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Development of multilanguage voice control for smart home with IoT

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Abstract: Internet of Thing (IoT) is very common and demanding nowadays and home automation system is not left behind in this technology. Home automation is the concept of making any home "smart". In this modern life, Automation is not a new thing. This technology has been using many years and normally can be seen in big companies. This automation concept can benefit our daily lives through many ways. However, the smart home technology in the market right now only support a few languages, generally English. For people who English is not their native language, it becomes a barrier in utilizing voice recognition installed in the smart home. Therefore this project will develop a Multilanguage IoT Home Automation System that focused on people who does not speak English especially elderly people in Malaysia to perform their chores routine such as turn on or turn off light by using voice commands given in their preferred language. Other than voice commands, it could be controlled wirelessly by using apps developed in the Smartphone. This system is based on Raspberry Pi and will be designed to be an affordable and reliable home automation system yet, easy to setup and use. The research focus on the methods of integrating voice recognition technology in many languages in home automation systems. This research can have a strong and positive impact to the society especially on persons with physical disabilities and older persons whom English is not their native language.

Keywords: IoT, Voice Control, Smart Home, Raspberry Pi, Multilanguage

1. INTRODUCTION

Internet of Things (IoT) has become one of the most common things nowadays. This is due to the existence of cloud storage that allows people to access their data and share all kinds of information with whomever they want to regardless when or where. With the growing number of users of cloud storage, a lot of manufacturers have started to build platform for the developers to build something that they refer to as smart things. This smart thing is the gateway between our physical world and the internet where it enables information to be spread quickly. Internet of things make human life easier, safe and smart. Z. Kamal et al. [1] mentioned in his report, with IoT, anything will be able to communicate to the internet at any time from any place to provide any services by any network to anyone. Smart cities, homes, transportation, energy and smart environment are the example of IoT. By the concept of IoT, we can manage our home connect with many devices wirelessly. Smart lighting,

air control and central heating, and security are the things we can easily implement to make it a smart home. Consumers have access to a portable controller for the electronics connected to the network. Consumers can control the electronic equipment that connected to the network by accessing the controller.

There are three main components in an IoT system for home automation namely IoT Gateway, Virtual Assistant, and User Interface as shown in **Figure 1**. These three components are the essential element to build an IoT system.
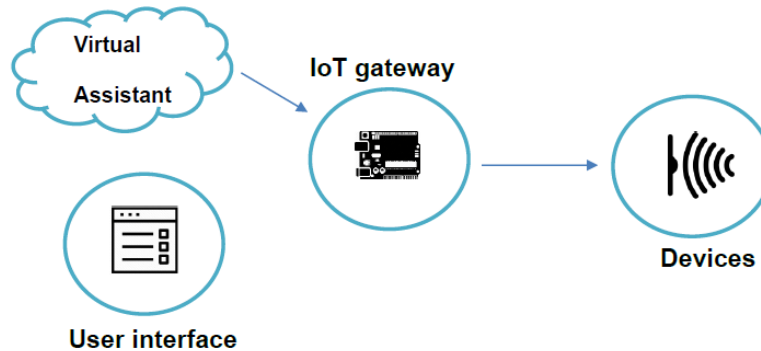
Figure 1. Components of IoT Smart Home [2].

1.1. IOT Gateways

TNóbrega et al. [2] stated that there was an absence of interoperability as a result of various developments of IoT applications, devices and protocols. Thus, to allow the communication of devices that rely on different communication technologies or devices that use different application protocols, an intermediate device typically known as IoT gateway, is required. Several solutions can be found in the literature; some are based on academic research projects that aim at solving problems, while others consider an extensive research and standardization of proposals. There are four technologies suitable for the research which are Arduino, Raspberry Pi, Zigbee and CC3200.

Among those, Rasberry Pi is the most suitable IoT Gateway for this system. A work on Raspberry Pi based Interactive Home Automation System through Email was suggested by S. Jain et al. [3]. A fundamental home automation application on Raspberry Pi by reading the subject on E-mail was designed. Raspberry Pi equipped a standard programming framework called Python programming language for this system. LEDs were the indicators of the shifting activities in this system. What lacks in this project was the tariff in home automation through DTMF (Dual Tone Multi Frequency) because no system security was given which means a hacked e-mail account could be accessed by any unauthorized individuals. Similar work was proposed by M. Narendar et al. [4] on Raspberry Pi based advanced scheduled home automation system through E-mail. A different technique, scheduled automation, was applied in this work though. Among the limitations of this work was the use of Raspberry Pi 2 model B which allowed a small number of devices to be connected to it. In addition, a lot of instructions were given at once by the E-mail instead of providing a step-by-step instruction. In a different circumstance, S. Hidayat et al. [5] recommended a work on Home Automation system through Voice schedule. S. Hidayat et al.'s [5] recommendation was to use the Raspberry Pi while connecting the tools that will be controlled by the voice command in a relay. The negative side of this work was that the system would be costly because a wired medium was needed. Another thing was, about one minute following the activation of Raspberry Pi only the scheduling system would be activated.

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. People of all ages can explore computing using this little device and code some scripts using Python. It is expected to function like a desktop computer from browsing the internet and playing high definition video, to making spreadsheets, word-processing, and

playing games.

1.2. Virtual Assistant

Many companies use the spoken dialogue systems to design their dialogue system devices such as Microsoft's Cortana, Apple's Siri, Amazon Alexa, Google Assistant, Samsung S Voice, Nuance Dragon and Facebook's M. These companies employed different approaches to design and improve their dialogue systems. There are many techniques used to design the VPAs based on the application and its complexity.

The Google Assistant is selected to apply in this development. Google has also developed an intelligent personal assistant called Google Assistant. It was designed to allow conversational usage [6]. Google Assistant's predecessor is Google Now. Google Assistant is linked with Google Home, a voice-activated speaker [6]. Google Now uses a natural language user interface to answer questions, make recommendations and perform actions by delegating requests to a set of services. It also delivers information to users predicting their requirements. K. Vishwakarma et al. [7] proposed the idea on using Google assistant in their smart home by introducing IFTT statement command. It creates a connectivity between Google Assistant and NodeMcu through Adafruit library. A comparable study was presented by L. Vanathi [8] regarding smart home regulated using Google Assistant but without user interface. As one of the world's most advanced company when it comes to software development, clearly, more supported languages are added to the list to ensure that it will remain competitive moving forward. Google Assistant currently supports 13 languages in total. Those languages are Danish, Dutch, English, French, German, Hindi, Indonesia, Italian, Japanese, Korean, Norwegian, Portuguese (Brazilian), Spanish, Swedish as well as various dialects of the 13 languages.

1.3. User Interface

Soundhar Ganesh et al. [9] proposed a system that operates with a built-in display as a central control panel and different sensors and relays perform the desired operations. The remote operation of the system is obtained by reading the title of an email. A lot of proposed systems either is web based or an application are a single interface. Technologies such as JavaScript and latest version of Hypertext Markup Language (HTML5) were used to develop the Web development. On the server side, Hypertext Pre-processor (PHP) languages been used to read the static data from the Javascript Object Notation (JSON) files. The static data contain information about the General Purpose Input/Output (GPIO) ports from the Raspberry Pi that are connected to devices [10]. Although web application can be accessed via mobile phone, a separate application can be very convenience for users because it provides standalone application so the users do not need to depend on a browser. According to D. Kehagias [10], the application been used can be run on any android devices as long as there is an internet connection. This android application can be accessed anywhere is becoming essential for the purpose of improving daily life condition. After going thoroughly the literature review, the very important aspects of the subject is discovered. One of them is their ability to control the devices both from a web fronted and also from android that eventually has been used in this research.

In this system, Blynk Application will act as the User Interface. Blynk Application [2] is a Platform that can be installed for both iOS and Android to control Arduino, Raspberry Pi, NodeMCU and variety of other boards over the Internet. In this technology, Blynk application was built to support the Internet of Things. Display data from sensor, control hardware wirelessly, store data as well as visualize it can be achieved with this application. Blynk application can be used to control smart home as an alternative to voice command.

2. METHODOLOGY

The system will allow users to give command in many languages using only one Smart Home System. The existing system in the market does not support many languages. This system has two main modules which are hardware interface module to connect with internet and the software

communication module. The main control unit (MCU) of this system is a Raspberry Pi which is also capable of functioning as a computer and also the interface for the connected hardware modules. All communication and controls in this system through this credit card sized computer equipped with ARM microprocessor. All these appliances can be controlled remotely from anywhere through smartphone application or multi-language voice recognition using Google Assistant. Google Assistant uses artificial intelligence to recognize our natural language and can support up to 37 language variants across 20 distinct languages. This application converts the user voice command into text and transmit to Raspberry Pi with the help of IFTTT, Google Assistant is used for giving feed to IFTTT. IFTTT serves as broker between two applications. Unfortunately, IFTTT is a free platform that support only up to 6 languages which are English, Japanese, French, Spanish, German, and Italian. The flow chart of the system is shown in **Figure 2.**

The system's architecture generally incorporates a Raspberry Pi computer for the purposes of network management and provision of remote access. The computer can be configured according to the desired home system. The system is operated through the voice command given via a smartphone, and the Raspberry Pi performs an action based on the voice command given. The speech is mapped through voice command by the Google Assistant, which was developed by Google.
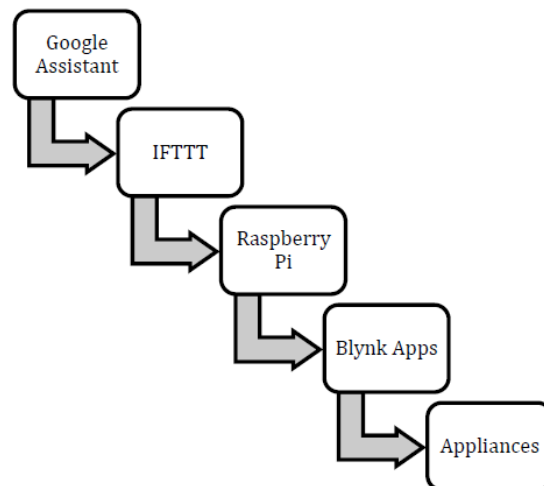

Figure 2. Flow Chart of the System.

IFTTT is an acronym for "If This Then That" was develop based on programming conditional statement. It provides a free software platform that allows to connect web services, devices, and applications to each other to automate simple tasks. This software provides more convenient to the users as they set up a condition and the result according to their preferences. Each of those formula is called an Applet that triggered by changes occur within other web services such as Google Assistant. The service runs on both iOS and Android which make it a better choice for smartphone users. Unfortunately, this free platform only supports up to 6 languages which are English, French, Japanese, German, Spanish, and Italian.

3. SYSTEM OPERATION

Speech is one of the most important inputs used for man-machine interaction. Therefore, to make smart homes more user-friendly, Google Assistant, along with the mobile-based application, can be used to control the home system.
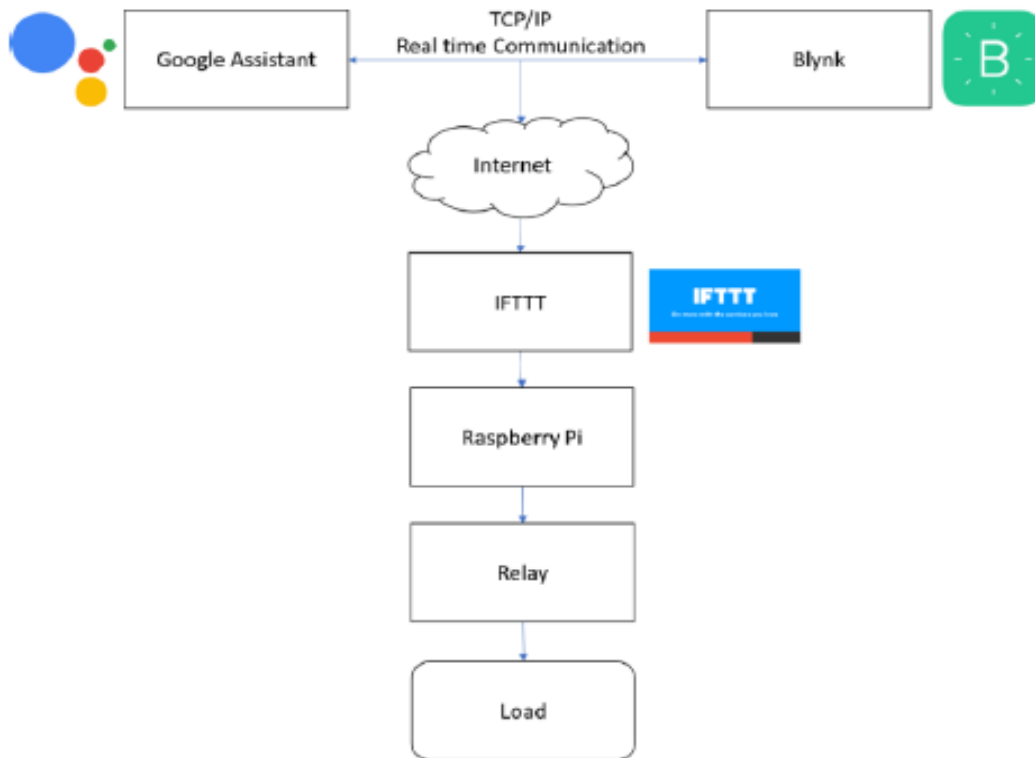
Figure 3. System's Architecture.

Figure 3 shows the details of the system's architecture. The idea of the project is to use the virtual assistants to achieve objectives by integrating Google Assistant and Raspberry Pi to control the loads. Google recently released the recent API for Google Assistant for other operating systems such as iOS, Windows and Linux, which makes it easier to install Google Assistant in all platform. Also, the flexibility is increased when the users are given an option to specify the specific commands according to their preference, such as language preference. Similarly, another way to control the loads is by using Blynk apps installed in the smartphone. The appliances are connected to the mobile device through a Raspberry Pi that established the concept of the Internet of Things. The Raspberry Pi was designed with an interface and program that will respond to mobile inputs, and then connect them with the appliances.

Google Assistant and Blynk application allows the user to communicate with the Raspberry Pi over the internet. Users can give the command to turn on or off the specific appliance via voice recognition or by pressing the ON/OFF button in the application. **Figure 4** shows the flowchart of the implementation of Google Assistant for home automation system. All codes and data are transmitted to the Raspberry Pi, and it reads the command and sends the signal to activate the General Purpose Input Output (GPIO) pins. The respected relay operates and turns the appliance ON or OFF.
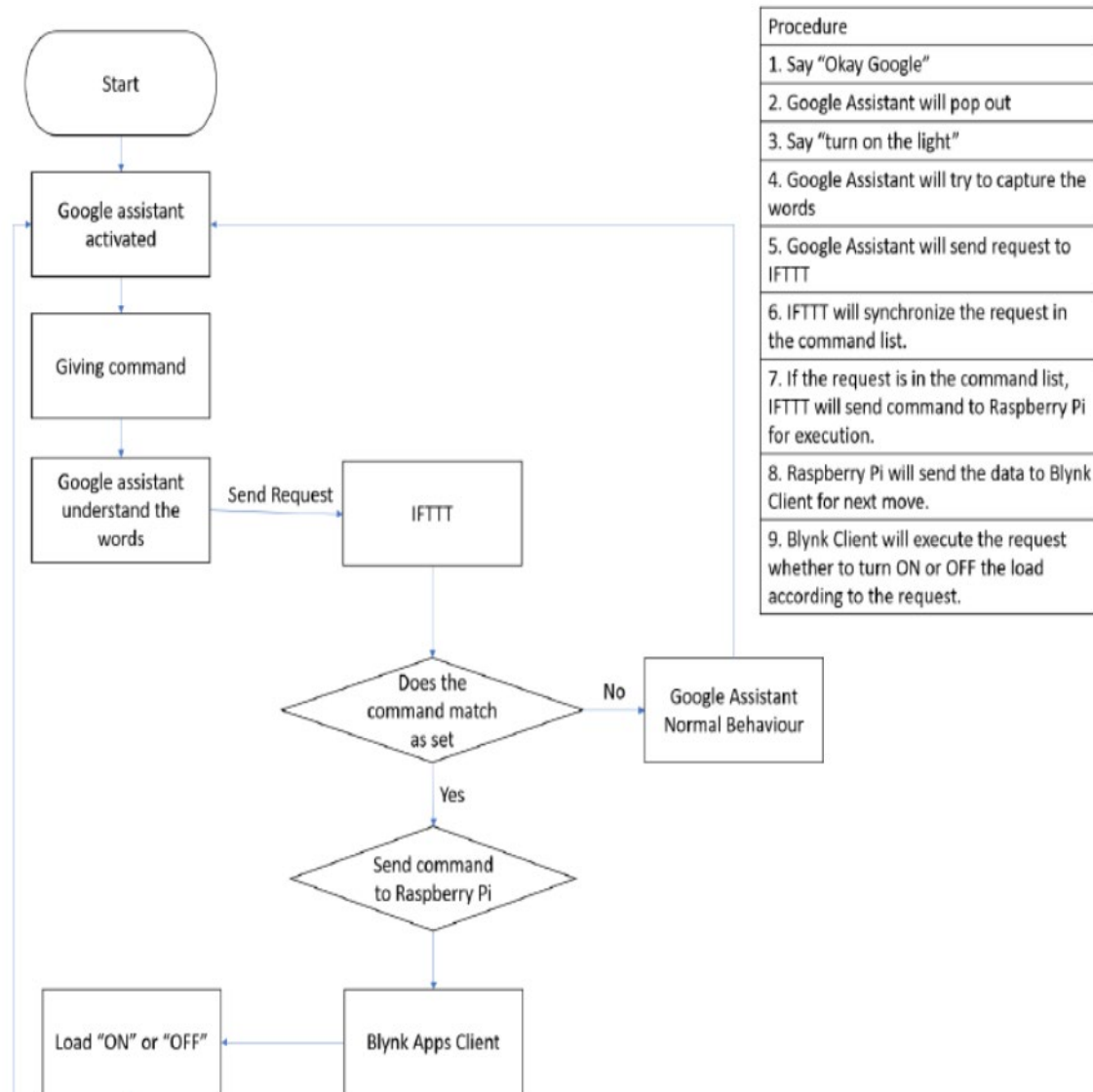
Figure 4. Flow Chart for Home Automation Using Google Assistant.

Figure 5 shows a flowchart of the system programming for the overall process to turn on and turn off the output device by using the GUI. As long as the smartphone is connected to the internet, the GUI can be accessed anywhere, making this a flexible system. This GUI operates in various languages according to the user's preference or referral. The system will start after the icon is pressed. Then, the application will send the command to the client, the Raspberry Pi, through the internet. After that, a command to turn a light on or off will be applied from the button inside the GUI. When the script passes the command to turn on the light, the data is transmitted to the Raspberry Pi, and it will trigger the relay. The system also forwards status update to the server whether the light is already switched on or off.
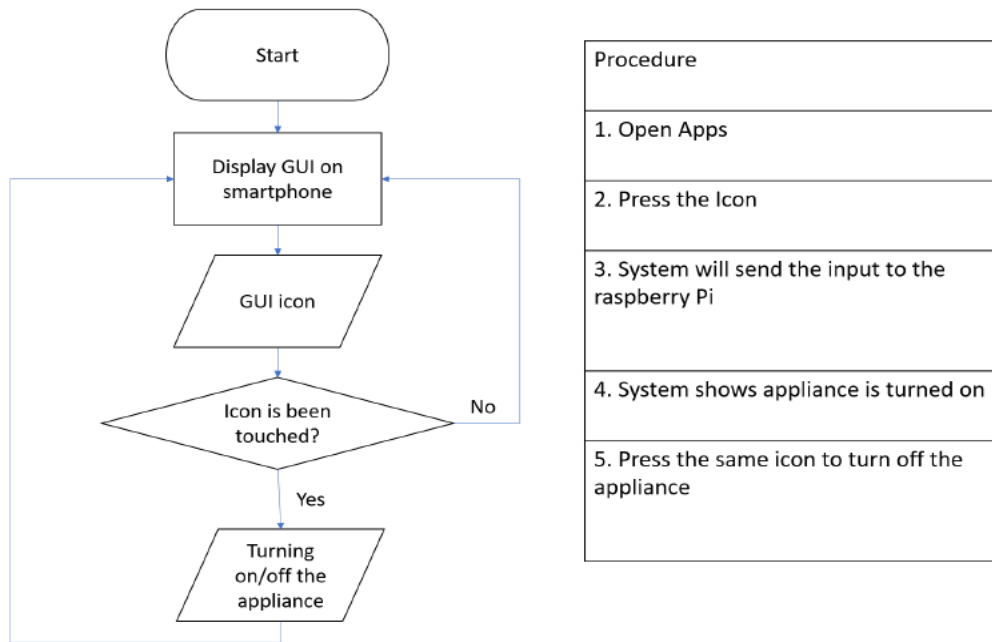
Figure 5. Flow Chart for Mobile Apps.

Figure 6 shows the flowchart for home automation using Google Assistant. Google Assistant can be activated by pressing the home button or home icon on the phone for 2 seconds. Hold the button and Google Assistant will pop out to help. Alternatively, user should also be able to start Google Assistant by uttering the word "Ok Google". The light that connected to the relay can be turned on by saying the command such as "Turn the lights on" or "Lichter an", Google Assistant will show its acceptance through voice command followed by displaying "turning on the light". It will try to verify the command given from the database and if it matches, Google Assistant will send the command to the Raspbery Pi to trigger the relay so that light gets ON. Likewise, turning off the light is done by saying "Lictenaus" and the commands are processed in the cloud, giving the necessary output. Similarly, home gadgets like aircond, fan and lights can be controlled through the internet without physical contact with the gadgets.
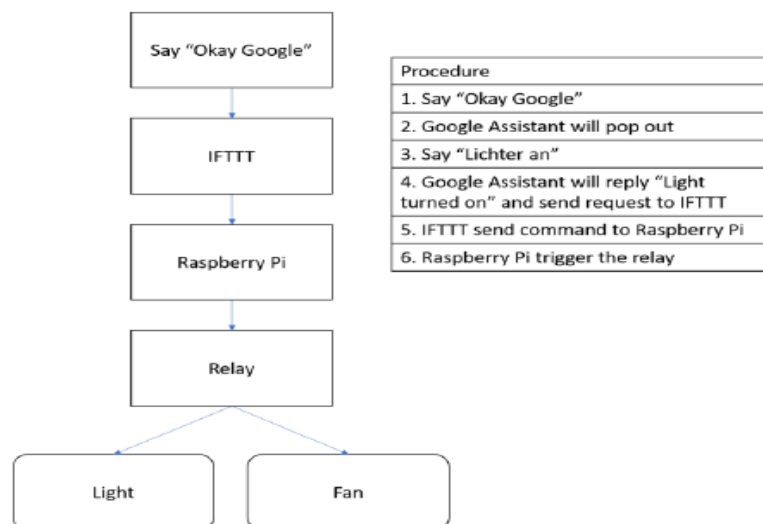

Figure 6. Block Diagram for Google Assistant.

4. CONCLUSION

The integration of multi-language voice recognition IoT Smart Home into Google Assistant system has been introduced in this study. This integration of a variety of languages into a smart home system would benefit the disabled people, elderly, and those who are not able to understand or speak the English language. A smart home or home automation can be implemented as a means to assist the owner in doing house chores and in facilitating advanced control on the home appliances. For example, the users can automatically and turn on the light or any other electrical appliances using a remote controller or voice recognition. The tasks can also be done remotely outside their home. After the project development, it is hoped that the language barrier will no longer be a restriction to those who do not understand the English language. Currently, the existing IoT home automation system only provides the instructions and commands via the English language. This project has proposed a better way to upgrade the existing system. The simulation of IoT technology features within a home automation system enables a novel possible way to connect the electrical devices such as smartphones, computers, and tablets, with the system's ability to monitor, control, and alert. Moreover, a flexible and cost-effective home monitoring and controlling system has been designed, which mobile application services are integrated as an interoperable system to connect the users and the home devices remotely. The project will be using the Google Assistant system, which will be merged with a variety of languages through the voice recognition feature in order to control the system. The selection of Google Assistant is due to its reliability and stable technology that can adapt to the modern system. Moreover, the huge number of Android smartphone users is one of the main reasons why Google Assistant is accessible and convenient to be integrated with home automation development. Besides, Google Assistant can also be installed by using an iPhone. Hence, the decision to bring in Google Assistant into the project would be the right decision. Apart from that, there are several studies that analysed the usage of Raspberry Pi and open source software as one of the platforms that can be used to control devices at home. The usage of those platforms can help the users to customize the program that can benefit them accordingly to their needs. In the future, if IFTTT allow more languages supported in their program, a smart home system in Bahasa Melayu can be achieved. In conclusion, the proposed system is more advanced in terms of its scalability, flexibility, and security point of view than the existing Smart Home systems in the current market.

ACKNOWLEDGMENTS

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