Technology Information System Project: Smart Home System

Group Members	
Airil Haziq	A21MJ5034
Ahmad Jalkhan	A21MJ5007
Muhammad Hazman	A21MJ5039
Nik Aishah	A21MJ5035

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Abstract

The coming of the fourth industrial revolution has brought in many forms of technology that affects everyone from all fields with one of them being the internet of things (IoT). From our findings through literature review using qualitative research, IoT allows devices to communicate and work with each other hence allowing automation and has been used in various industries like transportation, healthcare and agriculture. There are many ways of deploying IoT, such as WiFi, Bluetooth and the one currently we are proposing, through the use of ZigBee, a low powered mesh network system that is suitable for a home IoT system. Our project, Smart Home System utilises IoT in order to automate household chores in order to ease our client's increasingly busy lifestyle, benefiting average homeowners from, new families to couples and industries alike and utilising cloud architecture to design, host and maintain our system.

1. <u>Introduction</u>

It is in human's nature to innovate and invent new things. As we progress further into the years, more technology innovations would be produced until at a certain point, the advancement would be really crucial that it would result in an industrial revolution. These can be seen from the past revolutions that saw the birth of steam power through the first industrial revolution during the 1780s or the rise of electrical energy that resulted in mass production during the second industrial revolution in the 1870s.

1.1. <u>The Fourth Industrial Revolution</u>

The 4th Industrial Revolution (4IR) follows up the third industrial revolution that began in the 20th century during the 1970s, which eversaw the usage of automation, computers and electronics. What distinguishes the 4IR from the third is that 4IR has a faster pace of advancement, a larger scope of technologies and wider impact on the world. One that could potentially bridge the gap between the physical, biological and digital world.

As said before, 4IR covers a larger scope of technologies. These include but are not limited to Augmented & virtual reality, big datas, Internet of Things, artificial intelligence and the clouds. In this report, we'll be focusing on the usage of Internet of things or commonly known as IoT for our project. IoT has many applications and are used in all sorts of industries ranging from manufacturing, transportation, energy, retail and infrastructure planning for cities.

1.2. <u>Selection of 4th IR Technology</u>

IoT is essentially a platform that allows embedded devices to connect to the internet in order to exchange and collect data with other devices. In other words, it paved a way for devices to collaborate, learn and interact with each other. With this in mind, it unlocks countless possibilities of an intelligent network of devices. A great example of the usage of IoT is wearable devices. It allows for a combination of smart watch, heart rate monitors, fit bit and even other health monitoring features like glucose level. A bigger picture of the use of IoT is the term Smart Cities. Smart cities are equipped with smart infrastructures like street lamps, and smart management systems for monitoring air quality, traffic and wastes. The initial concept of IoT can be traced back to the mid-1800, specifically 1832 where the first electromagnetic telegraph was

designed based on the concept of connected devices. The field of study continued to gradually improve and solidify before it received its biggest leap in 1999. This was when the term "Internet of things "was coined by Kevin Ashton. IoT was described as a technology that worked by connecting several devices using the help of supply chain management by RFID tags. The idea of RFID-based device connectivity has diverged from today's IP based IoT; however, this breakthrough paved the way for the overall development of the Internet of things in the historical and technological aspects.

Modern understanding of the term "Internet of things" started to make headlines at the beginning of the 21st century, with the help of media, widespread from multiple named outlets creating an interest in IoT technology for the vast majority of society. These instances led to the 1st International Conference on the Internet of Things which was held in Switzerland in 2008. The IoT became a solid household name in the technology department in the 2010s, with the 1st mark in the field seen with its addition to the Gartner Hype Cycle event in 2011.

Since then, the dependency on IoT has reached new heights every passing year. Global tech giants worldwide have focused their efforts on developing new technology based on the understanding of IoT, leading to the extensive usage of IoT in various industrial markets such as manufacturing, transportation, healthcare, retail, agriculture, energy production and many more. The IoT revolution has arrived, and the future looks to be shaped into the idea of IoT itself.

1.3.   Uses/deployment of methods of IoT.

1.3.1.   RFID

Radio Frequency Identification (RFID) is a technology under the IoT umbrella that uses radio frequencies to transmit data. Data transmission is made possible by RFID tags that are inputted in respective locations/spots. There are 2 types of RFID tags: passive tags without an internal power supply, while active tags are those with an internal power supply.

1.3.2. Wi-Fi (IEEE 802.11)

Wi-Fi is a wireless medium that sends/receives data, signals, commands etc.… This deployment medium is globally accepted and understood to be the default service found in smartphones, laptops, tablets etc..

1.3.3. ZigBee (IEEE 802.15.4)

ZigBee is a wireless technology that utilises low-cost, low-power wireless IoT networks. The low power usage enables the ZigBee device to send data while passing through intermediate devices, creating a mesh network in the process. ZigBee allows for a more secure network connection while ensuring a long battery power backup.

1.3.4. Bluetooth

Bluetooth is commonly found in mobile devices, tablets and so forth. It is an open wireless technology, considered one of the earliest forms of modern IoT usage. It allows for seamless interconnectivity, which allows it to be versatile in its usage, as seen by the number of devices with this feature built into it.

2. Problem Statement

As we edge closer towards the future, human beings become busier hence the day to day tasks in our home could sometimes prove to be a hassle. As a solution to this, the Smart Home System harnesses the capabilities of computer technologies and combines it with household appliances which enables intelligence and automation for house chores ranging from security work to small tasks. It is a system that encourages cost, time and energy efficiency.

2.1. Project Objectives
● To study the challenges in repetitive house chores.
● To design impactful Smart Home System features.
● To develop game changing IoT technologies.

2.2.   Expectations

● General knowledge on how IoT applications work, including hardwares, softwares, its benefits and backdraws.

● Current market and prospects of IoT products

● Key things to consider when proposing and creating projects.

2.3.   Limitations

● The cost of installation, integration and compatibility

● Vulnerability of hacking and other security issues

● Latency, bottlenecks and capability for continuous interactions

● Ability and expertise to implement hardwares and softwares like Zigbee, Arduino, Intel Galileo or Raspberry Pi.

3.   Project Planning

3.1.   Task allocation

The first step in our project planning is task allocation. This step is important in ensuring that each member has a designated amount of work and that the workload flow can be shared fairly among each member.

Designated Task	Group Member
Introduction, Part of Description, Low-fidelity mock-ups & Conclusion	Ahmad Jalkhan
Selection of 4th IR technology, Steps & Part of Description	Airil Haziq

Potential Client Identification & Business process flow diagram and its description	Nik Aishah
Cloud Architecture Planning and Design & AWS	Hazman

3.2. <u>Research of 4th IR</u>

The second part of our project planning is identifying, analysing and conducting thorough research on the 4th IR phenomenon. This investigation and research are conducted so that we as a group have a better understanding of the topic at hand and decide on the technology that we eventually used on our project.

3.3. <u>Smart Home</u>

3.3.1. <u>A Home Automation System</u>

After extensive research, we as a group decided to choose a smart home as our 4th IR technology. This is because we came to the realisation as to how much potential this system has towards the future of home planning. We also understood the precision and efficiency this technology has to ensure comfortability and assurance to the user. We believe that creating a simple archetype of this technology will create an understanding parameter that everyone with even a small interest in the subject matter can appreciate.

We are creating a system that automates small repetitive tasks like turning on and off switches, ensuring locked doors and windows or controlling fan or air condition temperature. It starts from user interaction from user's devices like laptop or mobile devices, which then moves to the internet, into the cloud system that will transmit it to the receiver and onto the devices using a proposed ZigBee network. The reason why we chose ZigBee as our form of base technology is because of the practicality as well as strengths it brings to our smart home system. Zigbee allows for mesh networks that are proven to house a larger reach than any one form of radio. These mesh networks can also self-configure automatically. This self-configuration also

includes repairing itself if the nodes are disabled or removed. Zigbee, being an interoperability standard, allows for a universal form of communication as devices from different manufacturers can communicate in the space given. This acceptance, along with the modest cost, allows us to achieve a home automation device that is efficient and stable in any consumer-based product.

3.3.2. Details

Firstly is security. The ability to observe the CCTV system on the go and control the status of locks installed throughout the house. The Smart Home System will also have sensors that can indicate the level of dangers that enter the house.

Next is a lighting control system. The lighting control system is a feature that allows the user to control the lighting within a space that is covered by the smart home system. This process can be done by using the phone to connect to the occupancy sensors around the area and allow the user to control the amount of light or simply whether the light is on or off.

Another feature that we have included is the Temperature control system. This system allows the user to control the functionalities of air conditioners and fans in the smart home system. This includes the fan speed and the general temperature control that is available, all of this without the need to personally go to the wall switch.

Lastly is the hub. The control hub allows the user to connect to different available apps in the system, ala AI-generated control like Amazon's Alexa technology. The user can connect to apps such as Spotify and Netflix, allowing for a better control experience without the need for individual controllers. This feature also includes a voice trigger where the user can control the system with only their voices.

4. **Business Process**
4.1. **Potential Clients**
4.1.1. Individuals

Homeowners can install this as one of the security systems in their house. It would connect to the homeowners devices therefore it can quickly update them of any trespassing and

any suspicious activity. This system would also connect directly to the police so if the system is breached, it would immediately place an emergency call to the police. This will reassure security and safety for homeowners.

This smart home system can also assist in audio systems, lighting, telephone and temperature controls. This would make it easier for homeowners to dim their lights or turn on their air conditioner and control the temperatures. Homeowners with families can connect a speaker and phone in each room and make announcements for mealtimes.

4.1.2. For Real Estate Professionals

Real estate professionals and realtors can install the smart home systems to attract future house buyers with reassured safety and high tech homes.

4.1.3. Commercial

Commercial automation industry will also benefit from our smart home system. Commercial automation is a technological system used to regulate many components of a building. Businesses can implement commercial automation in their buildings through our smart home system. This system will automatically centralize the building's heating, ventilation and air conditioning, electrical, lighting, access control and security systems. Our system is also more affordable than the usual Building Automation System (BAS) so companies will be saving more money.

4.1.4. Industrial

This smart home system will also appeal to the industrial automation industry. Our system would make a smart factory with our IoT application. Our smart home system will also be connected to both wifi and a standard wired connection technology in order to assist in diagnosing and problem solving through big data collection and networks of all the machines in the factory so any issue can be detected easily. Another appeal of our system is that it can be used to predict and optimize the production process by implementing the more efficient and greener method in manufacturing. Besides, energy management, optimizing lighting and heating

and workers' general comfort are also assured. Security is also ensured through maintenance automation and predictive maintenance suggestions. This will reduce the chances of machine failure which can harm factory workers. Our smart home system also improves alarm systems to guarantee employee safety.

4.2. Process Flow Diagram

4.2.1. Customer or Home Users
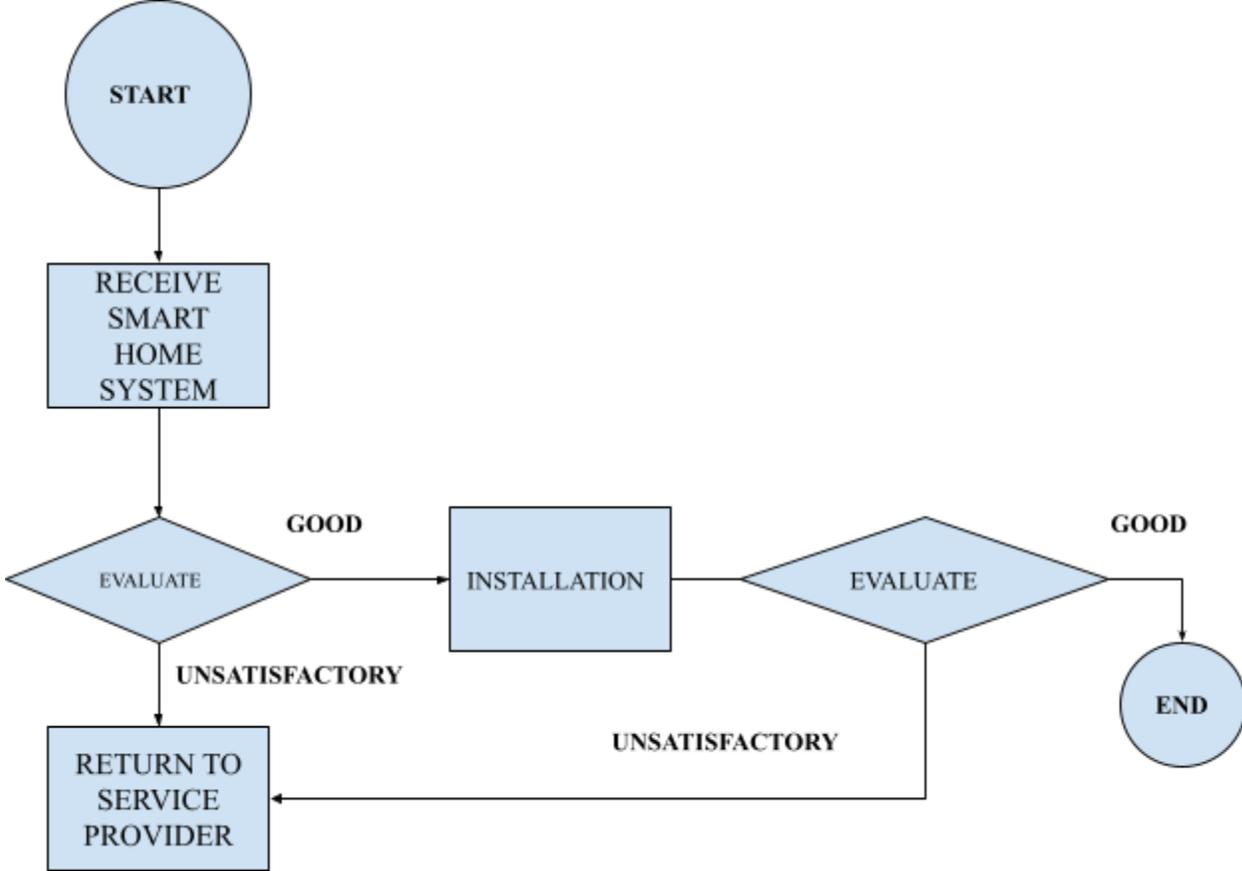
4.2.2.   Service Provider
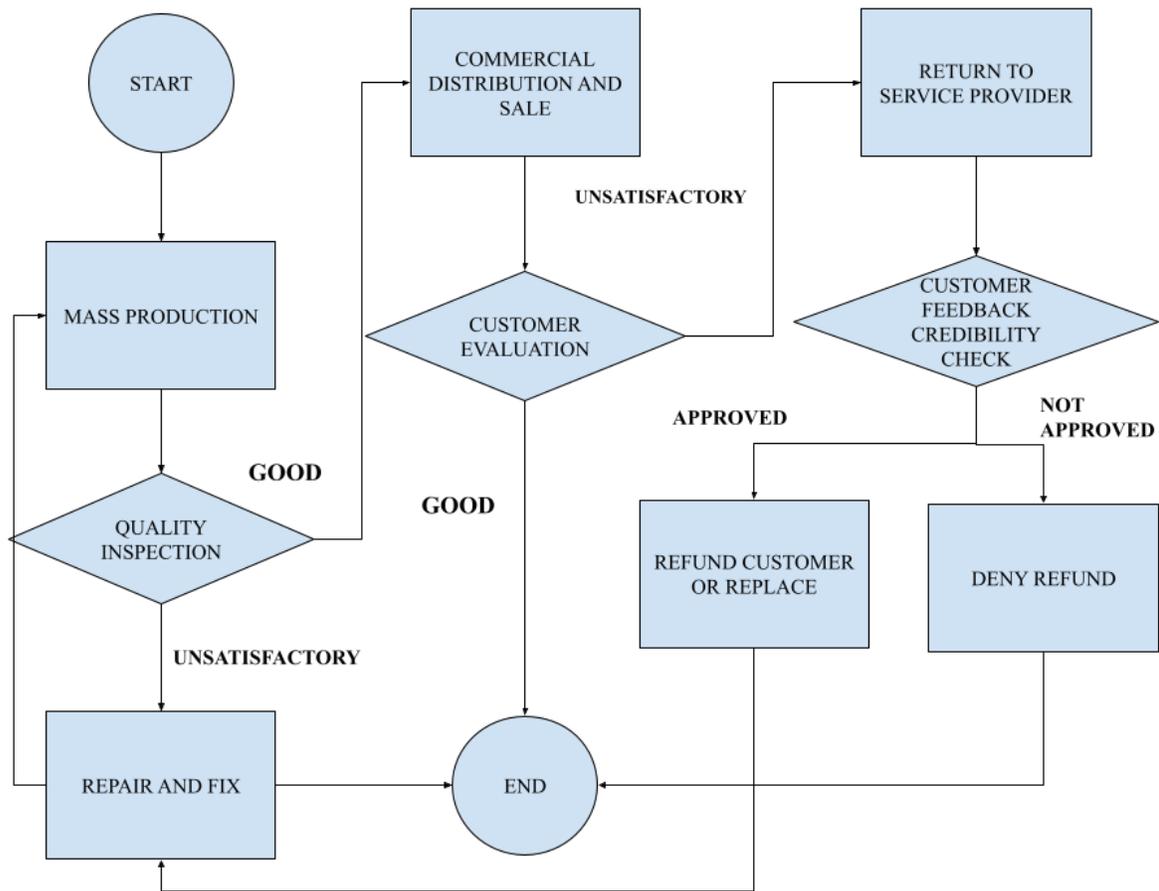
5. **Low Fidelity Prototype**

5.1. **Rough Sketches**
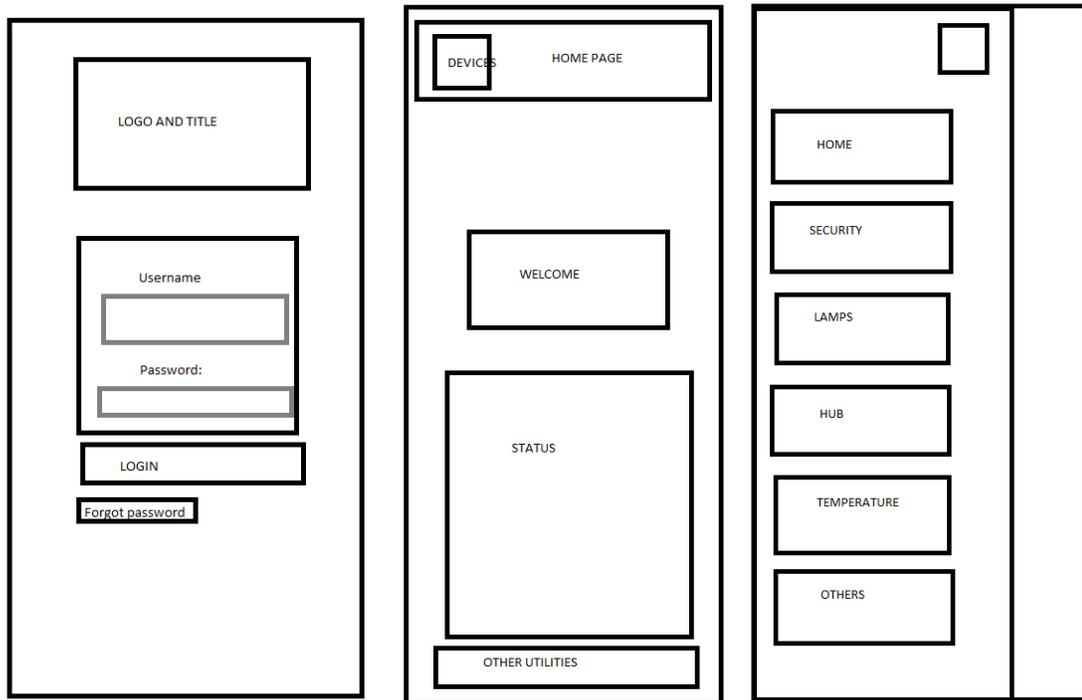
The first picture refers to the login screen where users will login using their account together with their password. Next is the home page, where the user will be welcomed and a few information such as current weather will be displayed, while status refers to the current status of the devices, from here users can select devices that they have installed, based on its categories to see their status.

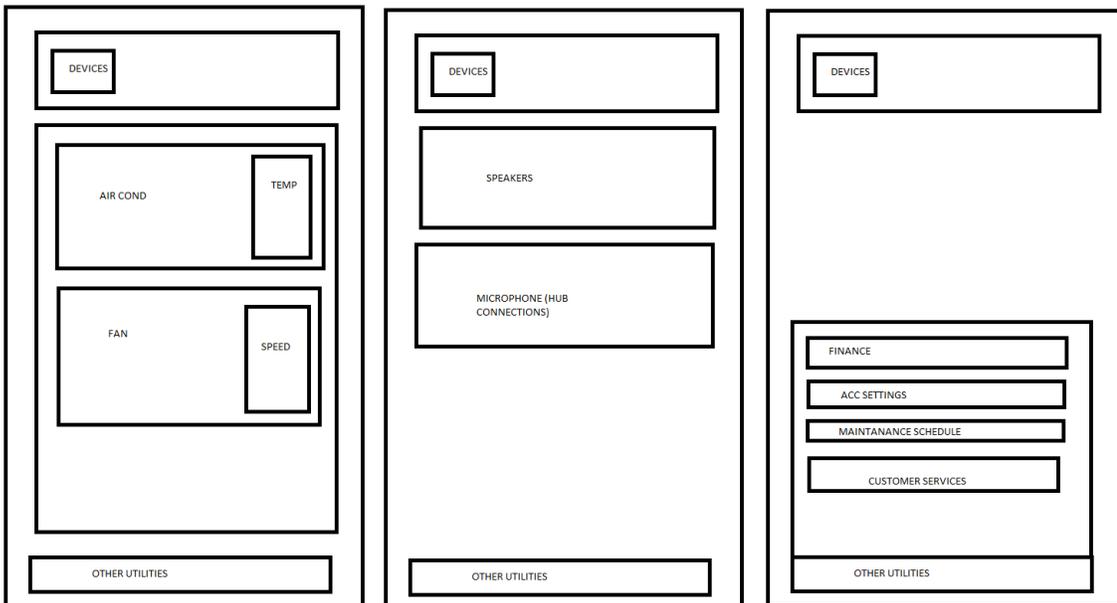| DEVICES	SECURITY
LISTS OF CAMERAS	
LIST OF LOCKS	
LIST OF SENSORS	
OTHER UTILITIES	

DEVICES	LAMPS
LISTS OF AVAILABLE LAMPS	ON OR OFF
OTHER UTILITIES	

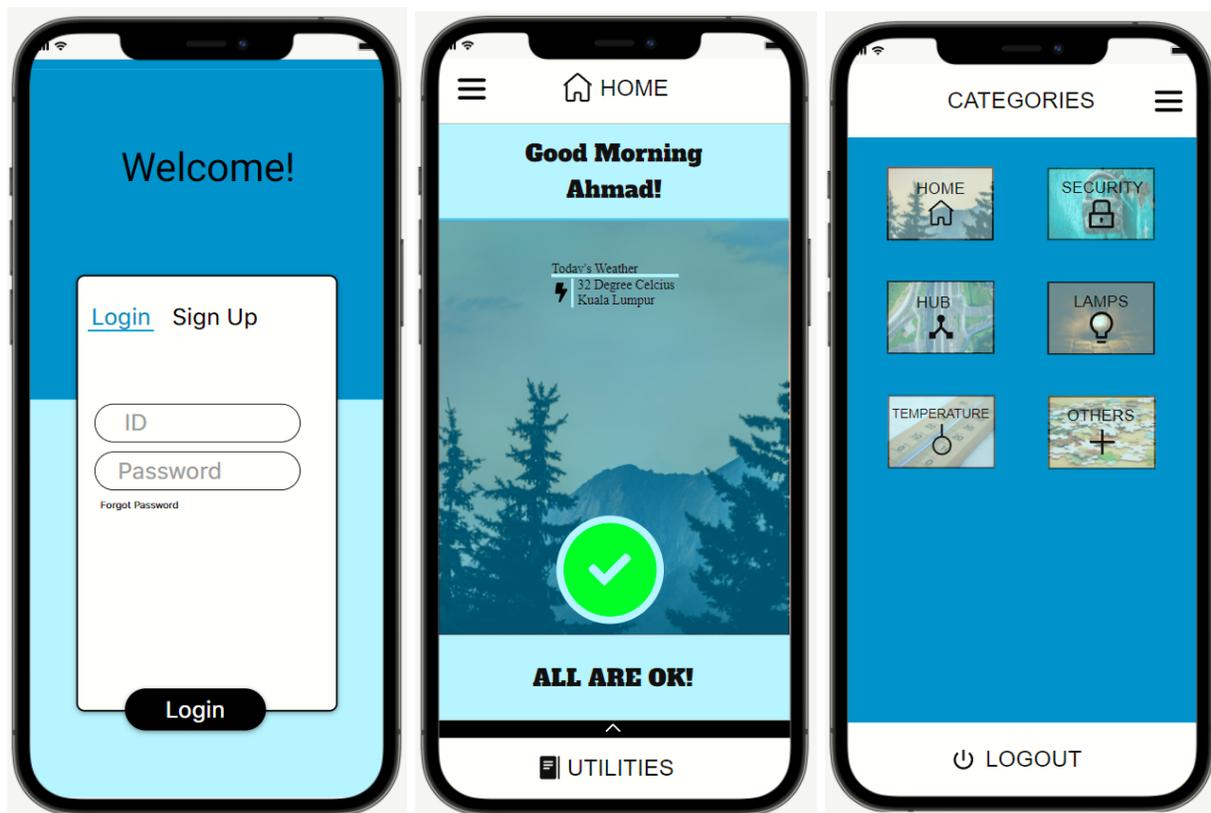| DEVICES	HUB
HUB SETTINGS: 1. ON/OFF 2. VOLUME 3. VOICE CALIBRATION 4.QUICK RESPONSE 5. KEY WORDS 6. PREFERENCES 6.1. MUSIC APP 6.2 BROWSE APP 6.3 lOCATION	
OTHER UTILITIES	
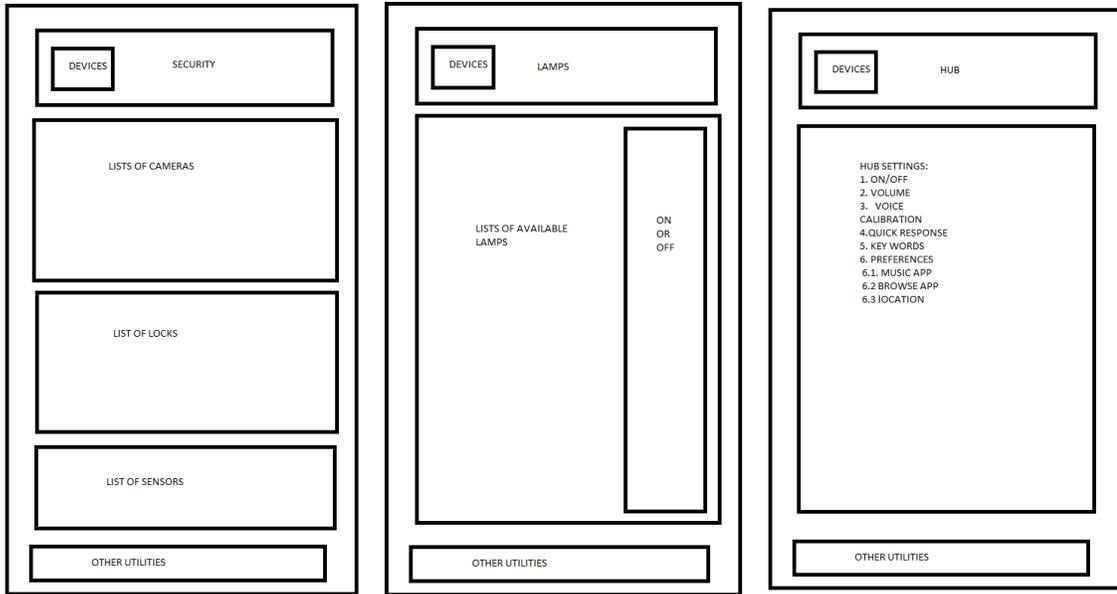
The first picture refers to the security tab, where they can see their CCTV cameras, status of any locks installed and if their sensors are in the safe or dangerous categories, functioning or not. The third is the hub settings that is similar to Alexa (Amazon Home). Users can celebrate their voice, change the trigger word and choose preferred location, browser and music app (like Spotify or apple music).

DEVICES	
AIR COND	TEMP
FAN	SPEED
OTHER UTILITIES	

DEVICES	
SPEAKERS	
MICROPHONE (HUB CONNECTIONS)	
OTHER UTILITIES	

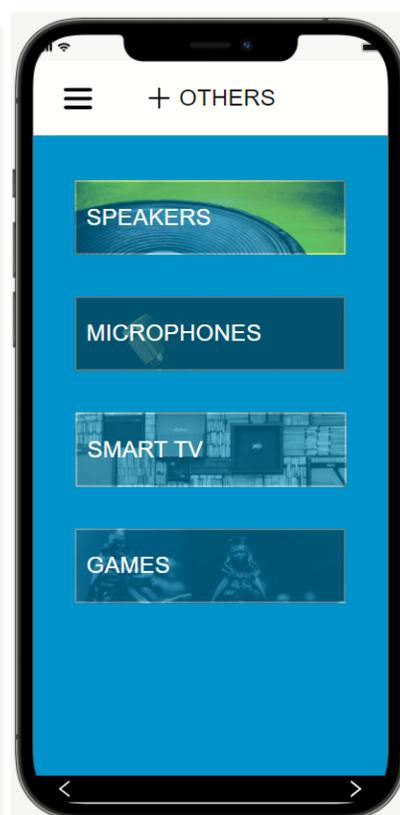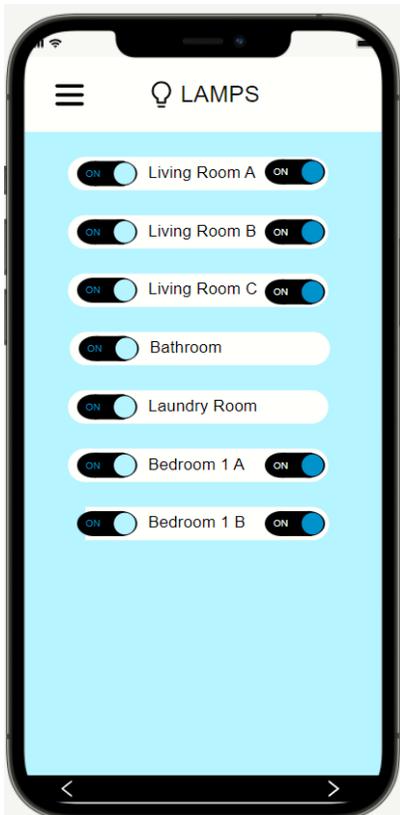| DEVICES	
FINANCE	
ACC SETTINGS	
MAINTANANCE SCHEDULE	
CUSTOMER SERVICES	
OTHER UTILITIES	

The leftmost is the temperature app, where users can turn on or off and change the speed or temperature of their installed fans or air conditioners. The middle picture is any other additional installed devices. Lastly is the utilities, where it will rise up if clicked on and allow users to see their finance status (any fees or additional devices wanted), account settings, future schedules for maintenance and customer services for any questions or problems.

5.2.   **Prototype**

The low-fidelity prototype is made using Wondershare Mockitt. A few changes were made compared to the rough sketches. Such as the design in Categories were changed and the logout feature was added and the choices in Hub were simplified into 3 options.

Screen 1 — Utilities Menu
FINANCE $
SETTINGS ⚙
MAINTENANCE 📅
CUSTOMER SERVICE 🎧
▤ UTILITIES

Screen 2 — Security
🔒 SECURITY
SECURITY CAMERAS
‹ LIVING ROOM ›
LOCKS
Front Door   Front Gate   Bedroom 1
Back Door   Back Gate   Bedroom 2
Attic Door   Small Gate   Bedroom 3
SENSORS
ON Flood Sensor SAFE
OFF Flood Sensor

Screen 3 — Hub
⋏ HUB
SETTINGS ⚙
VOICE COMMAND 🎤
PERSONALISATION 👤
▤ UTILITIES

Screen 4 — Lamps
💡 LAMPS
ON Living Room A ON
ON Living Room B ON
ON Living Room C ON
ON Bathroom
ON Laundry Room
ON Bedroom 1 A ON
ON Bedroom 1 B ON

Screen 5 — Temperature
🌡 TEMPERATURE
AIR CONDITIONERS
‹ BEDROOM 1 ›
20°C
−   +
CEILING FANS
‹ LIVING ROOM ›
− 05 +

Screen 6 — Others
+ OTHERS
SPEAKERS
MICROPHONES
SMART TV
GAMES

6. Architecture Planning and Design

6.1. Planning

Via Wifi

Connected Appliances

User and cloud computing platform
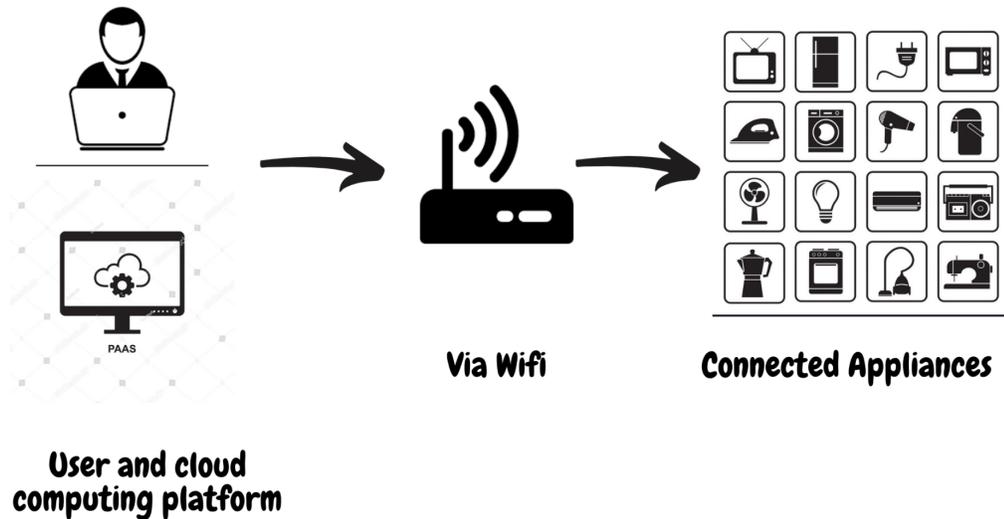
There are many appliances in our home that we can use as ioT things that are called cloud architecture as long as they are connected to the internet or Wifi. There are gates, lights, fans, doors, televisions, cameras, air conditioners and many others.

All of these appliances must have a system or chip built in them in order to function. These appliances also require cloud computing components such as platform as a service deployment tools (PaaS). This platform is used to design, create, and administer applications based on the needs of the users.

Users can set it up using any network device, such as a smartphone, computer, or tablet, by pressing the button displayed in the software. The data will be transmitted to the appliances, which will operate in accordance with the user's instructions. However, in order to avoid latency or errors, network devices require a strong wifi connection. There are numerous cloud architecture aspects that can be used:

- Users can set time for the things working

- Low cost than wired cloud architecture

- Users can save their time and energy by controlling it from anywhere

- Can advancing the security of house

6.2. <u>AWS Architecture</u>

Architecture and design are essential in creating and planning this Smart Home system. Based on our learning, we have decided to use the features available in the AWS technology catalogue as we believe that they offer the best and most suitable components needed to complete this project. These components include:

6.2.1. <u>Software = AWS IoT Greengrass</u>

For the choice of software we use in our Smart Home system, we decided that the most appropriate software would be AWS IoT Greengrass. This is because AWS IoT Greengrass is a cloud service that helps build, deploy and manage different device software. AWS IoT Greengrass also enables local processing, messaging, data management and many more. This software also importantly enables remote software management in the users' devices in the set field.

6.2.2. <u>Storage = Amazon Glacier</u>

The storage system that we decide to use is the Amazon Glacier (S3). We believe this storage system is the most suitable for our design because the Amazon Glacier is purpose-built for data archiving with high flexibility and low cost. Choosing from three archive storage classes also allows for better optimization, especially considering we implement different types of features in our system. Amazon Glacier's backup system has also made it very reliable and secure to ensure the well-being of the data stored.

We believe the most appropriate server for our system is the AWS Lightsail. The ease of use when it comes to handling and understanding the AWS Lightsail makes it very hard to turn down. The AWS Lightsail is a virtual private server (VPS) that finds simplicity and reliability important. Developers compute, storage, network capacity, and capabilities are something that Lighstail provides. All these features are also available at a very low cost.

7.   **<u>Reflections</u>**

a. What have you learned and your motivation to complete this project?

b. What issues and solutions are implemented to make the project a success?

c. What is your direction after completing this project?

d. What is the improvement necessary for you to improve your potential in the industry?

7.1.   **<u>Nik Aishah</u>**

I learned how convenient these systems are and how even countries like the United States of America haven't implemented much of this technology. The inspiration from other engineers' work motivated me to complete this project. The limited examples of this type of technology in Malaysia stunted this project's development but the vast application of similar IoT technolagy helped us solve this issue. Hopefully to experiment more with this type of technology in South East Asian countries to see its efficacy and establish a local market for it. To get more inspiration from other existing works of other engineers.

7.2.   **<u>Airil Haziq</u>**

We had to overcome many issues, especially regarding the planning and design of our project. The understanding of 4th IR became quite sparse, considering we as a group had only dipped our feet into the vast knowledge of information of technologies. However, after taking ample time to conduct research regarding the subject matter, we as a group came to appreciate the advancement society has made and how much innovation has intertwined with human livelihood. We believe our success can be attributed to intensive research and good coordination between group mates that led us to achieve this satisfactory result from our project.

7.3. Muhammad Hazman

What I've learned from this project is how crucial IoT technologies are, as well as how helpful and convenient technology can make our daily lives. Things that inspire me are how quickly technologies change and how these people who are developing new technologies are thinking about new breakthroughs. There are various challenges that we must solve, such as the source of funding for this project, because this technology is still in its early stages of development and invention. However, we can still complete this project successfully. After this project, I plan to learn more about cloud computing and create other projects including IoT technologies, as this 4IR era smart system will be extensively used.For me, the most important improvement is to stay updated on new technologies. As IT developers, we should follow the trend because technology evolves quickly, and there will be many new IoT things in a few years. As a result, we should read and explore as much as we can to learn or at least know as much as we can so we do not leave behind.

7.4. Ahmad Jalkhan

The main things I learned throughout the project are, first on how IoT technology specifically when it comes to smart environment (in this case house) works. Moreover I've learned how to make use of recent advancement in applications such as cloud computing and softwares for a low fidelity prototype to make my project a success. Lastly I've learned the few steps it takes to create a project, especially the prototype part. The main issues I've come across are on how to learn and figure out the flow of the software (for low fidelity prototype), the basics of project making (proposal) and the mechanism of IoT products currently. My direction after completing this project is to explore more on project making and any potential markets that implement the technologies of the 4th Industrial Revolution. The improvement that are necessary for me to improve my potential is to learn and explore more on what is going on in my fields and go out of my way to gain it.

8.   <u>Conclusion</u>

The priority of our project is to create a system that frees people from repetitive household tasks, allowing more time for other things such as leisure or work. With the use of Internet of Things technology and the help of cloud architecture, our system will have the ability to automate every task from lighting to security, enhancing our user's experience and boosting productivity and efficiency, a holistic Smart Home System.

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