Original Research Paper

Smart Home Automation System Using IOT

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Abstract: While the cost of living is going up, there is a growing focus to involve technology to lower those prices. With this in mind the Smart Home research allows the user to build and maintain a house that is smart enough to keep energy levels down while providing more automated applications. This concept can be suitably included to make our house smarter, saver, energy efficient and automated. This research focuses on building a save, automated system by using the internet connection that will smartly control the appliances like Lights, Fan, and other electrical appliances in our home. A smart home will take advantage of its environment and allow seamless control whether the user is present or away. This paper helps in saving the cost of electricity at home as well as saving the environment using wireless connections. With a home that has this advantage, you can know that your home is performing at its best in energy performance. By implementing this system, it is possible to explore a variety of different engineering challenges, including software programming arduino IDE, Wi-Fi, nodemcu, relay module, jumper wires and DC supply power. It can be control through smartphone. With prototype model, standard updates are basically a requirements. However, based on the result, this automation system provides great insights to the challenges of software and hardware design.

Keywords: Arduino, Industrial Revolution 4.0, Internet of Things, Smart Home.

1. Introduction

The theory of Smart home technology has been around for a long time while, though the practical concept was practice since early 2000. During this time smart home devices became more affordable and emerging to technology [1]. This first-ever fully automated smart home was created by Emin Mathias in Jackson, Michigan in the USA, to be known as the "Push Button Manor" which it controls every electricity consumer in the house by the remotes. It was the only home in 1950 that reached a complete state of automation. But sadly truth, Mathias never put his system up for sale in the market.

Back to today's homes require sophistication control in its different gadgets which are basically appliances. This is because the area of home automation with respect to an increased level connectivity of affordability and simplicity through the integration of home appliances with smart phone and tablet connectivity. Smart phone as android are already feature-perfect and can be made communicate to any other devices with a network connectivity through app/system in android.

Nowadays, as we know there is a lot of electricity loss in homes due to the fans and lights that are kept on even when no one is present in the room. So here, my idea is basically to inform or control a user that when he leaves his/her home, if any of the basic appliances like the fans or lights, televisions or air conditioners are left on accidentally, which are the basic and major electricity consuming appliances of our house. Some appliances like televisions and air conditioners consume electricity even when just their switch board switches are on, it isn't much but a cumulative sum of a 1000 houses with the same condition would be a large enough number.

Basically, Smart home uses arduino/node mcu processor that automates the whole monitoring of conditions of the house and also change the condition of other devices (Home automation). This research forward the design of smart home automation using android smartphone or tablet. This research uses nodemcu processor that automates home with connected to components and sensors. The running android in any smartphone connected to a network can access the status of the home appliances via a system. It presents the design and implementation of home automation system that can monitor and control home appliances via android phone or tablet.

Overall this research is for include centralized control of lightning, other household appliances which uses electricity to provide improved convenience, comfort, energy and efficiency. In today's technology world, home automation is being popular due to easiness, flexible means of viewing/monitoring and controlling the appliances, saves cost, reduce wastage, and make sure users comfort of the needs.

Energy consumption can be measured through its environmental impact and usage which is mainly contribute to amount of power consumed by the load side of an electrical circuit is termed energy consumption. When the electric circuit power is used more than the total power that generate in the transmission line, it requires more energy than the source provide and it becomes major issue, which results in load shedding and blackouts. So, for overcome this, smart home automation leads to control of energy according to human. When, we don't require electric circuit such as light, fan or television it automatically gets switched off and thus save power and cost of electricity. Smart Home is essential to make it cost effective and easy to configurate, if it used by people at home around the world and then it will be willing used to acquire it in offices, schools and all around other places that used electric circuit. Smart home automation provides energy efficiency, ease of use, lower in cost and adopted in technology.

2. Literature Review
2.1. Smart Home

Smart home is not new new term for science society however, it is still for more away from people's vision and audition. As electronic technologies are converging, the field of home automation is expanding. Smart home automation is very popular due to its numerous benefits in most area or house. These techniques will control all the electronic devices which will reduce the human involvement to get minimize. It will provide various benefits such as good safety, comfort, lower cost, more rational use of energy and other resources contributing to a significant saving. The system is very friendly with the dramatic increase in smart phones users, which is smart phones have gradually turned into portable devices where the people can provide for their daily. In this research, a low cost wireless controlled smart home system for controlling and monitoring the home environment.

A home automation system makes the operations of various home appliances more convenient and saves energy. With the energy-saving concept, home automation or building automation makes life very simple nowadays. It involves automatic controlling of all electrical or electronic devices in homes or even remotely through wireless connection. Centralized control of lighting equipment, air conditioning and heating and all other equipment used in home systems is possible with this system.
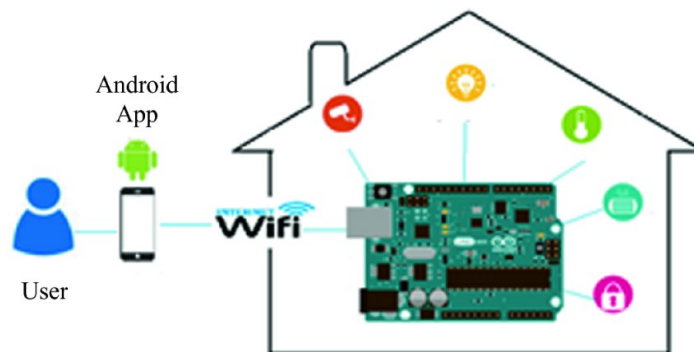

Figure 1. Home Automation System

There is also a system is mainly implemented by sensors, controlling devices and actuators. The sensors detect light, motion, temperature and other sensing elements, and then send that data to the main controlling devices. These sensors can be thermocouples or thermistors, level sensors, pressure sensors, current transformers, IR sensors and manymore which need additional signal conditioning equipment to communicate with the main controller.

Controllers may be personal computers/laptops, and smartphones, attached to the controlling devices like programmable logic controllers that receive the information from the sensors, and based on the program, control the actuators. This program can be modified based on load operations. The programmable controller allows connecting various sensors and actuators through various input and output modules whether they are analog or digital. Actuators are the final controlling devices like limit switches, relays, motors, and other controlling mechanisms which finally control the home equipment. Communication plays an important role in this home automation system for remote access to these operations.

Home Automation Systems consists of three types, which are:

1. Power Line Home Automation System
   This automation is inexpensive and doesn't require additional cables to transfer the information, but uses existing power lines to transfer the data. However, this system involves a large complexity and necessitates additional converter circuits and devices.

2. Wired Home Automation System
   In this type of automation, all the home equipment is connected to the main controller (programmable logic controller) through a communication cable. The equipment is attached with actuators to communicate with the main controller. The entire operations are centralized by the computer that continuously communicates with the main controller.

3. Wireless Home Automation
   This is the expansion and advancement of wired automation which uses wireless technologies like IR, Zigbee, Wi-Fi, GSM, Bluetooth, etc., for achieving remote operation. As a practical example, the following home automation system research, in which loads are controlled by a touch panel, is very informative.

There are few importance of home automation system, namely [1]:

1. Safety
   The ability to control small appliances and lighting with your fingertips anywhere you are will add safety in your home. You can make sure appliances are off when it's needed to be off and on when it's needed to be on.

2. Convenience

The ability to control everything with your fingertips is very convenient. You never leave the house without your wallet, keys and of course your smart phone. With our smart phone always with us, we can easily monitor our home and control everything with just touch of a finger.

3. Save Time

Since we are living in a very fast-paced environment, we don't even have time to worry about our home. With home automation, we can save time going back to our home and make sure everything is order, like if the kids or anyone at home turn on/off the lights, fans when they are use it or not use it when you are not at home.

4. Save Money

This is the biggest advantage of home automation. With the ability to control the light, whether turning on/off on specific time will saves homeowner a great ton of money. You can save money through household temperature, with proper automation of fan device at home. In addition, you can save electricity, by not driving back home if you forgot to turn off any appliances at home.

2.2. Internet of Things

The term 'Internet of Things' is represent electrical and electronic devices, of varying sizes and capabilities, that are connected to the Internet.The scope of the connections is broadening to beyond just machine-machine communication (M2M). IOT devices employ a broad array of networking protocols, applications and network domains. The rising of facilitated by physical objects being linked to the internet by various types of short range wireless technologies such as Zigbee, RFID, sensor networks, arduino and manymore. IoT will make the impact of the internet even more pervasive, personal and intimate in daily life. According to the CISCO Internet Business Solutions Group (IBSG), when more inanimate objects were connected to the internet than human users, the IoT entity was achieved.
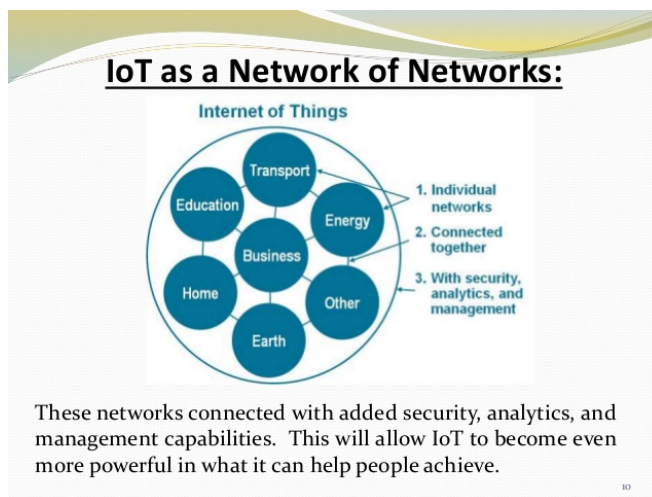

Figure 2. Internet of Things

Internet of Things become important part in our daily life, some of the interesting research using IoT can be seen below:

- Zariman, et al [2] develop a garbage monitoring using Arduino and ESP WiFi that can be used in the garbage management system in the city.
- Azahar, et al [3] develop intelligent egg incubator using Arduino Uno, PIR Sensor, and ESP8266 that can be used to control the temperature of the incubator.
- Ismail, et al [4] develop smart water level indicator using Arduino Uno, Servo Motor, and NodeMCU ESP32 that can be used to provide early warnings and control the dam of the river.
- Husin and Hisham [5] develop smart charger that can be used to control the charging time to preserve battery lifetime.

- Latif, et al [6] develop smart mirror using Arduino Uno, Raspberry Pi 3, and NodeMCU that can be used to provide latest news updates while the user do activity in front of mirror.
- Ghani and Zariman [7] develop smart cane to help provide safe navigation for user with vision disability.
- Hazhari, et al [8] develop smart delivery that help delivery items faster.
- Azizi and Zariman [9] develop health display based on ESP 8266 NodeMCU and pulse sensor to help display pulse rate.
- Saidatin, et al [10] develop automate feeder using ESP 8266 to help feeding birds.
- Hermansyah, et al [11] develop a remote monitoring and control system to switch main energy source to backup when main source goes out.

In today's time, there are multiple of standards and protocols implemented by industries. Each company is trying to implement their own technology into the market. Internet of Things (IoT) is the communication platform for light-weight microcontroller based devices. Each company or industries has its own unique way of implementing IOT based solutions. Some have their Zigbee based routers needed to communicate with their in-house manufactured devices, whereas some industries use Wi-Fi as its base wireless network, connected android or iOS connected with sensors and arduino and bluetooth also widely used for designing IoT based networks.

So, what is important here is fragemented in current times, which include Wi-Fi, Zigbee, Bluetooth, Arduino, Sensors, and other wireless techniques to from a dedicated small network of Internet of Things (IOT) [12].

Internet of Things is mainly about connected devices embedded in our everyday environment. Typically, 'interaction' in the context of IoT means interfaces which allow people to either monitor or configure IoT devices. Some examples include mobile applications and embedded touchscreens for control of various functions suxh as heating, lights, and energy efficiency in environments at homes and offices. Interaction in such applications is still quite straightforward, mainly consisting of traditional graphical interfaces, which often leads to clumsy co-existence of human and IoT devices. Thus, there is a need to investigate what kinds of interaction techniques could provide IoT to be more human oriented, what is the role of automation and interaction, and how human originated data can be used in IoT [13].

1. Short Form

    Short form interactions occur when a user is not satisfied with current physical conditions, such as when the thermostat is set to too warm or too cold of a temperature. This is an immediate and urgent issue for the user and is one they are willing to spend time fixing. Since the user did not anticipate this need of interacting with the system, it is important to resolve the issue quickly since the user is likely already in a negative mental state and likely have not allocated mental time for interaction. This user's interaction with the system should be complete within 5 to 15 seconds.

2. Medium Form

    Medium form interactions occur when a user consciously decides to interact with the application. There are two goals the user has when performing this type of interaction, planning for future events and changing the recurring scheduling. These interactions differ from short term interactions in that the user has allocated mental time to perform the change and has recognized that the change is part of a consistent and ongoing action. Therefore, these interactions should take between 15 and 30 seconds.

    On occasion, a user will want to make a temporary change to normal operation. When performing these changes, it is essential that the user understands how the current system is functioning so they know what change they have to make. Once they have identified the deficiency, they should be able to change it quickly and validate that the system has been modified. The primary goal of this system is to use sensor and short-form interactions to inform the user about the exact medium-form recurring system correction, without the user having to expend effort in deciding what they want changed and how to change it.

3. Long Form

    Long form interactions should rarely, if ever, occur. These are actions that 30 seconds or more. Examples of these interactions might include modifying temperature limits and naming rooms. This long form interactions are only performed by a user on initial setup of the system.

2.3. Components of Internet of Things

Nowadays, we can see a lot of research that implied IoT concept. There are many components that the developer use to build an IoT.

2.3.1. NodeMCU

NodeMCU is an open source LUA based firmware developed for ESP8266 Wi-Fi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. NodeMCU Dev Kit/board consist of ESP8266 Wi-Fi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Expressive Systems with TCP/IP protocol NodeMcu is an open-source development board, based on famous ESP8266 chip, which is a 32-bit controller with built-in WiFi transceiver. And it is very low cost. Best of all, this board is Arduino IDE compatible, you can utilize the millions of example code and library on NodeMCU. Besides Arduino IDE or Arduino programming langauge, NodeMCU supports many other languages like LUA script, microPython etc. With these scripting languages, you can develop your prototype within a few script lines [14].

2.3.2. Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, Mac OS, Linux) that is written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring research, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware [15].

3. Methodology

Based on the study, the author compared few methodologies to produce this research. The methodology being compared is Prototyping, Agile and Spiral Model [16] [17] [18].

For this research, we chose to use Prototype model. Prototyping model is a software development model in which prototype is built, tested, and reworked until an acceptable prototype is achieved. It also creates base to produce the final system or software. It works best in scenarios where the research's requirements are not known in detail. It is an iterative, trial and error method which takes place between developer and client. The any new developing system requirements are defined in as much detail as possible. This usually involves interviewing a number of users representing all the departments or aspects of the existing system. A simple quick design is created for the new system. A first prototype of the new system is constructed from the the quick design. This is usually a scaled-down system, and represents an approximation of the characteristics of the final product. The users thoroughly evaluate the first prototype and note its strengths and weaknesses, what needs to be added and what should to be removed. The developer collects and analyzes the remarks from the users. The first prototype is modified, based on the comments supplied by the users, and a second prototype of the new system is constructed. The second prototype is evaluated in the same manner as was the first prototype. The preceding steps are iterated as many times as necessary, until the users are satisfied that the prototype represents the final product desired. The final system is constructed, based on the final prototype. The final system is thoroughly evaluated and tested. Routine maintenance is carried out on a continuing basis to prevent large-scale failures and to minimize downtime.
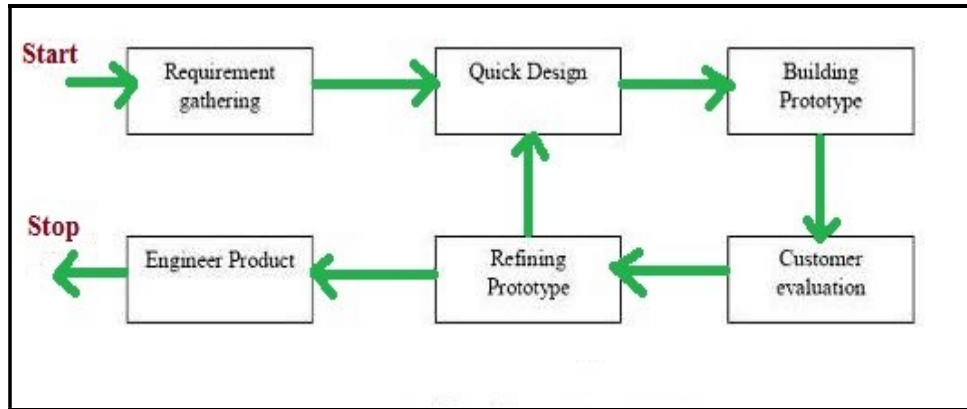
Figure 3. Prototype Model

In the second phase, a preliminary design or a quick design created. However, it is not a complete design. It gives a brief idea of the system to the user. The quick design helps in developing the prototype.
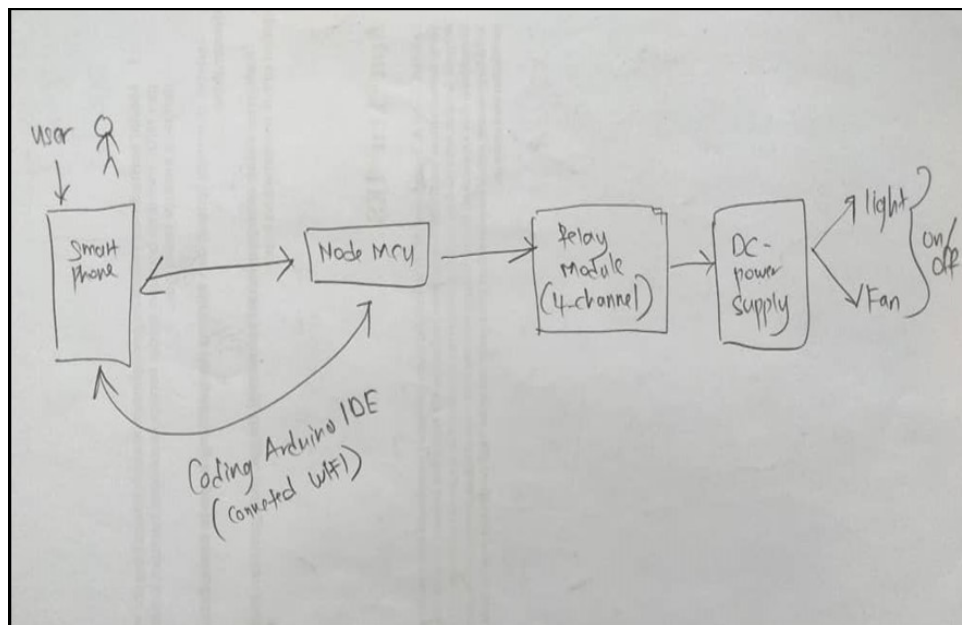

Figure 4. Sketch Diagram for Smart Home Automation System

4. Finding and Discussion
4.1. Product of Smart Home Automation Using IOT
Figure 5 shows the product of smart home automation using IOT

4.2. Evaluation Testing
An evaluation testing carried out by evaluation survey using Google Form and those who have tested the product. This survey consists of few sections which are Usability, Functionality, Easiness, Compatibility, Understanding, Knowledge and Product Impact. There are almost 7 questions was asked to 10 respondent, no limitation ages who tested my research. Majority of them chooses Very Satisfy with the research where people can turn On/Off the Home Appliances anytime and from anywhere in easy way through their smart phone.

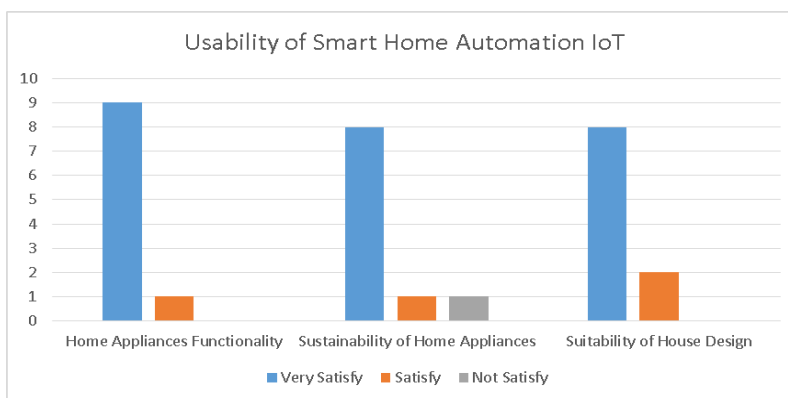Figure 5. Product of Smart Home Automation Using IOT

Figure 6. Usability Testing of Smart Home Automation IoT

Ten people was chosen as a respondent for the product which is no limiting ages and people surrounding. First, 9 over 10 people agreed that Home Appliances Functionality is worked with very satisfy while only 1 choose only satisfy answer. Functionality of the light and fan is working with good condition and respondent is very satisfy with it. Respondent also test it from anywhere, anytime and this make them this product useful for current and future generation because people tend to realized that they are often forget turn on/off the electricity in their house. Second, 8 over 10 people very satisfy with the Sustainability of Home Appliances while 1 people choose only satisfy and 1 more people choose not satisfy with sustainability. Sustainability of Home Appliances is about growth technology or economic and this make 2 respondent did not understand the meaning of the word. Third, 9 over 10 people very satisfy with suitability of House Design while 1 people choose only satisfy with house design. The House Design is suitable for the based research and it looks like a real house with the light and fan working well in the house. The respondent choose the answer preferable for their knowledge and understanding.
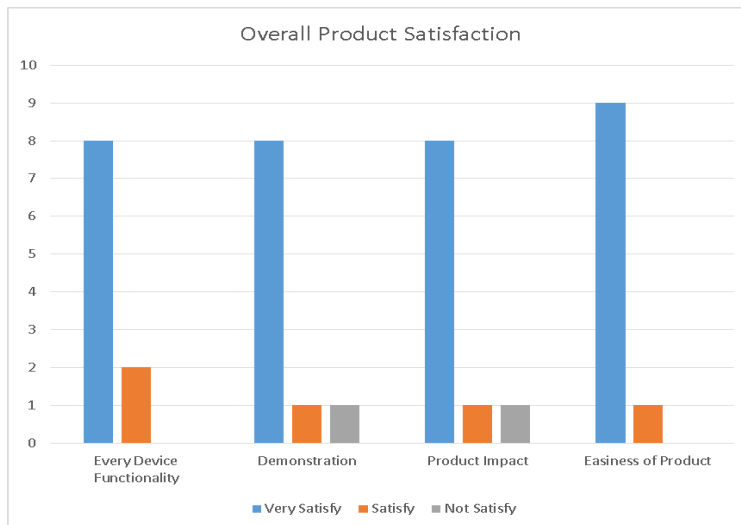
Figure 7. Product Satisfaction of Smart Home Automation IoT

Ten people was chosen as a respondent for the product which is no limiting ages and people surrounding. First, 8 over 10 people agreed that Every Device Functionality that used in the research is worked very well include back side and in front side of the product and very satisfy while only 2 choose only satisfy answer. Functionality of the light and fan is working with good condition and can see the changes the light as well it uses different color of the light with turn on/off the lights and respondent is very satisfy with it. When in this research the back side devices give responses and make this research become success. So the compatibility with the devices working perfectly each other. Second, 8 over 10 people very satisfy with the Demonstration of the Product while 1 people choose only satisfy and 1 people choose not satisfy. Respondent understand the research well with the functions and devices working perfectly and they agree this is one of the easiest IoT to be used. Since it related to the Internet of Things as this research dependable to Internet. Third, 8 over 10 people very satisfy with the Product Impact while 1 people choose only satisfy and 1 people choose not satisfy. Impact towards this product can be satisfy the respondent with several of the aspect such as impact towards user easiness or understanding, technology and economic growth. Lastly, 8 over 10 people very satisfy with the Easiness of the Product that can be used in this research while only 2 choose only satisfy answer. This research can be used by all ages, no limiting ages as it is safe for all the people. People can easily use blynk application to turn on/off the home appliances using smart phone. Knowledge of using smart phone is preferable. The respondent choose the answer preferable for their knowledge and understanding.

5. Conclusion

The first objective of this research is to any state error that could affect the whole system. There are several activities that have been done to achieve the first objective. The activities are gathering the requirements, analyze the requirements and lastly document the requirement. All of the activities are done by interacting with distribute the questionnaire, observing the existing application and reviewing the existing documents resulting in delivering the deliverable for the first objective. Next, to design the suitable diagram for the guideline in development phase. After all requirements had been collected, it must be proceeded to design phase where the development part can have the guideline on how to build the research and meet the requirement. The next objective of this research is to develop a complete system. As the system is completed, the final objective is achieved. Lastly, the research that have been made must be test to ensure the requirement that been gathered earlier had been reached to give full satisfaction to the user who use Rumah Pintar.

With the objectives have been achieved, the significance of this research can extend in the future. To the researcher who are interested in in continuing this system, there are several suggestions for this system that can be done:

1. Smart Mirror with Smart Home Automation
2. Smart Home with Voice Control/Assistant
3. Add security alarm or finger print onto the system to increase the security.
4. Add other more home appliances with connectivity of sensors so it can notify the users with various of aspects
5. Build my own app that can accommodate this research instead of using a built-in app, such as Blynk.

All of the recommendations are recommended as it can enhance the systems to be more efficient and can help with the productivity in the industry and future generation.

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