Ministry of Education and Science of Ukraine
Ternopil Ivan Puluj National Technical University

Faculty of computer and information systems and software engineering
(full name of faculty)
Department of Computer Sciences
(full name of department)

QUALIFYING PAPER

For the degree of

bachelor
(degree name)

opic: **Development and analysis of a smart home management information system**

Submitted by: fourth year student _____ , group ICH-42
specialty 122 Computer Science
(code and name of specialty)

	_____ (signature)	Slyusarenko J.O. (surname and initials)
Supervisor	_____ (signature)	Martsenko S.V. (surname and initials)
Standards verified by	_____ (signature)	Matsiuk O.V.. (surname and initials)
Head of Department	_____ (signature)	Bodnarchuk I.O. (surname and initials)
Reviewer	_____ (signature)	Lutsyk N.S. (surname and initials)

Ternopil
2023

Ministry of Education and Science of Ukraine
Ternopil Ivan Puluj National Technical University

Faculty Faculty of computer and information systems and software engineering
(full name of faculty)

Department Department of Computer Sciences
(full name of department)

APPROVED BY
Head of Department
_____ Bodnarchuk I.O.
(signature) (surname and initials)
« 11 » July 2023

ASSIGNMENT
for QUALIFYING PAPER

for the degree of bachelor
(degree name)

specialty 122 Computer Science
(code and name of the specialty)

student Slyusarenko Juliet Otojareri
(surname, name, patronymic)

1. Paper topic Development and analysis of a smart home system

Paper supervisor Serhii Volodymyrovich Martsenko
(surname, name, patronymic, scientific degree, academic rank)

Approved by university order as of « *07* » *February* 2023 № 4/7-134

2. Student's paper submission deadline 11.07.2023

3. Initial data for the paper Development and analysis of a smart home information management system

4. Paper contents (list of issues to be developed)
Introduction 1. Analysis of the subject area 1.1 Overview of the scope of work 1.2 Using of Artificial Intelligence in Smart Home System 1.3 Security and surveillance 1.4 Smart hubs or controllers 1.5 Conclusion for chapter 1 2. Development of smart home management information system 2.1 General Approach 2.2 Data collection 2.3 Design considerations 2.4 Components selection 2.5 System requirements and specifications of the automation lighting system 2.6 System architecture diagram 2.7 Analysis of the usability of automated lighting system 2.8 User experience evaluation 2.9 System strengths 2.10 System limitations 2.11 Areas for improvement 2.12 Conclusion for chapter 2 3. Safety of life, fundamentals of occupational safety 3.1 Constitutional Principles of Occupational Safety 3.2 Safety Equipment 3.3 Conclusion for chapter 3 Conclusion References

5. List of graphic material (with exact number of required drawings, slides)
1 - Aqara Hub E1. 2 - Aqara Motion Sensor P1.3 - Aqara Smart Plug. 4 - Light Bulb.
5 - Power Cord. 6 - System Architecture

6. Advisors of paper chapters

Chapter	Advisor's surname, initials and position	Signature, date	
		assignment was given by	assignment was received by
Safety of life, fundamentals of occupational safety			

7. Date of receiving the assignment 23 January 2023

TIME SCHEDULE

LN	Paper stages	Paper stages deadlines	Notes

Student _____ Slyusarenko Juliet Otojareri
(signature) (surname and initials)

Paper supervisor _____ Martsenko S.V.
(signature) (surname and initials)

ABSTRACT

Development and Analysis of a Smart Home System // Diploma thesis, Bachelor degree // Slyusarenko Juliet Otojareri // Ternopil Ivan Puluj National Technical University, Faculty of Computer Information System and Software Engineering, Department of Computer Science // Ternopil, 2023 // P. 35, Fig. – 8, References – 30.

Keywords: IoT, smart home, hub, voice control, ZigBee, smart plug, remote control, automation.

This research project focuses on the development and analysis of a smart home management information system, specifically targeting the automated lighting system. The primary objective is to explore the functionalities, performance, and user experience of the system, while also evaluating its strengths, limitations, and areas for improvement.

The project begins with an in-depth examination of system requirements and specifications, outlining the necessary criteria for the successful implementation of the automated lighting system. The system design and architecture are then described, highlighting the interconnectivity and interaction between the components, such as the Wi-Fi smart hub, motion sensors, smart plugs, and standard bulb.

The strengths of the automated lighting system are highlighted, however, the limitations of the system, such as dependency on electricity, network connectivity issues, compatibility challenges, and privacy concerns, are also addressed.

The identified strengths serve as a foundation for further system enhancements, while the limitations inform strategies for addressing potential challenges.

АНОТАЦІЯ

Розробка та аналіз системи «Розумний дім» // Кваліфікаційна робота освітнього рівня “Бакалавр” // Слюсаренко Джуліет Отожарері // Тернопільський національний технічний університет імені Івана Пулюя, факультет комп’ютерно-інформаційних систем і програмної інженерії, кафедра комп’ютерних наук // Тернопіль, 2023 // С 35, мал – 8, бібліогр. – 30.

Ключові слова: IoT, розумний дім, хаб, голосове керування, ZigBee, розумна розетка, дистанційне керування, автоматизація

Цей дослідницький проект зосереджений на розробці та аналізі інформаційної системи управління розумним будинком, зокрема на автоматизованій системі освітлення. Основна мета — вивчити функціональні можливості, продуктивність і взаємодію з користувачем системи, а також оцінити її сильні сторони, обмеження та області для вдосконалення.

Проект починається з поглибленого вивчення системних вимог і специфікацій, окреслюючи необхідні критерії для успішного впровадження автоматизованої системи освітлення. Потім описується дизайн і архітектура системи, підкреслюючи взаємозв’язок і взаємодію між компонентами, такими як розумний концентратор Wi-Fi, датчики руху, розумні розетки та стандартні лампочки.

Виділяються сильні сторони автоматизованої системи освітлення, однак також розглядаються обмеження системи, такі як залежність від електроенергії, проблеми з підключенням до мережі, проблеми сумісності та конфіденційності.

Виявлені сильні сторони служать основою для подальших удосконалень системи, тоді як обмеження визначають стратегії для вирішення потенційних проблем.

TABLE OF CONTENTS

INTRODUCTION

In recent times, smart homes have been popular; making a lot of people happy and comfortable. In some cases, interacting with humans [2]. This is because for decades there was research carried out between mankind and machines to see how humans can react to things around them [1,3].

However, it gave a process called cognitive modeling which deals with the simulation of human thinking. This process involves how humans solve problems. After knowing how humans solve problems, software like Alexa and the likes of others came into place (that were developed) [4] .

The practical result achieved from my finding is the development of an automated lighting system using an ordinary device or devices to replace most smart devices e.g an normal bulb 78mA which I used to illustrate my finding. It is demonstrated in figure [2.6] below.

In addition, Smart homes are interconnected devices or systems that function together to make human living comfortable, convenient, and adaptable. There are stages of processes which make up a smart home. I would like to mention a few and elaborate on them later in the scope.

- Automated devices / home automation.
- Internet of things (IOT).
- Voice control / voice assistant and artificial intelligence.
- Security and surveillance.
- Smart hubs.

Basically, they are more which makes up a smart home. I chose to list these to expand it later.

Let's talk about the objective of a smart home management information system. I would say, the major objective is to create a user friendly environment for the smart

home users. Another objective is the functionality and effectiveness of all connected devices working in harmony or simultaneously.

1. ANALYSIS OF THE SUBJECT AREA

1.1 Overview of the scope of work

Developing a smart home, you will need a designer and an engineer. Well, in most cases, a designer can also do the work of an engineer. It varies depending on the type of context or implementation. The designer is in charge of the overall look of the smart home, while the engineer is in charge of the implementation and functionality of the devices, making sure they work simultaneously.

A smart home comprises of the following which I mentioned earlier:

- Automated devices / home automation: Automated devices are also known as sensor devices, they are categorized under “smart sensor” devices or “environment iot devices. These sensor devices are usually used to detect humidity, motion, sound, or pressure. These types of devices are assigned to collect transmissive data from the environment or objects [9)]
- Environment IoT devices: Internet of things is a component of small networks embedded in devices. Therefore, they are called “embedded controllers”. These are found in physical objects like traffic lights, cars, washing machines, temperature sensors, wifi etc. It is usually found in software, for the purpose of sharing data with other technological devices. Basically in a smart home management information system, all electrical appliances are embedded in a software sensor. Most of these devices could be in thermostat nests, tracking health, exercise activities which can be called wearable iot or health iot devices. Environmental IoT devices can also be motion detectors, voice control, CCTV cameras etc. It is interconnected to other devices in the home to enhance safety.
- Voice control and artificial intelligence: Voice control is the process whereby a machine or system recognises human voice through commands. Voice control

has gained population which enables human interaction by giving instruction to the machine or the devices. The process machine understands human voice recognition involves advanced technology.

However, Artificial intelligence is not ruled out when it comes to voice control [2]. The process for machines to speak with humans involves algorithms, embedded in the device for decision making and response(1).

Most artificial intelligence machines are voice controlled or voice recognition devices. We can derive examples from Alexa, automated cars, google search engine [27] etc.

1.2 Using Artificial Intelligence in Smart Home Systems

Artificial intelligence is the concept of computer or branch of computer science which involves how machines or devices can perform and interact with humans. Over the years, Artificial intelligence has become known and proven useful to human existence. It is not ruled out that most humans now rely on artificial intelligence for studies and other things.

As a matter of fact, I've always fantasized about how robotic cleaning devices move around the house. Also, how the automated gates open when a car it recognizes approaches. Artificial intelligence is further explained in security and surveillance.

1.3 Security and surveillance

In every smart home, you see smart doors lock, or finger print lock, video camera doorbell, security cameras, motion sensor detector. All these enable the use of monitoring the home remotely. In a case, where the owner is out of the house and intruder(s) come into the premises, immediately the motion sensor and alarm indicate

the owner via the mobile app while the security cameras capture every move of the intruder(s).

This enables the owner to call police to their premises, if the intruder is a suspect.

Another important thing is the smart hubs or controllers. As a matter of fact, there is no functionality or no connectivity without the controller.

1.4 Smart hubs or controllers

The smart hub or controller helps the devices to function effectively. It is the intermediary of all devices, technologies, and protocols allowing the devices to work and send signs or data simultaneously [12].

Permit me to say, the smart hub or controller is the brain of the smart home, because it sends all the signal to all devices, often making the devices user friendly for the smart home owner [14].

1.5 Conclusion for chapter 1

The first section of the qualification work analyzes the purpose of a smart home system and identifies its main components. Based on this analysis, it has been found that there are many specific technologies used in such systems that require the application of various integration approaches. Examples of utilizing existing technologies to solve specific automation tasks are provided.

2. DEVELOPMENT OF SMART HOME MANAGEMENT INFORMATION SYSTEM

2.1 General Approach

In this section we will discuss how to light a space,common mistakes, and basic rules of lighting a room or a smart home [10].

Lighting is important in a smart home management information system. It provides beauty and comfort to the users.

However, there are common mistakes associated with setting up lights in a room or in an automated smart home. I will discuss a few common mistakes below:

Not considering the size of the room: Using big lights in a small room can cause fatigue, eye stress, and mental stress. For example, in a small hotel single room, an overall illuminating light is not necessary. It is advised to use a cool, friendly, and appropriately sized light. Additionally, each room has its own unique features that should be considered when choosing a light fixture design.

Not considering the design: Each room has its own unique design that should match the lighting. In an automated home with two or three rooms, different patterns of lights should be considered to correspond with the artwork, frames, or furniture. Matching warm, cool, or accent lights or designs can enhance the comfort of the home.

Before I move on, I would like to mention the most common types of interior automated lighting:

- Motion-activated lighting: It uses sensors to detect movement within a specific area.
- Color change lighting system: This allows users to play with colors, making it fun and interesting to beautify the home and set the mood.

- Timer-based lighting: This light works on scheduling, serving as reminders for appointments or as a call to action.

Now, let's continue with the common mistakes associated with lighting a room or a smart home management information system.

Shadows: Consider how you place your lights. Forgetting about shadows in your smart home can make it look unpleasant.

Using only one type of light in a study room, bathroom, or kitchen can become overwhelming. In such places, task lights are the best and most convenient option. For example, desk lamps, under-cabinet lights, or bathroom vanity lamps.

Using overhead lights that are too bright: Personally, I do not prefer too much bright overhead light. It can make it difficult to concentrate or cause fatigue, especially at night. This is why an automated lighting system saves the day, as it helps regulate the brightness and also stores data analysis for different lighting settings of the day.

A great summary of tips for lighting design can be found in this online video: https://www.youtube.com/watch?v=oA-uLPzMilU

2.2 Data collection

It is very important to conduct questionnaires and surveys with future users of the system prior to making any development and design decisions.

Question: What time of lighting fixtures do you prefer in your different rooms (e.g. living room, bedroom, kitchen, library)?

Response based on interview: Living room (bright), bedroom (dim), kitchen (bright), library (bright).

Another person’s response: Living room (bright), bedroom (dark), kitchen (bright), library (adjustable desk lamp).

Question: How do you prefer to control your lighting system?

Response based on interview: Voice command.

Another person’s response: Mobile app for long distance command.

Question: Are you interested in a customizable lighting option that allows you to adjust brightness and color temperature?

Response based on Interview: Yes.

Another person’s response: Yes, depending on the mood.

Question: Do you have specific lighting design preferences or considerations for different rooms or areas in your home?

Response based on interview: Yes, I would like a library desk lamp to turn on automatically when I'm approaching the desk.

2.3 Design considerations

When selecting a smart home management information system for analysis, you will need to consider the following:

Compatibility: How compatible are the devices you want to use for automation. Most devices in the market don’t integrate with other devices. E.g ZigBee and Z-Wave devices only work with the Z’s devices. However, this is where home assistants come into play.

Availability: How available is that device or devices in the market. Putting this into consideration is a major thing as well. It is good to explore the market to know the most used and reliable devices.

Functionality: You will consider the functionality such as device control, mobile app feature, voice control, data analysis etc.

Security features: Analysis of the security of a smart home management system is very important. Such as enabling two factors authentication, encryption, data privacy.

User friendliness: Clearly make research to see if the device or devices are user friendly. Check for users feedback to know what kind of product you want to buy.

Budget friendliness: Consider the cost before deciding which to purchase. Some also have a high subscription price (cost of ownership). While some could be just the cost of purchasing the devices.

There are several home management systems available in the market these days. I would like to mention a few of them:

- Google Assistant
- Apple Siri
- Amazon alexa
- Samsung SmartThings
- Apple Home
- Aqara (the one I specifically picked for the lighting automation system).

2.4 Components selection

Aquara Hub E1

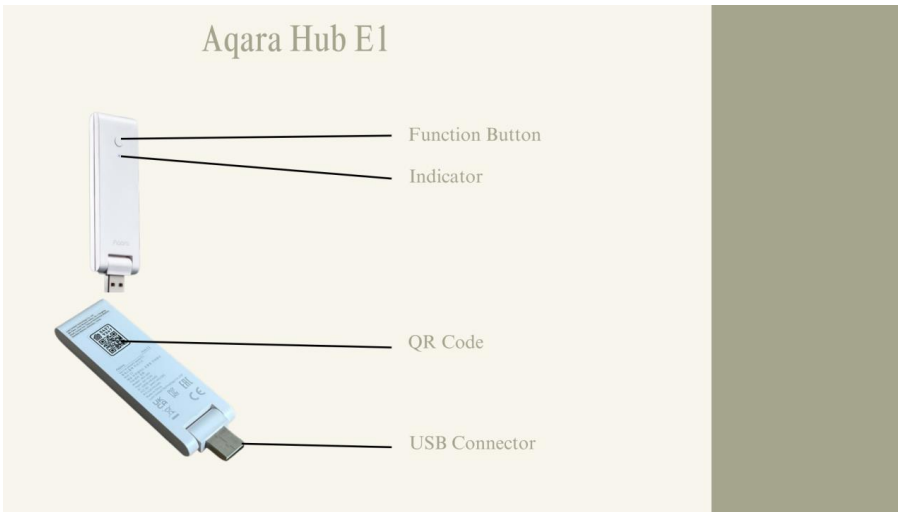

Figure 2.1 – Aqara Hub E1

Description: Aqara Hub E1 - This serves as the central control unit of the lighting automation system. It coordinates and communicates between other components. This is known as a smart central control unit. This helps smart home users communicate and use smart devices comfortably. This E1 hub shown in the diagram is ZigBee 3.0 protocol. It is flexible and can be installed on USB ports, sockets and laptops or any electrical appliances with the USB port connector.

Aqara Motion Sensor P1

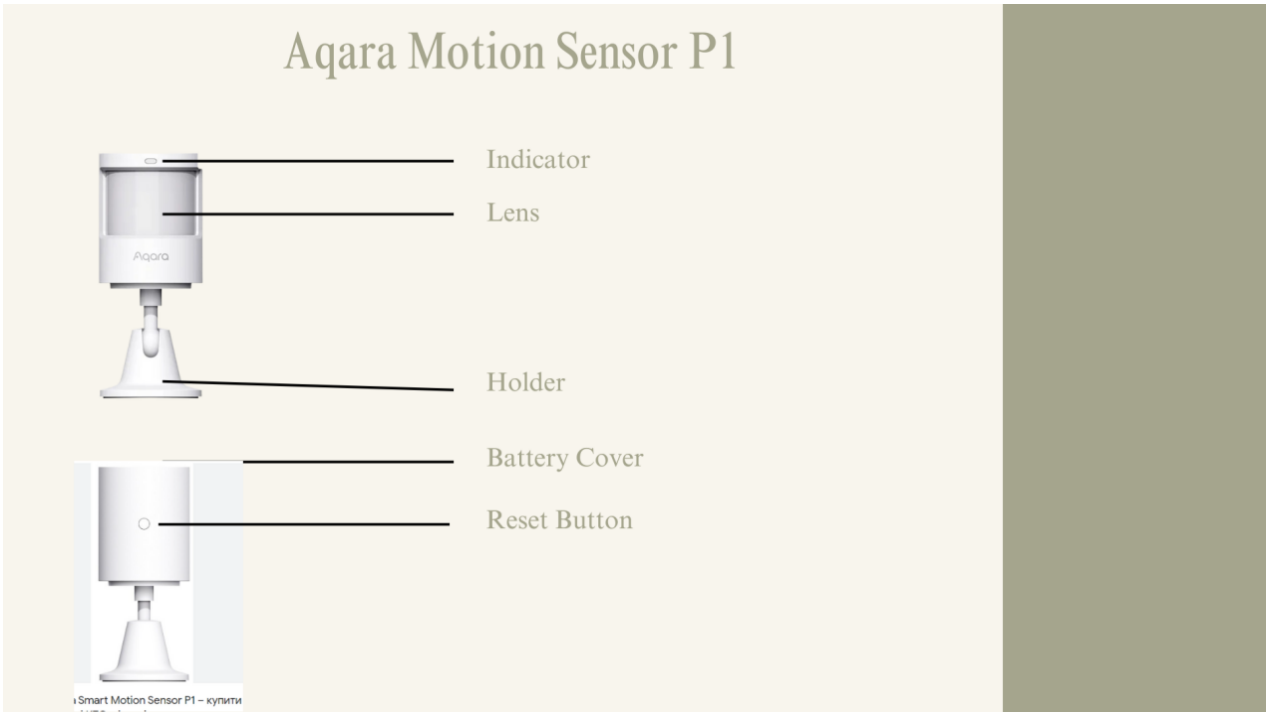

Figure 2.2 – Aqara Motion Sensor P1

Description: Detects movement of a person or an object. This is basically connected to the light and also the placement of the Aqara motion P3 sensor, should not be far from the light. This sensor is either placed on the wall or on a flat surface area for better communication with the lighting system. It also can be connected to mobile wifi or home wifi for an effective process.

Aqara Smart Plug

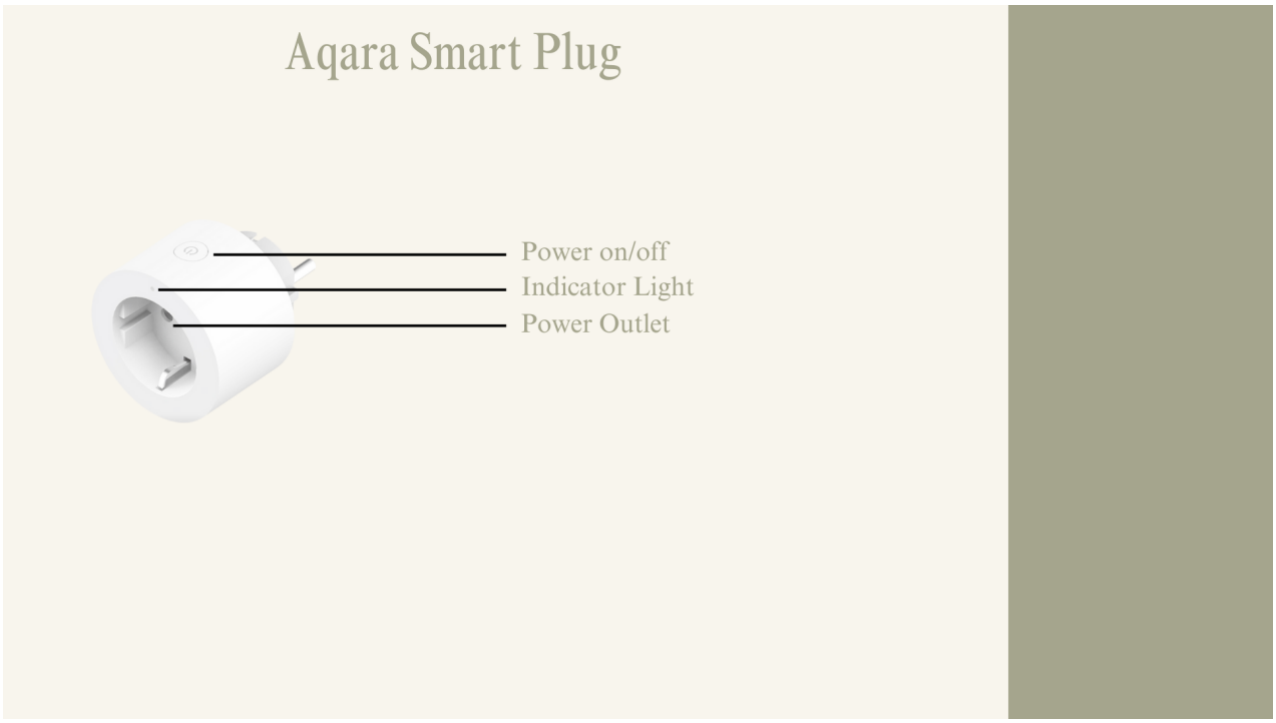

Figure 2.3 – Aqara Smart Plug

Description: Aqara smart plug - This right here, works together with the smart E1 hub to automate and control all the smart appliances. The other aspect of the smart plug is that it can be used to automate TV, microwave, fan, garage appliance etc.

In other words, the smart plug is a versatile device. Connecting the smart plug to the E1 hub using wifi makes it easy for smart home owners to control, manage and interact with smart and non smart appliances using mobile app effect or voice command.

Light bulb. 78MA E27 BLUE 3W 38LM

Figure 2.4 – Light Bulb

Description: Ordinary light bulb, directly controlled by electric current. Does not have any smart functionality and IoT connectivity.

Product Code breakdown:

- 78MA: This indicates that this is an ordinary electric controlled bulb.
- E27: This is the screwable bottom of the normal bulb blue light I am using for the lighting automation system.
- Blue: I chose this blue color for a particular reason, blue when turned on to provide or emit an aesthetic lighting environment.
- 3W: This is the power rate. That is the amount of energy consumption, when the light is turned on during the automation process.
- 38lm: This is the amount of light output (38 lumens). Lumens is the brightness and lighting intensity of a bulb. Which means, even if it was a smart bulb with 38lm, it can not be increased beyond the lumens amount. However, they are bulbs

with higher lumens. These bulbs can vary from normal bulb to smart bulb and all have their specifications and functionalities.

Power cord with E27 adapter and switch. LEN E27 T20 250V 4A LE-27B

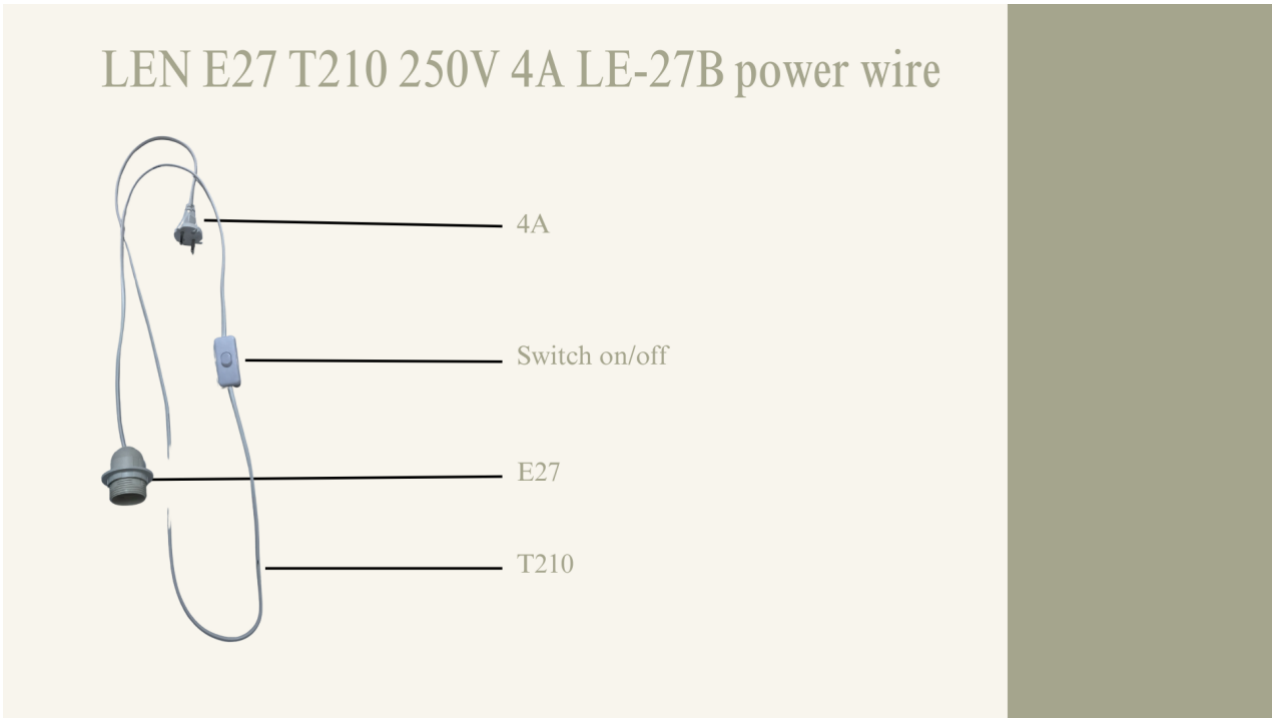

Figure 2.5 – Power Cord

Description: Power cord with EU electric plug on one side and E27 light bulb adapter on the other side. Allows the E27 light bulb to connect to a smart wallet but on its own does not have any smart functionality or IoT connectivity. Has a physical switch which allows for manual control of the connected light bulb.

Product Code breakdown:

- T20: This is majorly used for electrical connection, with the E27 base screw bulb. Then the power fire allows the current to follow.
- E27: refers to the type of socket or base used for light bulbs, rather than a power wire. E27 is a common standard for screw-type bulb sockets. It signifies that the socket has a 27mm diameter and is designed to accommodate bulbs with a

corresponding screwable bottom. This type of socket is widely used for various lighting fixtures and allows for easy installation and replacement of compatible bulbs. It is important to note that the power wire connects to the socket, providing electrical current to the bulb, but the designation E27 specifically refers to the bulb socket type rather than the power wire itself.

- 250V: represents the maximum voltage rating of the power wire. This indicates the highest voltage level that the wire is designed to safely handle. It is important to ensure that the voltage supplied to the wire does not exceed this maximum rating to prevent potential damage or safety risks. Adhering to the specified voltage limits helps maintain the integrity and performance of the power wire within its intended operating conditions.
- 4A: indicates the maximum amount of electrical current that the wire can safely carry without overheating or causing damage. It is typically measured in amperes (A). The specific current rating will depend on factors such as the wire section, insulation material, and installation conditions. It is important to ensure that the wire's current rating matches or exceeds the expected load to maintain safety and prevent electrical hazards.

2.5 System requirements and specifications of the automation lighting system

- Remote Access – The ability to control and monitor the lighting app automation remotely.
- Integration – All the automated devices can be integrated into one app using home kit app or home assistant.

- Scheduling and Timing – This is set in the process of a triggered event. It could be either for the light to turn at a specific time when it is dark and turn off at a specific time when it is bright to conserve energy consumption.

On the other hand, this approach can be implemented which I used for this lighting automation system like “If motion is detected, turn on the light at 00 second (acting time) all conditions are met”. Then turn off the smart plug 3 seconds later.

Automated light control: This turns the light off and on using a motion sensor.

Security system- Based on motion sensors and the security trigger, if an unauthorized person entered the house, the owner immediately receives a signal via the mobile app.

Also if there are security cameras installed, the owner can see the person as well. Every home automation owner has their preferences.

2.6 System architecture diagram

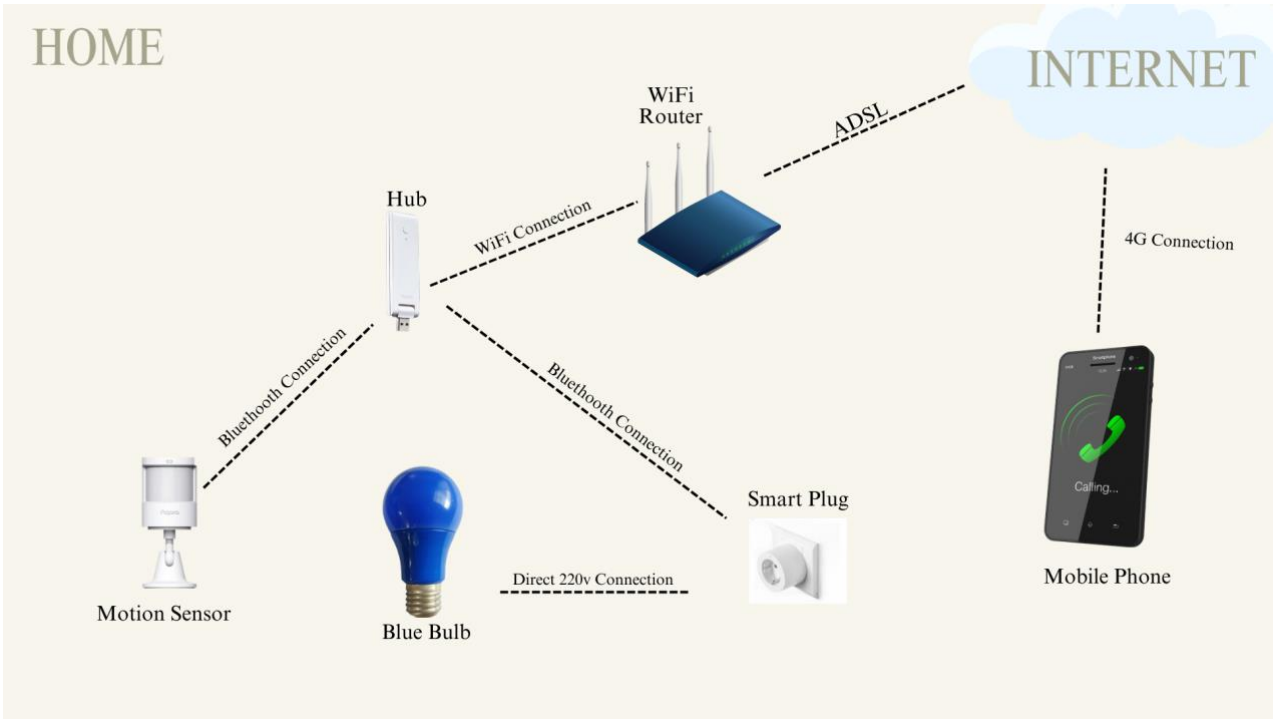

Figure 2.6 – System Architecture

2.7 Analysis of the usability of automated lighting system

Ease installation setup of the automated lighting information system (manual instruction) In each Aqara device which I used in this project setup of automated lighting information system, each device has a manual booklet with written instructions for the seek of better understanding and user friendly experience. These instructions help users know how to connect all devices. If, clearly read and understand, the installation becomes simple.

- Pairing process: Check and understand the compatibility of the pairing process each device or the lighting system component has. For example, hub, bulb, smart plug, control interface (mobile app).
- Automated setup procedures: Check the automation process, if the devices or lighting components are aligned. That is, how the commands are placed and the timing activity.
- Help center: Like troubleshooting, in case there is a problem with the devices. It is easy to reach out to the device help center.
- Plug: Check if the device or the lighting device will require additional or external tools for an effective connection process.

2.8 User experience evaluation

Based on the previous survey and questionnaire I got during the interview carried for this project, which I stated in one of the pages above. Most people prefer bright living room light, bright kitchen light, dark bedroom light, dim bedroom light, adjustable desk lamp, bright library, automated desk lamp for reading, voice control command, mobile app command.

They also talked about the comfort each lighting system gives and the mood it gives to them.

There are also many ways to enhance user experience by adding more integrated components such as:

- Voice Assistant Integration (e.g., Alexa or Google Assistant): The integration of voice assistants, such as Alexa or Google Assistant, has greatly enhanced the user experience in many households. Users can effortlessly control various aspects of their smart home, including music playback and entertainment, using simple voice commands.
- Smart Robotic Cleaner: Many households have adopted smart robotic cleaners as a quick and efficient solution for keeping their homes clean, particularly the floors. These devices provide convenience and time-saving benefits, allowing users to automate the cleaning process with minimal effort.
- Automated Window Blinds: Opening windows early in the morning or adjusting window blinds can be challenging for individuals who prefer to stay in bed.
- The introduction of automated window blinds has addressed this issue, allowing users to easily control their blinds without leaving the comfort of their bed. This enhances convenience and enables a more personalized and comfortable living environment.
- Smart security system: The adoption of smart security systems has significantly improved the home security of many homes. Especially, in an area where the security system is being threatened now and then. This gives the smart home user’s peace of mind.
- Smart water management system: This system includes a water timer, which enables users to monitor their water usage. This can be useful in areas of water supply shortage.

2.9 System strengths

These are the strengths associated with the development and management information system of a smart home. But for the purpose of my project, I will give the following example:

- Convenience
- Compliance
- Power saving.
- Lamp life cycle
- Friendly user interface
- Reliable performance system
- Customized and personalized lighting preference
- Integration compatibilities
- Automation compatibilities
- Voice control
- Remote control
- Data analysis
- Security and surveillance

2.10 System limitations

In building or developing a smart home management information system, you should have these in mind that it comes with certain limitations.

For the purpose of the lighting automation system, I will discuss on the following:

- Inability of control during electric blackout.
- Brightness and color can not be changed.

- Learning curve. Teaching the family members on how to operate and interact with the devices or the interface.
- Maintenance and upkeep. This involves the periodical workframe.
- Compatibility with existing infrastructure.
- Network and connecting issues. It requires a stable network.
- Cost effectiveness.

2.11 Areas for improvement

They are certain areas which I highly would recommend for improvement for the purpose of this project and these areas includes:

- Backup battery system: In an automated home, where there is loss of power and no other means to automate the lighting system, the battery should be considered as an alternative.
- Lamp Color: Using smart light gives different automated lighting colors and makes the users feel every mood associated with the lighting system.
- Illumination: The lighting automation can be done in a different process, which means the smart home user does not need to switch on the full brightness of the lamp or turn it on the lighting system when it is bright outside. For example, the setting can be done as the light works with the atmospheric condition outside and knows when is dark to turn it on or when is bright, to switch the light off.
- Voice control: In a situation when the user of the smart home management information system is coming into the home from shopping at night with so many bags or from a trip with so many traveling bags. The user will just use the command to switch on the lighting system instead.

2.12 Conclusion for chapter 2

The second section of the qualification work presents the methodology for developing a smart home automation system project. A range of planning and implementation techniques for automation systems are provided, taking into account the users' needs and the integration peculiarities with the existing infrastructure. The design and implementation of a real system for automatic control of lighting using motion sensors, a ZigBee hub, and a controllable electrical socket have been carried out. It has been demonstrated that existing automation systems can be used to automate the existing infrastructure without the need to replace the already installed equipment, thus preventing excessive costs.

An analysis of the implemented system has been conducted, highlighting its strengths and weaknesses. The analysis has shown that the strengths significantly outweigh the potential drawbacks and has proven that smart home systems will continue to spread until they become mainstream among a wide range of users.

3. SAFETY OF LIFE, FUNDAMENTALS OF OCCUPATIONAL SAFETY

3.1 Constitutional Principles of Occupational Safety

The Constitution of Ukraine and relevant laws establish the fundamental provisions for ensuring occupational safety and protecting the lives of individuals in the workplace. These laws include the Constitution of Ukraine, the Law on Occupational Safety, the Law on Health Protection, and the Law on Fire Safety. Specific legislative acts, such as state regulations on occupational safety, construction norms, and rules, further contribute to ensuring a safe working environment. The Constitution of Ukraine dedicates Articles 43, 45, and 46 to matters concerning occupational safety. Article 43 guarantees the right of individuals to freely choose or voluntarily agree to work, ensuring safe and healthy working conditions, fair wages, and the prohibition of employing women and minors in hazardous occupations. Article 45 enshrines the right of workers to rest, including weekly rest days, paid annual leave, and reduced working hours for specific professions and night shifts. Article 46 grants citizens social protection, providing support in cases of work capacity loss, loss of a provider, unemployment, and in old age or other circumstances as defined by law. The Law on Occupational Safety is the primary legislative document governing occupational safety in Ukraine, emphasizing the rights and guarantees of employees.

3.2 Safety Equipment

Ensuring safety within the workplace requires the implementation of effective safety measures. Fire alarm systems play a crucial role in promptly detecting fires and ensuring the safety of individuals within buildings. Ideally, all buildings should be equipped with a reliable 24/7 fire alarm system. These systems consist of a range of

technical devices and personnel responsible for timely fire detection and response. In case of electrical outages, fire alarm systems can automatically switch to battery power, ensuring uninterrupted functionality. Special sensors, including temperature, smoke, and gas detectors, form an integral part of these systems. Different sensor models, such as non-addressable threshold detectors or advanced analog addressable detectors, are used to detect and locate fires within the premises. Smoke detectors, available in ionization-based or optical variations, respond to the presence of smoke and measure its concentration. Optical detectors utilize scattered infrared radiation, while ionization-based detectors utilize an ionization chamber. Additionally, specialized sensors are installed on windows and doors, including broken glass sensors, infrared motion and presence sensors, magnetic contacts, and vibration sensors, ensuring comprehensive monitoring and security. Information from these sensors is transmitted to a control panel via computer or telephone lines. Motion sensors are often used to monitor areas adjacent to building entrances. Modern devices can be programmed to distinguish movements caused by household pets, preventing false alarms.

3.3 Conclusion for chapter 3

In conclusion, this section has provided an overview of the constitutional principles governing occupational safety and the measures employed to ensure safety within the workplace. By adhering to these principles and utilizing appropriate safety equipment, organizations can create a secure environment that prioritizes the well-being and protection of individuals.

CONCLUSION

Automating ordinary devices without significant expenses is possible by utilizing smart plugs. Incorporating smart plugs into the existing setup, ordinary devices can be transformed into automated devices. This cost-effective solution allows users to control their ordinary devices remotely, set schedules, and even integrate them into smart home systems. Smart plugs provide an accessible entry point into home automation, enabling users to enjoy the benefits of automation without the need for expensive smart devices.

Versatility and Flexibility: The discovery that the concept of smart home automation is convertible opens up new possibilities for integrating ordinary devices into the smart home ecosystem. Users can leverage smart plugs, smart switches, or other smart devices to automate and control a wide range of everyday appliances and devices, such as TVs, electric kettles, heaters, fans, and curtain openers. This versatility and flexibility allow for personalized and customized automation solutions tailored to individual needs and preferences.

Cost-Effective Solution: Converting ordinary devices into smart devices using smart home automation techniques, users can achieve the benefits of automation without the need to invest in expensive smart devices for each appliance. This cost-effective approach makes home automation more accessible to a broader range of users, enabling them to enjoy the convenience and efficiency of smart technology without significant financial burden.

Seamless Integration: The ability to integrate ordinary devices into the smart home ecosystem enhances the overall user experience. Users can control and manage multiple devices through a unified smart home platform, simplifying daily routines and creating a more streamlined and connected living environment. This seamless integration improves convenience, efficiency, and user satisfaction.

Energy Efficiency and Environmental Impact: Converting ordinary devices into smart devices allows for more efficient energy management. Users can schedule, automate, and monitor the operation of their devices, optimizing energy consumption and reducing wastage. Leveraging smart home automation, users can contribute to energy conservation and minimize their environmental impact.

User Empowerment and Customization: The convertibility of the smart home concept empowers users to take control of their living spaces and customize their automation setups according to their preferences and lifestyle. Users can define automation rules, set timers, create scenes, and establish personalized routines to suit their specific needs. This level of customization enhances user satisfaction and engagement with the smart home technology.

Education and Adoption: The discovery of the convertibility of smart home automation highlights the importance of educating users about the possibilities and benefits of integrating ordinary devices into the smart home ecosystem. Educational initiatives can focus on raising awareness, providing guidance on device compatibility, and offering support for setting up and configuring automation systems. Increased education and awareness can drive wider adoption of smart home technology.

Enhanced Integration: As smart home technology continues to evolve and become more mainstream, there is a growing need for improved integration capabilities. Future directions may involve developing standardized protocols and communication interfaces to facilitate seamless integration of old and ordinary devices into the smart home ecosystem. This will provide users with a more unified and cohesive experience across their entire range of smart devices.

Interconnectivity Standards: The development of industry-wide interconnectivity standards will play a crucial role in enabling the seamless integration of old and ordinary devices. This includes establishing protocols that ensure compatibility and

interoperability between different smart devices, allowing users to control and manage them through a single interface.

Artificial Intelligence and Machine Learning: The integration of artificial intelligence (AI) and machine learning (ML) algorithms holds great potential for the future of smart homes. Leveraging these technologies, smart home systems can learn user preferences, anticipate their needs, and automate routine tasks more intelligently. This will enhance the overall user experience and make the integration of old and ordinary devices even more intuitive and efficient.

Enhanced Energy Management: Future directions may focus on further improving energy management within the smart home ecosystem. This includes developing advanced energy monitoring systems that provide real-time feedback on energy consumption, as well as intelligent algorithms that optimize device usage based on energy efficiency criteria. These advancements will enable users to make informed decisions and further reduce energy waste.

Security and Privacy Enhancements: With the increasing number of connected devices within smart homes, ensuring robust security and privacy measures is of utmost importance. Future directions should prioritize the development of advanced encryption methods, authentication protocols, and secure communication channels to protect user data and prevent unauthorized access to smart home systems.

Seamless User Experience: Future advancements should aim to provide a more seamless and intuitive user experience. This involves simplifying the setup and configuration processes, refining user interfaces to be more user-friendly, and incorporating voice control and natural language processing for effortless device interaction. These improvements will encourage wider adoption and enhance user satisfaction.

Accessibility and Affordability: As smart home technology becomes more prevalent, future directions should focus on increasing accessibility and affordability.

This includes developing cost-effective solutions for converting old and ordinary devices into smart devices, ensuring compatibility with a wide range of devices, and providing support for users with different needs and abilities.

Environmental Sustainability: Future directions should prioritize the development of smart home solutions that promote environmental sustainability. This involves integrating energy-efficient technologies, encouraging the use of renewable energy sources, and providing tools for users to monitor and reduce their ecological footprint within the smart home ecosystem.

REFERENCES

1. Fundamentals of the internet of things by Prof. Palamar Andriy (2023).
2. Artificial intelligence with python by Alberto Artasanchez and Prateek Joshi (January 2020).
3. Analysis of Smart Home systems in the context of the internet of things in terms of consumer experience by Serap Turkyilmaz and Erkut Altindag (January 2022).
4. Design and analysis of the effectiveness of smart home control systems based on using the internet of things. Rohadi Erfan, H. Susanto, Moechammed Sarosa (February 2021) https://www.researchgate.net/publication/349651464_Design_and_analysis_of_the_effectiveness_smart_home_control_systems_based_on_using_the_Internet_of_Things
5. "PIR motion sensor and garden LED light wiring" (2020) https://www.youtube.com/watch?v=ykSQ9jVcmw4
6. "How to install a motion sensor". David Mester. (2019) https://www.youtube.com/watch?v=WR9pBgAVmYY
7. "Tuya ZigBee Smart PIR Sensor | Use a Smart Motion Sensor to Turn on/off your Lights Automatically". Reyzz Tech. (2021) https://www.youtube.com/watch?v=5QJjkuGcs5M
8. "Ultimate Guide to Starting and Growing a Smart Home". Smart Home Solver. (2021) https://www.youtube.com/watch?v=-_vtoUmkot4
9. "What is the difference between Smart Home and Home Automation". Schneider Electric https://www.youtube.com/shorts/mtu3GeaAYgQ
10. "How To Light A Space | Mistakes, Rules + Lighting In Interior Design". Reynard Lowell. (2022) https://www.youtube.com/watch?v=oA-uLPzMilU

11. "This Smart Home Sensor is INCREDIBLE! Aqara FP2 mmwave". Smart Home Solver. (2023) https://www.youtube.com/watch?v=yarollsdao4
12. "Smallest Hub Yet? The Aqara Hub E1 - Homekit Smart Home". Brad Lloyd. (2022) https://www.youtube.com/watch?v=tqoWUDxL4N4
13. "The best Zigbee Motion Sensor - Aqara P1 in Home Assistant". Home Sight. (2022) https://www.youtube.com/watch?v=pFhijEdX_JQ
14. "How to install and set up Aqara Hub E1 for iOS". Smart & Secure Centre. (2023) https://www.youtube.com/watch?v=XuFg_4Ww560
15. "How to Get The Aqara Motion Sensor Setup With Samsung SmartThings". Automate Your Life Tutorials. (2021) https://www.youtube.com/watch?v=6MF6_sIjV1w
16. Analysis of Smart Home Systems in the Context of the Internet of Things in Terms of Consumer Experience. Serap Turkyilmaz. Erkut Altindag. (January 2022) https://www.researchgate.net/publication/357642710_Analysis_of_Smart_Home_Systems_in_the_Context_of_the_Internet_of_Things_in_Terms_of_Consumer_Experience
17. Smart homes lighting options and considerations. Audio Device. (2021) https://youtu.be/h9s2FcAknHM
18. Beginners guide on things to know before buying a security camera. Steve DOES. (2022) https://youtu.be/QYlv8JRjTjk
19. Ten practical home automation ideas for 2023. Smart Home Solver. (2023) https://youtu.be/gF5646C4IOE
20. Lighting for beginners part 1. Stemmer Imaging. (2017) https://youtu.be/vHnj1XY1yqY

21. Smart home technologies: appliances and benefits. Analytics Insight. (2021) https://youtu.be/Qxe68ExM148
22. What is a smart home or building? Eye on Tech. (2020) https://youtu.be/IC0mkHh7MaA
23. Smart street lighting automation and energy conservation automation. MEMIGHTY Inventions Private Limited. (2021) https://youtu.be/G1hXreapAIc
24. Smart home protocols explained. Home Automation Guy. (2023) https://youtu.be/egTu7x6sADc
25. 7 common smart home failures and how to avoid them. The Hook Up. (2023) https://youtu.be/5CvrGPmeTxE
26. Apple smart home with over 100 home kit devices. Stephen Robles. (2023) https://youtu.be/8vQGhs7cKSo
27. Let's review my home: This is a google smart home in 2023. Technology Paul. (2023) https://youtu.be/GhBphfRucU0
28. How to start a smart home in 2023. 6 Months Later. (2023) https://youtu.be/uYjxzsgM0J4
29. Smart light switches: I'm rethinking everything. Smart Home Solver. (2022) https://youtu.be/HDnkXEyjI64
30. Ultimate smart home tour 2022. Shane Whatley. (2022) https://youtu.be/Ylf5rhIaS7I