves to learn more about the meaning from human languages. This whole process usually takes up a lot of computational power, therefore it is usually carried out on servers.

Although the time taken starting from a voice command is issued to a result is given back to the user seems very quickly, it is a very complex process. The general flow of a personal assistant is as follows:

i. Signal processing

The first crucial step is to ensure the whole process is successful and highly accurate by signal processing. When there is a voice input, the device needs to clean the signal to make the audio to make as much sense as possible. Signal processing is one of the most critical tests in far-field audio (Gonfalonieri, 2018). The objective of the signal processing is to identify and minimize the ambient noise like the radio or the lawnmower. For example, in Alexa, seven microphones are used to perform beamforming to identify the source of the signal and allow the device to focus on it.

ii. Wake Word Detection

This determines whether the user says the specific word to turn on the program so that the program is ready to receive commands. This is needed to prevent accidental usage of the program and making the user furious. The challenge of this part is that there are pronunciation differences and it needs to be done on the device, which usually has