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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGENEERING

OPTION: ELECTRICAL TECHNOLOGY

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DESIGN AND IMPLEMENTATION OF AN ENERGY-EFFICIENT SYSTEM FOR DISABLED INDIVIDUALS' HOMES

A project submitted in partial fulfilment for the requirement of award of advanced Diploma in Electrical Technology (ELT)

By

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Kigali, September 2024

DECLARATION A

This research study is my original work and has not been presented for a Degree or any other academic award in any University or Institution of Learning. No part of this research should be reproduced the author's consent or that of ULK Polytechnic Institute.

Student name………………….

Sign:……………….Date……./SEPTEMBER2024

DECLARATION B

I confirm that the work reported in this research project, was carried out by the candidate under my supervision and it has been with my approval as the UPI supervisor.

Supervisor Name: Eng. KARIKURUBU Emmanuel

Sign:……………………………….Date:…./……/2024

DEDICATION

I dedicate and thank Almighty God for His guidance, grace, and mercy throughout my lifetime.

This project is dedicated to my parents who have supported me all the way since the beginning of my studies.

Also, this project is dedicated to all my lecturers who have been a great source of knowledge, motivation, and inspiration.

Finally, this report is dedicated to all my friends and those who had faith in me for the completion of this project, and to my fellow juniors who are fresh minds in other colleges.

ACKNOWLEDGEMENT

I first thank the good Lord who helped me and gave me the courage and patience to carry out this modest work.

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My gratitude goes to my supervisor, Engineer Karikurubu Emmanuel, for his guidance, monitoring, and the precious time he devoted to supervising this project. Without his supervision and constant help, this project would not have been possible.

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Finally, I send my most sincere thanks to all my loved ones, girlfriend, friends, who always supported and encouraged me during the completion of this work: Liliane Gatesi, Atosha Bahaya, Amida Bahaya, Guylaine Bahaya, Isaac, Yassine, Asha Bahaya, Hermens Bagunda.

Special thanks to my followers and relatives who have contributed to my studies and prayed for me so that I could achieve my goals.

I appreciate your support. God bless you abundantly.

ABSTRACT

The project entitled "Design and Implementation of an Energy-Efficient System for Disabled Individuals' Homes" aims to develop a comprehensive solution that improves energy efficiency and accessibility of residential environments for people with disabilities. The system integrates smart home technologies with assistive devices, a CD4017 microcontroller, automated controls, and energy management algorithms to optimize energy consumption while maintaining home comfort and safety for the user. Key features include adaptive lighting, temperature control, and automated device management, all tailored to residents' specific needs and preferences. The implementation involves both hardware and software components, ensuring seamless interaction between the user and the system through intuitive interfaces. The result is expected to demonstrate significant energy savings, improved quality of life for people with disabilities, and a scalable model for wider application.

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LIST OF ABBREVIATIONS

ASCII: American Standard Code for Information Interchange

CHAP: Chapter

EN: Enable

GND: Ground

IR: Infrared

CRI: Color Rendering Index

MR: Master Reset

MIC: Microphone

VCC: Voltage at the Common Collector

VDD: Voltage Drain to Drain

LDR: Light Dependent Resistor

VSS: Voltage at the Source

SSII: Computerized Information Subsystems

CHAPTER 1: INTRODUCTION

1.1. Introduction
In the pursuit of creating more inclusive and sustainable living environments, integrating energy efficiency with accessibility for disabled individuals offers a significant opportunity. Modern smart home technologies can effectively address the dual goals of reducing energy consumption and enhancing the quality of life for disabled residents. This project, titled "Design and Implementation of an Energy-Efficient System for Disabled Individuals' Homes" aims to develop a smart home system that optimizes energy use while providing intuitive, user-friendly controls and automated assistance. Through this initiative, the project aims to showcase how technology can transform homes into eco-friendly and accessible spaces.

1.2. Statement of the problem
Many disabled individuals face challenges in their homes due to unreliable electricity, which impacts their safety, communication, and ability to perform daily tasks comfortably. We believe automating lighting can significantly alleviate these issues. Our project aims to develop a remote-controlled system that enhances household tasks, making them quicker and safer. Our goal is to reduce movement within the home, improve access to controls, and enhance overall home security. To achieve this, we have established several objectives for our study. The primary objective is to design and implement an energy-efficient system tailored to the needs of people with disabilities, promoting greater autonomy, ease of use, and cost savings. This system will integrate smart home technologies, energy-efficient devices, and user-friendly interfaces to optimize energy consumption while ensuring accessible control options.

1.3. General objective
The primary objective of this study is to design and construct an electronic circuit for remote control, utilizing hand claps and environmental parameters, to improve accessibility to lighting for individuals with reduced mobility.

1.4. Specific objectives

Recognizing that lighting automation is the most suitable solution for addressing common challenges in homes where individuals have reduced mobility, we have chosen to design an

electronics remote-control circuit. This circuit will manage activities within the household, aiming to minimize travel time, enhance access speed to controls, and improve security. To achieve these goals, our study is focused on the following objectives:

i. Ensure swift control of lighting.
ii. Enhance visibility during nighttime.
iii. Automate tasks that are currently performed manually.
iv. Enhance protection of human health.

This project is of great significance as it encompasses various disciplines such as mechanical design, automation, telecommunications, electronics, and interface development, thereby resembling the principles of mechatronics as an interdisciplinary field.

1.4.1. Potential Research Questions

a. How can energy-efficient systems be tailored to meet the specific needs of disabled individuals?
b. What technologies can be integrated into homes to improve energy efficiency while ensuring accessibility?
c. What are the cost implications of implementing energy-efficient systems in homes for disabled individuals?
d. How effective are current smart home technologies in reducing energy consumption while being user-friendly for disabled individuals?
e. How can user comfort and safety be maximized through the design of energy-efficient homes?

1.5. Scope of the study

The project titled "Design and Implementation of an Energy-Efficient System for Disabled Individuals' Homes" was conducted as a final year project at ULK Polytechnic Institute during the 2023-2024 academic year. The scope of this project includes:

- Constructing a prototype house for demonstration purposes.
- Analyzing energy consumption patterns tailored to the specific needs of disabled individuals.
- Developing smart devices and circuits for energy monitoring and control.

- Implementing user-friendly interfaces customized for various disabilities.

- Integrating renewable energy sources to reduce reliance on conventional power.

- Ensuring compatibility of the system with existing home infrastructure.

- Evaluating the impact of the system on energy savings and user comfort.

- Conducting user training and gathering feedback to facilitate continuous improvement.

1.6. Significance of the study
1.6.1. Personal interest
This project will enable researchers to enhance their knowledge and skills through practical research and implementation. Additionally, it holds potential for financial benefit should the system be adopted by government agencies or disabled centers. Beyond energy conservation, the significance of this project lies in its potential to profoundly impact the lives of disabled individuals. It aims to advance technological and environmental goals, fostering broader societal benefits through innovation and empathy.

1.7. Organization of the study
This study focuses on the design and implementation of an energy-efficient system for disabled individuals' homes. The work is structured into five chapters, distributed as follows:

Chapter 1: Introduction: Presents an overview of the project.

Chapter 2: General Overview of Electric Lighting. Covers fundamental concepts related to electric lighting.

Chapter 3:Reasearch methodology

Chapter 4: system design analysis and implementation. Focuses on the practical implementation of an electronic remote-control circuit and environmental lighting parameters.

Chapter 5: Conclusion, Recommendations, and Suggestions for Further Study

Concludes the study with recommendations and suggestions for future research.

The objective of this study is to automate lighting using light detectors and infrared remote controls operated by hand claps, aimed at easing tasks for individuals with reduced mobility. The hypotheses guiding this study include:

A. Motion detectors can simplify movement within interior spaces for individuals with reduced mobility, automatically turning on lighting as they enter or leave rooms, with adjustable intensity per room.

B. Remote controls enable lighting control from a distance, eliminating the need for physically accessing light switches.

C. Hand claps can serve as a convenient method for issuing commands.

Such a home environment offers significant benefits to the elderly and those with reduced mobility, including enhanced assistance, security, reduced energy consumption, and improved comfort and tranquility. Additionally, it aims to minimize the adverse effects of solar radiation on visual comfort for disabled individuals.

CHAPTER 2: LITERATURE REVIEWS

2.1. Introduction

This chapter focuses on the essential theory and critical assessment of related work necessary for the development of the project; it also seeks to present the main arguments and publications. by different experts on the subject of design and implementation work of a system energy efficient for people with disabilities homes. An in-depth analysis of the elements that influence the power factor as well as the control devices necessary to achieve the desired objectives in the energy field was carried out.

2.1 Concepts, Opinions, and Ideas from Authors/Experts

Key Concepts

1. Universal Design:

- Universal design principles ensure that homes are accessible and usable by all people, regardless of age, disability, or other factors.
- Incorporating features such as adjustable countertops, wide doorways, and non-slip flooring can significantly enhance the livability of a home for disabled individuals.

2. Smart Home Technology:

- Integration of smart home systems (e.g., voice-activated controls, automated lighting, and climate control) can greatly improve the independence and comfort of disabled individuals.
- Energy-efficient smart appliances can reduce energy consumption and lower utility bills.

Opinions from Experts

Electrical power control systems play a crucial role in this design by enabling users to manage their home appliances and systems with greater ease and efficiency. These systems often incorporate smart technology, allowing users to control lights, heating, and other devices through voice commands or mobile applications. This not only enhances accessibility but also promotes

independence, as individuals can perform tasks that might otherwise require assistance from caregivers or family members. For instance, smart plugs and automated lighting can be programmed to respond to specific needs, reducing the physical effort required to manage daily activities.

Moreover, energy efficiency is a significant consideration in the development of these systems. By integrating smart sensors and automation, the energy consumption of the home can be optimized, leading to lower utility bills and a reduced environmental footprint. Features like motion-sensor lighting and programmable thermostats ensure that energy is used only when necessary, which is particularly beneficial for disabled individuals who may have limited mobility. Additionally, the implementation of renewable energy sources, such as solar panels, can be explored to further enhance sustainability and energy independence. This holistic approach not only addresses the immediate needs of disabled individuals but also contributes to a more sustainable and energy-efficient living environment, ultimately improving their quality of life while promoting independence and self-sufficiency.

1. **Personalization and flexibility**:

- Experts emphasize the importance of personalized solutions that cater to the specific needs and preferences of the individual.
- Flexibility in design allows for future modifications as the individual's needs change.

2. **Cost and accessibility:**

- The initial cost of implementing energy-efficient systems can be high, but long-term savings on energy bills and the improved quality of life can justify the investment.
- Governments and organizations should provide subsidies or financial assistance to make these technologies more accessible to those in need.

Ideas for Implementation

1. **Technologies:**

- Use of adaptive technologies such as motion sensors and adaptive lighting that adjust based on the presence and activity of the individual.
- Implementing systems that can learn and adapt to the user's routines and preferences over time.

2. **Energy-Efficient Retrofits:**

- Retrofitting existing homes with energy-efficient windows, insulation, and HVAC systems can improve energy efficiency without the need for complete reconstruction.
- Adding smart plugs and energy-efficient lighting can further reduce energy consumption.

3. **User Training and Support:**

- Providing training and ongoing support to users ensures they can effectively use and benefit from the energy-efficient systems.
- Establishing a support network that can assist with troubleshooting and maintenance issues.

2.2. Theoretical perspectives

Lighting is provided by devices that transform electrical energy into light, thus meeting the lighting needs in various places such as halls, lecture theaters, and roads.

Figure 1: A light bulb

2.2.1. The history of lighting

From the beginning, we have been talking about lighting. This notion is familiar to everyone, but what exactly is its definition? In many dictionaries related to the development of public spaces to ensure the safety of people and property, the term "lighting" is not always clearly defined, with the exception of that of Pierre Merlin and Françoise Choay. They define public lighting as "the diffusion of artificial light to extend daytime activities, beautify, and enliven the city.".

Electric lighting began around 1840 with the use of arc lamps (Davy, 1813), but it did not really develop until the invention of the incandescent lamp by Edison and Swan in 1879.

Figure 2: History of lighting

2.2.2. Lighting use sector
2.2.2.1. Industrial use

Industrial lighting must comply with standards relating to workstation lighting. This type of lighting is specifically designed for the premises where it is installed, taking into account volume, dust, and maintenance constraints. It is used in industries carrying out fine and precision mechanical tasks, as well as in the electronics sector. Lighting in industrial environments is generally designed in a simple manner, with particular attention to efficiency and ease of use, while being equipped with energy-efficient sources. Certain industrial sectors, notably chemicals, require the use of protected devices.

Figure 3: Industrial lighting (b)

Figure 4: Industrial ligthing (a)

2.2.2.2. Medical and hospital use

- Lighting in operating rooms, certain examination and treatment rooms, as well as rooms dental practices use suitable lighting devices for high-level lighting, luminance control, color temperature spectrum,
- Premises lighting is essentially utilitarian, and so on.

Figure 5: Medical and Hospital lighting use

2.2.2.3. Safety lighting

Safety or emergency Lighting is crucial in workplaces and public spaces to ensure safe evacuation in the event of an emergency. According to regulations, these lights are designed to be bright enough to guide occupants to the exits, even if the main lighting fails.

Figure 6: Safety lighting

2.2.2.4. Agriculture

Some countries have specialized in greenhouse cultivation, where temperature and lighting are controlled to accelerate the maturation of plants. This method uses lamps that emit wavelengths specific to the needs of the plants. In the same way, intensive battery poultry farming uses lighting to accelerate growth by reducing the length of the day-night cycle.

Figure 7: Lighting use in Agriculture

2.2.2.5. Museums and art galleries

Since the 1990s, fiber optic technology has been used to direct light over short distances ranging from a few tens of centimeters from a source to the object to be highlighted. This method makes it possible to obtain precise and discreet lighting, which can be elegantly integrated into a presentation window. In addition, it has the advantage of diffusing very little infrared, thus reducing the risk of temperature rise inside the display case, which is crucial for the preservation of works of art.

Figure 8: Lighting use in museums

Figure 9: Lighting use in Art galleries

2.2.3. Types of lighting
2.2.3.1. Interior lighting

Interior lighting systems fall into two main categories: manual controls and automatic controls. Manual controls, although often more economical, require regular human intervention. For example, manually turning off lights at the end of the day as part of a daily routine can be an effective solution for industrial buildings with fixed working hours. On the other hand, in office buildings with groups of switches near elevators, employees may leave the lights on when they leave because they don't know which switch controls which area of the building.

Figure 10: Interior lighting

2.2.3.2. Exterior Lighting

Outdoor lighting is often regulated by sensors or computerized systems to ensure efficiency and effectiveness. Common control systems include photocells, which activate lighting only during nighttime. Additionally, outdoor lighting can be managed through automatic or manual controls. For instance, public lighting systems typically employ a combination of these methods to optimize energy use and, concretely.

Figure 11: External lighting

2.3 Related study

Combining these areas : Assistive technology, Energy efficiency in residential buildings, universal design, smart home technology , environmental and sustainability studies can lead to the development of a system that is not only energy-efficient but also tailored to meet the needs of disabled individuals.

"For this study, several relevant works were examined, including that of:"

- Kotler P .(1973-1974) argued that lighting plays a crucial role in creating an atmosphere in a point of sale, thus contributing to the store's image. Lighting is a visual dimension that improves the perception of the internal environment and allows a better representation of products thanks to directed light. It not only ensures good visibility of products and facilitates the movement of customers in the store, but it also helps create an atmosphere, both inside and outside, thus influencing buyer behavior.

- Mehrabian (1976) actually examined the impact of lighting on the emotional states of individuals. He noted that stimulating lighting environments can induce states of excitement and nervousness, while more relaxing lighting tends to promote feelings of relaxation and calm. This research highlights how lighting can influence people's perceptions and behaviors based on the atmosphere created by the light.

- Markin R. J et alii (1976) suggest using soft lighting for retailers wishing to extend the time spent by their customers in the store. Lighting therefore, appears an active component of store layout as well as a vector of their commercial policy. The lighting to be used depends on the nature of the product, the marketing style, customer needs and expectations (The Association Française de l'Éclairage, 1992).

- Samir Triki's dissertation on "Design and production of a lighting management system for a photovoltaic house" aims to optimize lighting comfort while minimizing electrical energy consumption. The proposed system is based on the following principle: artificial lights in each room are only turned on when a person is present and the available natural light is insufficient to achieve the required level of light comfort. This approach allows efficient lighting management by reducing electrical energy consumption, especially in the context of a house equipped with photovoltaic panels.

Here is a slightly revised version:

" On a scientific level, this work will make it possible to apply the knowledge acquired during university training. In addition, it will provide valuable documentation to researchers wishing to pursue investigations in the same field.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter describe different researches and procedures of conducting this project called "Design and Implementation of an Energy Efficient System for Disabled Individuals' Homes" where the researchers design its circuit diagram depending on their objectives. Therefore, materials and equipment are used to implement this research project and describe the steps of how it is conducted. It classifies the research methods used to collect all date , analyze the system and design it.

3.1 Research Design

In order to obtain satisfactory outcomes, I have used different methods and techniques for carrying out this research and data collection. The design and implementation of an energy efficient system for disabled individuals' homes is done by taking references and consultation with those having more experience such as facilitators, lecturers, GATAGARA health center, CONGO Handicap and Clinical Hospital, different views done by researchers and internet .

3.2 Research population

I have also found the information in our country that there is a problem. The research population for this study includes people with disabilities residing in urban areas, focusing specifically on those living in City X. This population includes people with physical, sensory, or cognitive disabilities who are over the age of 18. The study particularly targets those who regularly use more than three electrical devices per day, because this use can highlight challenges and needs related to accessibility and autonomy within their living environment. Inclusion criteria ensure diverse representation of disabilities, with the aim of collecting comprehensive data on the experiences and requirements of this group. This research aims to inform better design practices and policy recommendations to improve accessibility in urban housing.

3.3 Sample Size

For determining an appropriate sample size, statistical power analysis is essential to ensure that the results are both reliable and representative of the population. The key factors to consider include the desired confidence level, margin of error, and the variability within the population.

For instance, to achieve a 95% confidence level with a 5% margin of error, a sample size of around 50 households might be chosen. This size is often sufficient to capture a diverse range of

disabilities, allowing for meaningful analysis while balancing practical constraints such as time and resources. The actual number may vary based on the specific characteristics of the population and the study's objectives.

3.3.1 Sampling Procedure

To assess the energy efficiency system, a purposive sampling method was employed, targeting homes with diverse disabilities. The sample included 50 households equipped with various assistive technologies. Data collection involved energy usage monitoring for a six-month period, focusing on heating, cooling, and lighting systems. Energy consumption was compared against local averages to identify efficiency improvements. Participants' feedback on system usability was gathered through structured interviews. This data provided a comprehensive understanding of the system's performance and areas for enhancement.

3.4 Research Instrument

1. Surveys and Questionnaires: Collect data from disabled individuals, caregivers, and healthcare professionals to understand their needs, preferences, and current challenges related to energy efficiency.

2. Interviews: Conduct interviews with stakeholders to gain deeper insights into specific requirements and experiences related to energy use and accessibility.

3. Case Studies: Analyze existing energy-efficient systems implemented in similar settings to identify best practices and areas for improvement.

4. Observations: Observe how energy is used in homes of disabled individuals to identify inefficiencies and areas where energy-saving technologies could be beneficial.

5.Technical Assessments: Perform energy audits to assess current energy consumption and identify potential areas for implementing energy-efficient solutions.

6. Usability Testing: Evaluate the practicality and effectiveness of proposed energy-efficient systems in real-world scenarios to ensure they meet the needs of disabled individuals.

Each of these instruments can help gather comprehensive data to design and implement a system that is both energy-efficient and tailored to the specific needs of disabled individuals.

3.4.1. Choice of the research instrument

By choosing the type of research instrument I used surveys, interviews and observational studies and experimental setups have the effectiveness of the data for the realization of my project.

1. Surveys : I used surveys to quickly collect data and information from a large population at health centers and hospitals by asking various questions."

- ➤ What specific daily challenges do you face related to mobility, access, and safety in your home?
- ➤ What are common accessibility and safety issues faced by disabled individuals at home ?
- ➤ What feedback have you received from patients about the benefits and challenges of implementing such systems ?
- ➤ What considerations should be prioritized when designing systems for disabled individuals' homes ?
- ➤ How do you feel about the idea of an energy-efficient system tailored to your needs?

People are ideal if your project involves understanding general trends, attitudes, or good behaviors.

2. Interviews and observational studies: I used observational studies to collect data on behaviors, actions and phenomena in their natural environments by asking questions such as:

- ➤ How do you currently manage energy consumption in your home ?
- ➤ What are your top priorities when considering changes or upgrades to your home ?
- ➤ Do you provide advice on energy management for patients transitioning to home care?
- ➤ What are the most energy-intensive devices or systems commonly used by disabled individuals at home ?
- ➤ How do you feel about investing in energy-efficient solutions if they could reduce long-term costs?

This method is particularly useful if your project involves the study of interactions, processes or environmental factors.

3. Experimental setups: I used this to establish cause and effect relationships by manipulating variables in a controlled environment, asking questions such as:

➢ What emerging technologies have you observed to significantly improve the quality of life for disabled individuals?

➢ How can health centers and hospitals collaborate with designers and engineers to ensure the energy-efficient system meets the medical and daily living needs of disabled individuals?

➢ From your experience, what improvements in quality of life have you observed when disabled individuals have access to better designed home environments ?

This method is appropriate if your project requires testing specific hypotheses or interventions and observing their effects.

3.5. Data Gathering procedures
3.5.1. Data Collection
Data collection procedures are crucial to understanding energy consumption patterns and the unique needs of people with disabilities. Data collection will involve a mixed-methods approach, including surveys and interviews with residents, caregivers and healthcare professionals to gather qualitative information on daily activities and specific energy needs. Additionally, quantitative data will be obtained through the installation of energy monitoring devices in selected homes to track energy consumption in real time. This dual approach will provide a comprehensive understanding of how energy is consumed and identify areas where efficiency improvements can be made to better meet the needs of residents. The data collected will serve as the basis for designing a tailor-made energy-efficient system that improves comfort and accessibility for people with disabilities.

3.5.2. Procedures Followed
For this project, the procedures followed included a comprehensive approach starting with a needs assessment to identify the specific efficiency requirements of people with disabilities energy and accessibility. The project then carried out a literature review to explore existing technologies and systems, followed by stakeholder consultations, including engagement with potential users and experts in relevant fields. Technology selection involved evaluating and choosing components based on their efficiency and usability. A prototype was developed and tested in selected homes, with data collected on performance and user feedback. The system was refined based on these results and a detailed implementation plan was created, including a

scalability assessment and deployment strategy. The process concluded with comprehensive documentation and reporting of findings.

3.6. Data Analysis and interpretation
The implementation of our circuit involved five stages:

- **First stage:** This was the most challenging stage as it required gathering bibliographical and technical information and identifying the techniques needed to achieve the objective.
- **Second stage:** Testing the assembly in the ISIS environment.
- **Third stage:** Building the complete assembly on a test plate, followed by constructing a model.
- **Fourth stage:** Interpreting the results.

3.7. Ethical Considerations
3.8. Limitations of the Study
The primary limitations of this study may include constraints related to the diversity and size of the participant pool, which could limit the generalizability of the findings. The study may also face technological challenges, such as the integration and interoperability of various energy-efficient devices and smart home technologies tailored to different disabilities. Financial limitations could restrict the scope of system deployment and testing, while time constraints may limit long-term observation of energy efficiency benefits. Additionally, ethical considerations and the need for informed consent might pose challenges in ensuring the accessibility and usability of the system for all participants, potentially affecting the comprehensiveness of the evaluation.

CHAPTER 4: SYSTEM DESIGN ANALYSIS AND IMPLEMENTATION

4.0. Introduction

In this chapter we will explore the methodologies used to achieve an optimal balance for this project: Design and implementation of an Energy Efficient System for Disabled individual's homes.

This project consists of two designs, namely the material design, which includes the physical components, and the design involving programming tools (Proteus ISIS). This chapter will provide valuable information and implementation strategies to ensure that the system is both efficient and user-friendly.

4.1. Calculations

- CD 4014

U= 9V   Imax= 10 mA

P=U(V)*I(mA) = 9*10 = 90 mW

- **Buzzer**

U= 5V Imax = 20 mA

P= 5V*20 mA= 100 mW

- **N-Channel MOSFET**

Rgate = 10KΩ   Vgate= 5V

Igate = V/R= 5V/10kΩ= 0.5mA

P= 5*0.5= 2.5 mW

The total power is 5 mW because we have two transistors.

- **2N2222 Transistor**

U= 9V Imax= 800mA

P= 9*800= 7200 mW

- **LDR**

U= 9V   Imax= 10mA

P= 9*10= 90mW

- **Infrared sensor**

U= 5V Imax = 20mA

P= U*I = 5*20 = 100mW
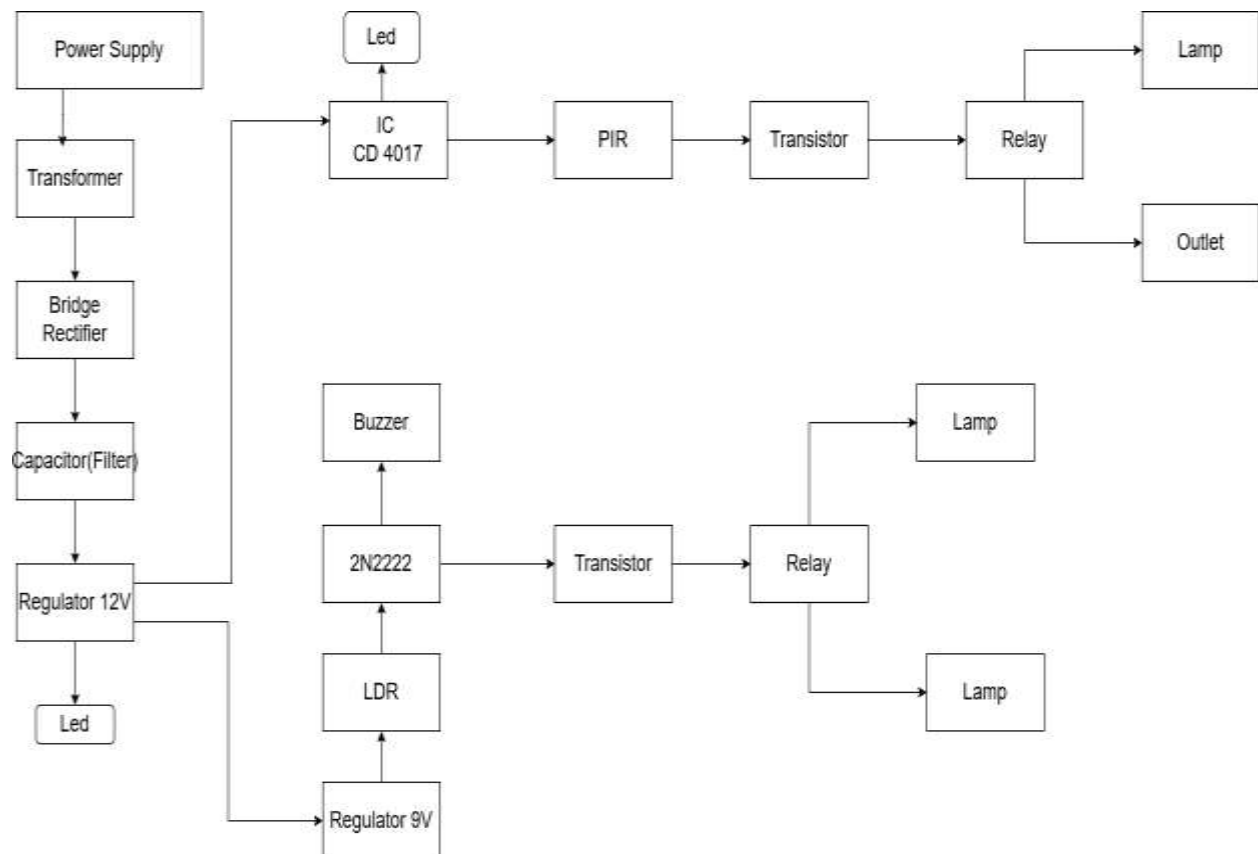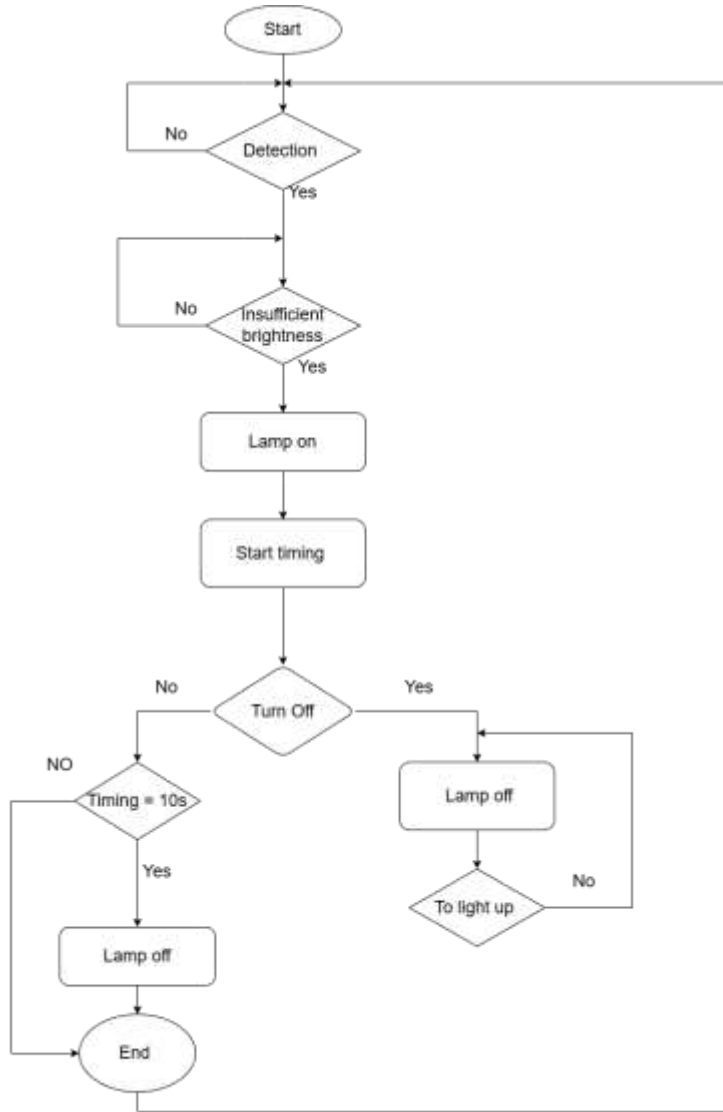
- **Relay**

U= 5V Imax= 20mA
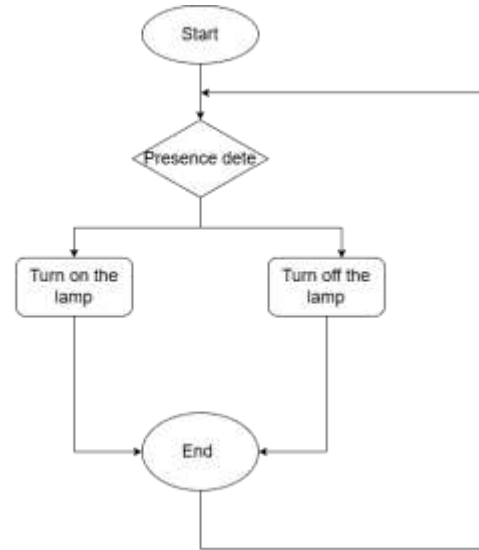
P= 5*20= 100 mW

4.2. Drawing

A. Block diagram

B. Flowchart

Interior Lighting Flowchart

Flowchart of presence detector
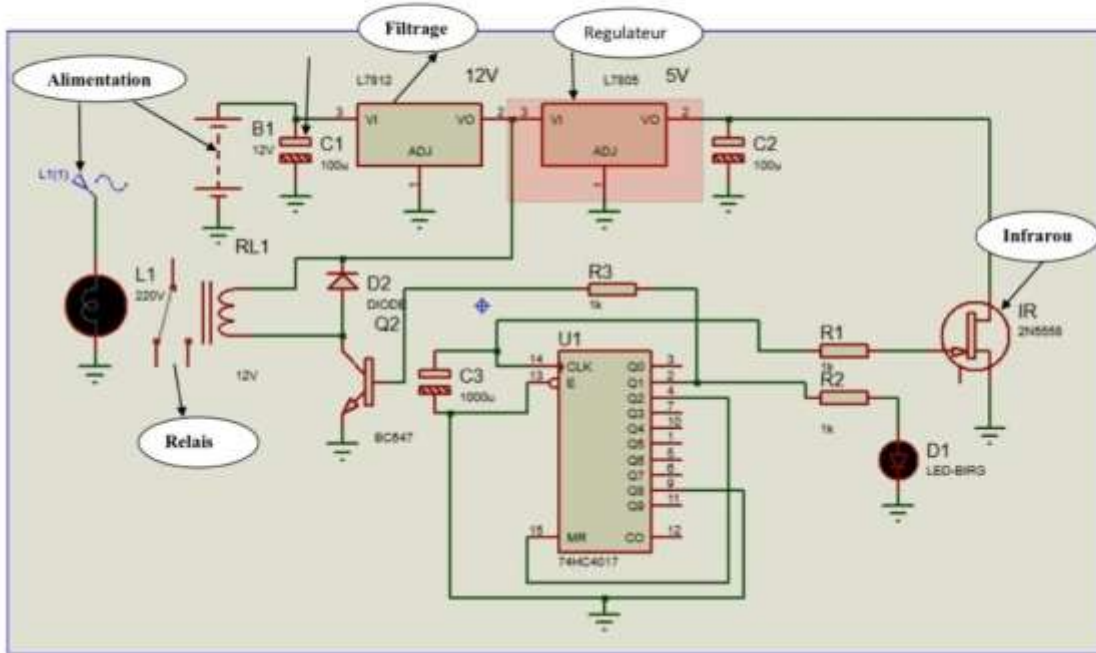
C. Circuit

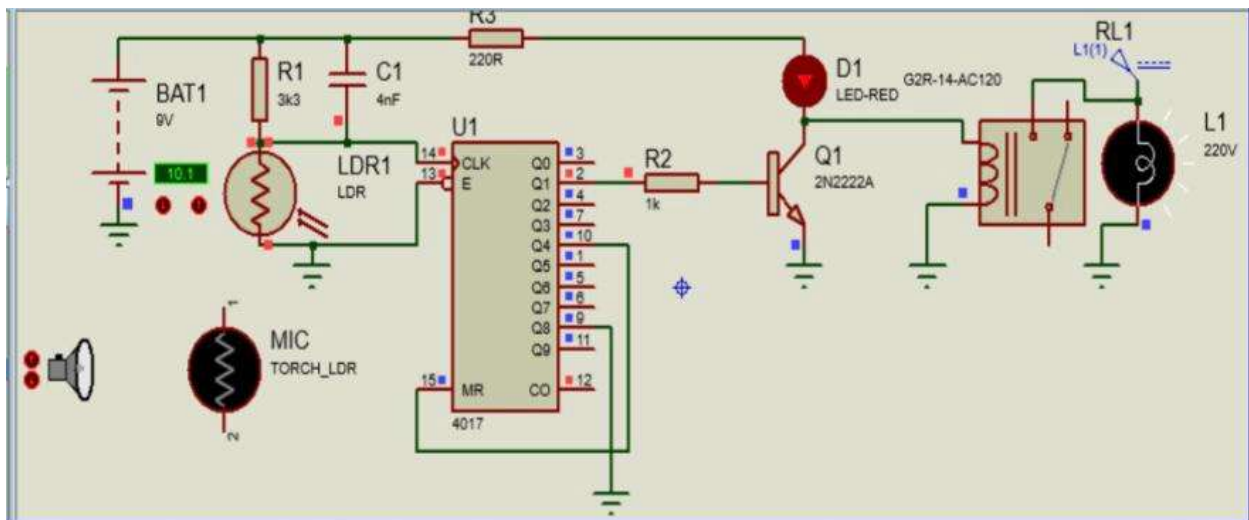*Figure 12: Electronic circuit of our project*

Figure 13: Electronic circuit of our project with presence detector

4.3. Specification

№	Component name	Specification	Number of components
1	Transformer	Input voltage: 220V Output voltage: 12V Frequency: 60Hz Rated Power: 24W Efficiency: 95% Temperature Rating: -20℃ to +60℃	1
2	Incandescent lamps	Voltage Rating:220V AC Power: 9W Luminous flux : 800 lumens Lamp Type : LED Energy Efficiency: A+ Beam Angle: 120□	6
3	Electrical socket or socket outlet	Voltage Rating : 220V Current Rating : 16A Socket type: E Material quality: retardant plastic body Safety Features: Surge protection	1
4	Electrical Switch	Voltage Rating: 120/220V Current Rating: 15A Switch Type: Single-Pole Safety features: Overload protection Additional features: Illuminates switch indicator	2
5	Light socket	Voltage Rating: 220-250V Current Rating:10A Socket type:E27 Material: Thermoplastic Temperature Rating: 100℃	6
6	Relay	Coil voltage: 5V Contact Rating: 10A at 250V Contact type: SPDT(Single pole double throw) Coil Resistance: 70Ω	2

		Switching time: 10 mS	
		Isolation: 4kV between coil and contacts	
		Operating temperature: 40℃ to 85℃	
7	Infrared sensor TSOP1738	Operating Voltage: 3.3V to 5V	1
		Detection Range: 2Cm to 80Cm	
		Sensor types: PIR (Passive infrared)	
		Current: 15 mA	
		Response time: <500 mS	
		Operating temperature: -20℃ to 70℃	
		Dimensions: 15mm	
8	LDR	Light sensitivity: 0 to 10000lux	1
		Resistance Range: 1M Ω and 10M Ω	
		Response time: 10 ms for rise time and 20ms for fall time	
		Operating Voltage: 3V to 12V	
		Size and Form factor: 5mm	
		Temperature Range: -20℃ to +70℃	
9	Integrated circuit CD 4017	Counting Range: from 0 to 9 in decimal	1
		Output configuration: Provides 10 output pins (Q0 to Q9)	
		Input Pins: clock(CLK), Reset(R), Carry out(Co)	
		Power supply: 3V to 15V	
		Current: Up to 10mA	
		Propagation Delay : 50ns	
		Package Types : DIP-16, SOIG-16	
10	2N2222	Type: NPN	3
		Collector-Emitter voltage (Vc Bo): 40V	
		Collector-Base Voltage (Ve bo): 6V or 0.7V	
		Collector Current (Ic): 800mA	
		Power Dissipation (Plot): 500mW	
		DC Current Gain (hFE): 100 to 300	
		Transistor Frequency (Ft): 250MHz	
		Package: To-92 (Plastic)	

		Pin1: Emitter (E)	
		Pin2: Base (B)	
		Pin3: Collector (C)	
11	Resistance	Resistance value: 1kΩ (1000 ohms)	6
		Tolerance: ± 5%	
		Power Rating= ¼ W	
		Voltage Rating: 220V	
		Temperature Coefficient: ± 100 Ppm/	
		Type: fixed	
12	LEDs	Forward Voltage (VF): 3.3V	3
		Forward Current (IF): 10 mA	
		Viewing Angle: 15□	
		Maximum Power Dissipation: 75 mW	
		Lifespan: 25000 hours	
13	BUZZER	Operating voltage: 6V	1
		Current Consumption: 20 mA	
		Sound level: 90 dB	
		Frequency: 5 kHz	
		Types: Piezoelectric	
		Size: 20mm	
		Operating Temperature: -20℃ to +70℃	
14	Remote Controller	Power supply: 1.5V	1
		Physical Dimensions: 58mm	
		Type: TV Remote control	
		Manufacture: ABC Electronics	
		Infrared(IR) range: up to 25 feet (7.6 meters)	
		Frequency: 36KHz	
		Safety features: Low battery indicator	
15	Capacitor	Type: Electrolytic capacitor	1
		Capacitance: 4.7 µF	
		Tolerance: ± 20 %	

		Rated voltage : 25V DC	
		Temperature Range: -40℃ to +80℃	
16	Diode	Maximum Reverse voltage: 100V	1
		Forward current(IF): 1A	
		Forward voltage drop (VF): 0.7V	
		Power dissipation(P): 1W	
		Junction temperature(JT): 150℃	
		Surge current rating: 30A	

4.4. Working principle

The core principle of my project is to control the automatic switching on and off of lamps using a photoresistor sensor, infrared sensor, and sound sensor.

- At 0% switching, the lamps remain off because the ambient light is strong (e.g., sunlight).
- At 50% switching, the lamps partially turn on due to low ambient light (such as during sunset or overcast conditions).
- At 100% switching, the lamps are fully illuminated when the infrared sensor detects movement.

4.5. Implementation

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.0. Introduction

As we conclude this chapter, it becomes evident that the integration of energy-efficient technologies not only enhances the sustainability of homes for disabled individuals but also significantly improves their quality of life.

5.1. Conclusions

In recent years, the fields of computer science, electronics, and communication technology have significantly advanced and found application in residential design. These technologies aim to assist residents in various domestic situations, enhance comfort, improve living conditions and security, and enable energy savings.

Within this framework, we developed a system tailored for individuals with reduced mobility, focusing on efficient use of limited space. The system is based on the CD4017 (or HCF4017) circuit, which serves as the control unit. Additionally, we implemented an automated communication protocol to facilitate remote control of the lighting system. Our project sought to enable automatic operation of the lighting, both from within and remotely, while also addressing building security and the needs of a facility for individuals with disabilities.

Despite facing some challenges related to material availability during the project, we successfully met the primary objectives. This project provided us with an excellent opportunity to enhance our skills, deepen the knowledge we gained during our university studies, and explore the promising field of automation. The experience has equipped us with practical expertise that will undoubtedly benefit us in the future.

5.2. Recommendations

I declare that the project titled "Design and Implementation of an Energy-Efficient System for Homes of Disabled Individuals" represents a forward-thinking approach to enhancing the quality of life for disabled individuals through the adoption of energy-efficient technologies. This initiative aims to create accessible, sustainable, and smart home environments that enhance comfort and autonomy while reducing energy consumption.

To further improve comfort and safety, several enhancements can be explored. Potential additions to the system include multimedia management, comprehensive surveillance with

internal and external cameras, and a communication network system for controlling home functions and managing interactions with the disabled care center

5.3 Suggestion for further study

User Experience and Accessibility Evaluation: Perform an analysis to evaluate how the energy-efficient system affects the daily lives of individuals with disabilities. Emphasize aspects such as usability, comfort, and overall satisfaction by conducting user surveys and interviews. This evaluation will pinpoint areas for enhancement and ensure the system addresses the varied needs of its users effectively.

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APPENDICES

Components	Packets	Unit cost (RWF)	Total cost (RWF)
Transformer	1	10,000	10,000
Incandescent lamps	6	1,000	6,000
Socket outlet	1	2,000	2,000
Electrical switch	2	2,000	4,000
Light socket	6	2,000	12,000
Relay	2	3,000	6,000
Infrared sensor TSOP1738	1	5,000	5,000
LDR	1	2,000	2,000
Integrated circuit CD 4017	1	5,000	5,000
Transistor 2N2222	2	1,000	2,000
Resistance	7	300	

			2,100
LEDs	3	250	750
BUZZER	1	1,500	1,500
Remote controller	1	7,000	7,000
Capacitor	4	1,000	4,000
Diode	1	500	500
MOSFET	4	2,000	8,000
Bridge rectifier	2	3,000	6,000
Circuit breaker	1	6,000	6,000
PCB board	2	1,000	2,000
Board	1	4,000	4,000
Screw	12	300	3,600
Silicon	1	8,000	8,000
Super glue	8	700	5,600
Bristle paper	3	2,500	7,500

Box	5	2,000	10,000
Jump Wires	4	300	1,200
Metallic box	1	3,000	3,000
Total			134,750

Components	Image
	Transformer
	Incandescent lamp
	Socket outlet
	Switch

	Light socket
	Relay
	Infra-red
	LDR
	Integrated circuit CD4017

	Transistor 2N2222
1=Emitter 2=Base 3=Collector	
	Resistance
	LEDs
	BUZZER

	Remote controller
	Capacitor
	Diode
	MOSFET
	Bridge rectifier

	Circuit breaker
	PCB board
	Wires