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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

OPTION: ELECTRICAL TECHNOLOGY

FINAL YEAR PROJECT

DESIGN AND IMPLEMENTATION OF AN AUTOMATIC CURTAINS OPENING AND CLOSING CONTROLLER SYSTEM USING ARDUINO UNO

Final year project Submitted in Partial Fulfillment of the Requirement for the Award of Advanced Diploma in Electrical Technology.

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Kigali,October 2024

DECLARATION A

I, Alistone BYUKUSENGE Declare that this research 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 without the authors' consent or that of ULK Polytechnic Institute.

Student's names: BYUKUSENGE Alistone

Sign: ____________________________ Date: _________________

DECLARATION B

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

Supervisor's name: Annuarita GATESI

Sign……………………………. Date………………

DEDICATION

I would like to dedicate this project to my family, who have been my constant source of love, support, and inspiration throughout my academic journey. Your unwavering encouragement and belief in my abilities have been invaluable, and I am grateful for the sacrifices you have made to help me pursue my dreams.

My gratitude goes to my lecturers, whose guidance and expertise have challenged me to grow and develop as a student. Your dedication to teaching and commitment to excellence have been a source of motivation and inspiration, and I am honored to have had the opportunity to learn from you.

Finally, I would like to acknowledge my family members, classmates and friends, whose camaraderie and support have made this journey even more fulfilling. Your encouragement, collaboration, and friendship have helped me to overcome obstacles and celebrate achievements, and I am grateful for the memories I have shared.

This project is a testament to the power of collaboration, dedication, and perseverance, and I am proud to share it with you.

ACKNOWLEDGEMENT

I would like to express my gratitude to the almighty God for blessing us with strength and courage to complete this project. From the beginning until the end of this project, I have so many people who stand by us; gives guidance for every obstacle that stand in my way. Therefore, I would like to express my deepest appreciation to those involved in this project.

I would like to express my gratitude and to my project supervisor who had showered us with ideas and guidance through the whole time the last second. I will never forget all your sacrifices and only God could ever repay that you have done for us.

Finally, yet importantly, I cannot forget to thank ULK Polytechnic Institute.

ABSTRACT

Home automation systems are growing in popularity because they can increase convenience, comfort, and energy efficiency. Automating curtain control is a crucial component of home automation because it maximizes the use of natural light, which can lower energy costs by reducing the need for artificial lighting and increase indoor comfort. Hand-operated curtains frequently result in inefficiencies, like daytime exposure to excessive sunlight or underuse of natural light, which raises the cost of energy for lighting, heating, and cooling. Furthermore, regular manual adjustments might be cumbersome, especially for windows that are difficult to reach or for people who are elderly or disabled. I suggest an Arduino Uno-based automatic curtain opening and shutting system as a solution to this problem. Light Dependent Resistor (LDR) sensors are used by this system to sense the amount of ambient light and modify the curtain position accordingly. The curtains open to let daylight into the room when there is enough natural light detected, which lessens the need for artificial illumination. On the other hand, to preserve comfort and privacy, the curtains close when light levels drop or become too strong. The curtains are physically moved by a motor (a DC motor), which is controlled by the Arduino Uno microcontroller once it has processed the data from the LDR sensors. In addition, the system has physical switches for manual control, enabling users to override automatic processes as needed. This straightforward yet efficient method provides an economical means of incorporating smart technology into homes, offering advantages in terms of reduced energy use and improved user comfort. This project shows how accessible technologies like Arduino and sensors can be used to improve everyday living circumstances in a sustainable and intelligent way by automating curtain control.

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LIST OF ACCRONYMS AND ABBREVIATIONS

RTC: Real-Time Clock

IDE: Integrated Development Environment

DC: Direct Current

IoT: Internet of Thing.

NC: normally closed

USB: Universal Serial Bus

LDR. Light Dependent Resistor

I/O: Input/output

CHAPTER 1: GENERAL INTRODUCTION

1.0 Introduction

This chapter presents the design and implementation of an automatic curtain control system based on Arduino Uno. It explores the use of Light Dependent Resistor (LDR) sensors for detecting ambient light, automating curtain movement to optimize natural light and reduce energy consumption. The system components, including Arduino Uno, motors, and sensors, are analyzed. The chapter also outlines the project's objectives, scope, and significance, highlighting its contribution to energy efficiency and home automation solutions.

1.1 Background of the study

The history of curtain used dates to the early 31st century BC, when the great Egyptians invented and utilized curtains for the duration of their rule. Animal hides were used to make the first curtains, which were hung on hooks in doors. Nonetheless, over time, the Egyptians spun fabrics from flax and linen, then wool and silk. These were extremely valuable because, according to Encyclopedia Britannica, another discovery of curtain panels dates to the 6th and 7th century B.C. (blinds and curtains) (Encyclopedia Britannica, 2023). These materials were more flexible but yet supplied a similar layer of warmth as that from the skins. In the ruins of the modern Greek Olynthus culture and the Italian Pompeii and Herculaneum civilizations. It is hypothesized that instead of using window treatments proposed, these people employed curtain panels to partition rooms (James, Peter, 2014).

Since the early to Middle Ages are sometimes referred to as the "dark ages," there isn't much evidence of curtain use during this period. However, between the sixth and the fifteenth centuries, it is assumed that, at the very least, the wealthier individuals draped curtains over windows and at doors to stay warm. Those big castles can be chilly, dark, and quiet (Koller, Anny, 2019).

1.2 Statement of the problem

For most people, opening and closing every curtain twice a day may not only be annoying but simply impossible because they have physical limitations like live in a home with many of windows, or have windows that are hard to reach. After many observations made to analyze the effort that some people used to put at work but neglected to close the curtains in their offices for the sun lighting and oxygen reasons, we decided to overcome this existing challenge by designing and implementing an Automatic Curtains by Opening and Closing Controller System.

1.3 Research objectives

1.3.1 Main objective

The main objective of this Research is to design and implement an Automatic Curtains by Opening and Closing Controller System.

1.3.2 Specific objectives

(i) To extend knowledge in automatic curtains opening and closing system controllers.

(ii) To analyze the time spent during opening and closing the window curtains.

(iii) To increase safety in office, institutions.

1.4 Research questions

(i) What automatic curtains opening and closing system controller?

(ii) How to manage the time spend to open and close curtains manually?

(iii) How to control curtains automatically will increase safety?

1.5. Scope

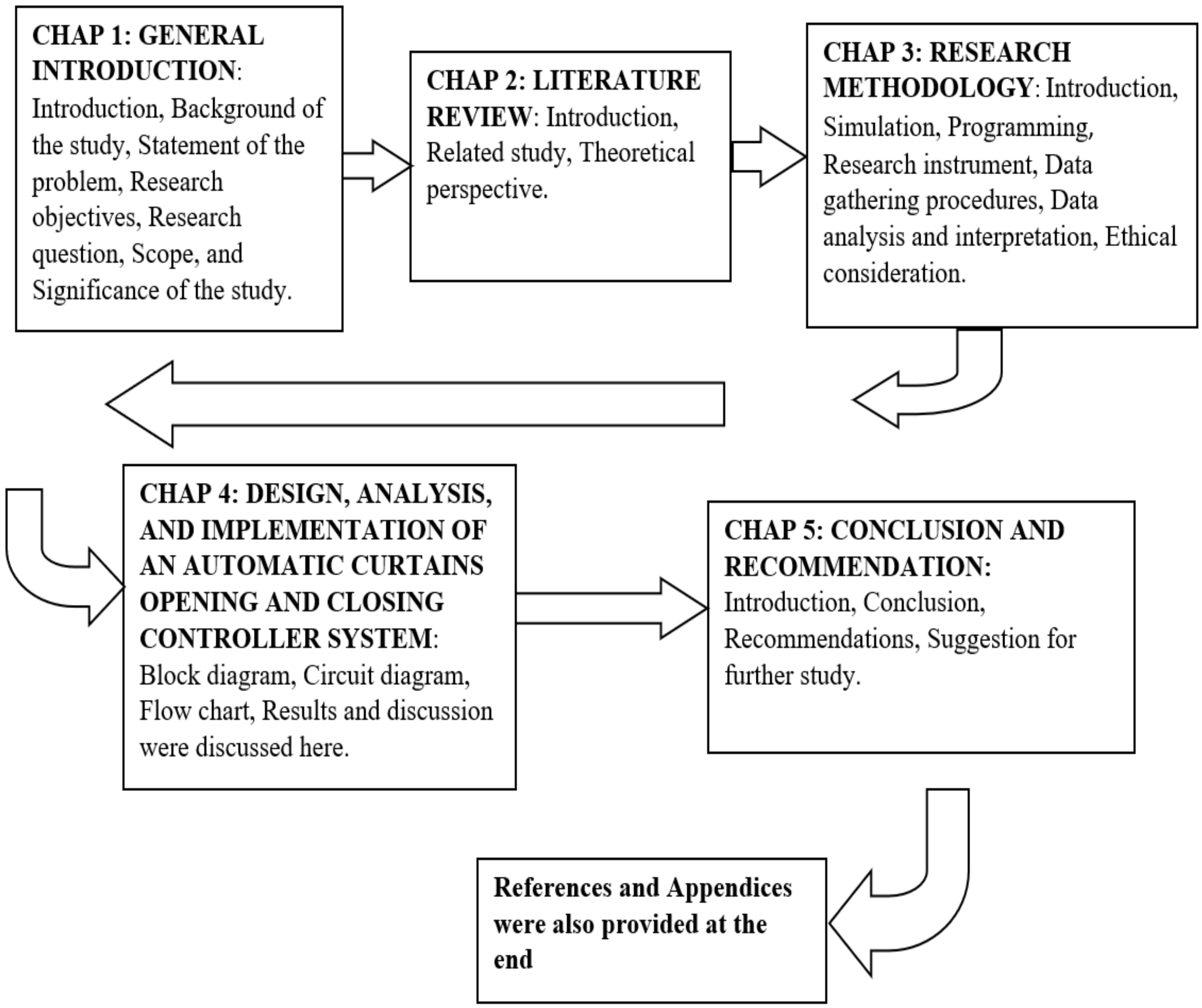
This project is based on the Design and Implementation of Automatic Curtains Opening and Closing Controller System by using Arduino Uno.

1.6. Significance of the study

Since technology is advancing so quickly these days, I'm taking advantage of the chance to leverage my engineering background to investigate the possibility of utilizing this microcontroller to build an effective and user-friendly automation system for curtain control. When taking into account aspects like hardware connectivity, programming, and sensor integration, most individuals can generally grasp this topic and learn more about how to incorporate the Arduino Uno into a curtain control system. Then, using this knowledge, useful solutions for automating curtain opening and closing procedures in a variety of locations, including homes, workplaces, or retail establishments, can be implemented with the aim of enhancing user experience, convenience, and energy efficiency.

1.7 Organization of the studies

The following block diagram depicts the organization of the whole project in five chapters:



CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter describes the previous related research, conceptual notes on automated opening and closing Curtains System as well as description of all components related to the topic so that we can develop our new idea based on the existing system.

2.2 Related study

Automating the opening and closing curtains involves a blend of several disciplines, including electronics, mechanical engineering, and software development. Let us see some key aspects and related studies that might help us:

(Orji, E.Z, 2018), in their research entitled “The paper of automatic door control system using Arduino microcontroller was designed”. The system combined ultrasonic sensor, servo, and Arduino to achieve the desired goal. When the ultrasonic sensor installed at the entrance of the building detects a person or an object within the range of the sensor, a signal is sent to the Arduino microcontroller which controls the servo motor to automatically open the door.

(Karande and Sriskanthan, 2015), the study focused on “developing a home automation system that utilizes Arduino Uno as a central controller”. The system is integrated with IoT capabilities, allowing users to control various home appliances, including curtains, through a smartphone app. The study highlights the versatility of Arduino in handling multiple sensors and actuators, enabling automated tasks based on environmental conditions such as light intensity or time of day.

(H. Elkamchouchi and M. Elkamchouchi, 2015), they explored the “development of an Arduino-based home automation system designed to assist elderly and disabled individuals”.
The system includes automated curtains, controlled by voice commands or smartphone apps, providing ease of access, and enhancing the quality of life for users with mobility challenges.

(C. Ochoa, M. Aries, and J. van Loenen, 2015), they developed "Impact of Automated Window Shades on Building Energy Performance". This research investigates the role of automated window shades (or curtains) in enhancing energy efficiency in buildings. The study uses simulation models to show how automated curtain systems, controlled by light sensors and time schedules, can reduce heating and cooling loads in residential and commercial buildings.

2.3 Theoretical perspectives

This part provides a description, summary and evaluation of each source and indicates all details about used components. It consists of the discussion about the basics of electronic elements and electrical devices that are joined together in order to achieve the desired result during the Design and implementation of an automatic curtain opening and closing system controller. Although there are several electronic and electrical elements and devices, this chapter will focus on those, which are included in regulation and automation of the system as the purpose of project. They are difference devices and sensors like LDR, Arduino microcontroller, motor, buzzer, PCB and power supply. This part highlights the summaries and explanations of complete knowledge for theories related to the work done.

2.3.1. Microcontroller

2.3.1.1 Introduction

Arduino is an open-source microcontroller, which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, Employees and professionals to create devices that interact with their environment using sensors and actuators. Based on simple microcontroller boards, it is an open source - computing platform that is used for constructing and programming electronic devices. It is also capable of receiving and sending information over the internet with the help of various Arduino shields, which are discussed in this paper. Arduino uses a hardware known as the Arduino development board and software for developing the code known as the Arduino IDE (Integrated Development Environment). Built in microcontrollers can be programmed easily using the C or C++ language in the Arduino (Simon Monk, 2021).

Figure 1: Arduino Uno (Banzi, M., & Shiloh, M).

2.3.1.2 Arduino pins

The Arduino Uno is a microcontroller board based on the ATmega328. It is a programmable micro controller for prototyping electromechanical devices. You can connect Digital and Analog electronic signals:

It has 14 digital Input / output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic Resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features theAtmega16U2 (Atmega8U2up to version R2) programmed as a USB to-serial converter. The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet (Steven F. Barrett, 2021).

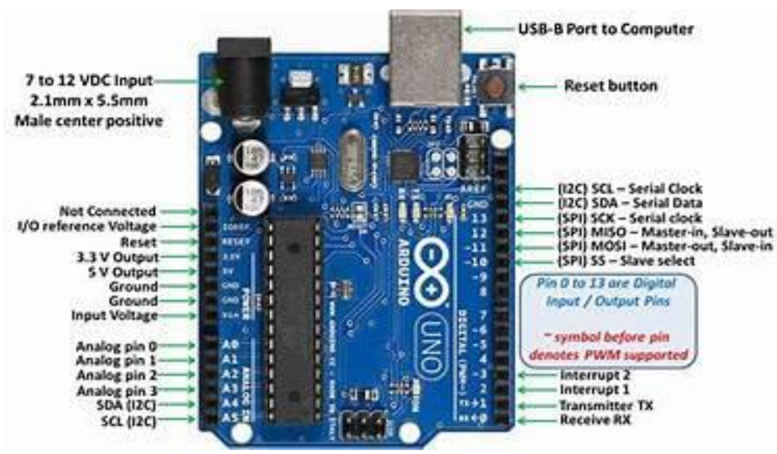


Figure 2: Arduino uno pins (Monk, Simon 2016)

2.3.1.3 Main Pin functions

- LED: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- VIN: The input voltage to the Arduino/Genuine board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator and can damage the board.
- 3V3: A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino/Genuine board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields which block the one on the board.

2.3.1.4 Special pin Functions

Each of the 14 digital pins and 6 Analog pins on the Uno can be used as an input or output, using pinMode (), digital Write (), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference () function.

In addition, some pins have specialized functions:

- Serial: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM (Pulse Width Modulation) 3, 5, 6, 9, 10, and 11 Can provide 8-bit PWM output with the analog Write () function.
- SPI (Serial Peripheral Interface): 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

➢ TWI (Two Wire Interface): A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

➢ AREF (Analog Reference: Reference voltage for the analog inputs. (leonardo, 2018)

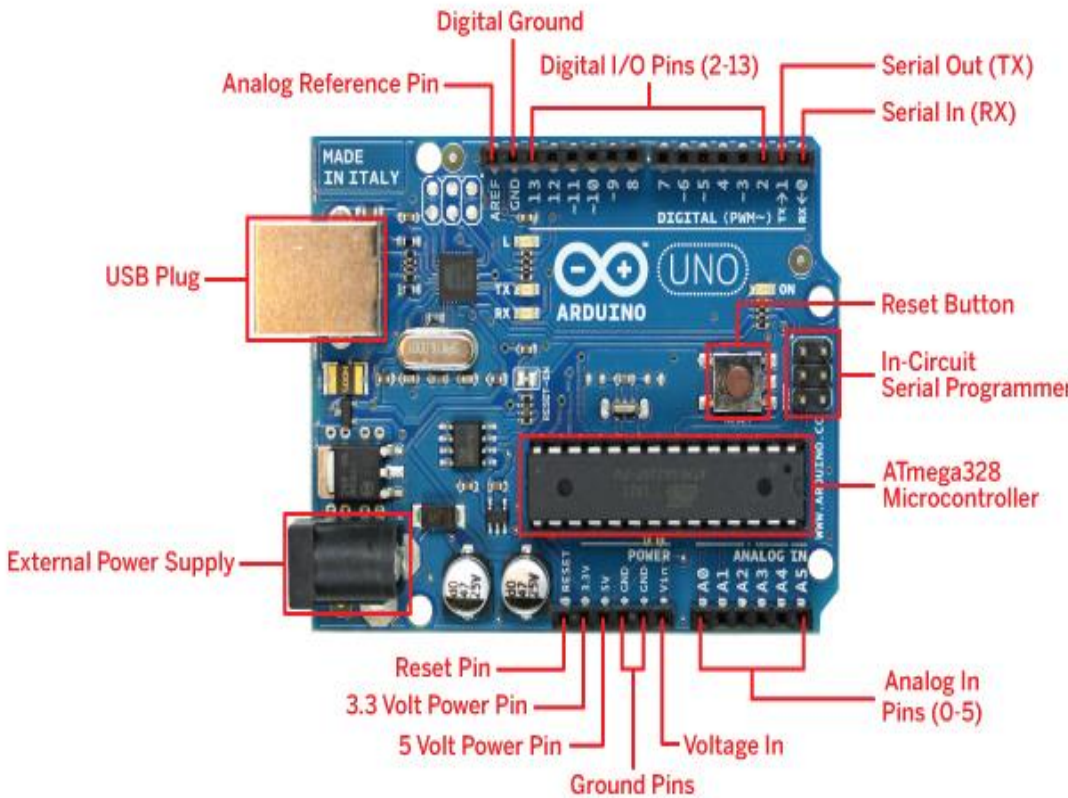


Figure 3: Special pin Functions

Types of Arduinos:

They are many types of Arduinos including:

➢ Arduino UNO

➢ Arduino NANO

➢ Arduino MEGA or Mega 2560

➢ Arduino Leonardo

➢ Arduino Mini

➢ Arduino Pro

➢ Arduino Micro

➢ Lilypad Arduino

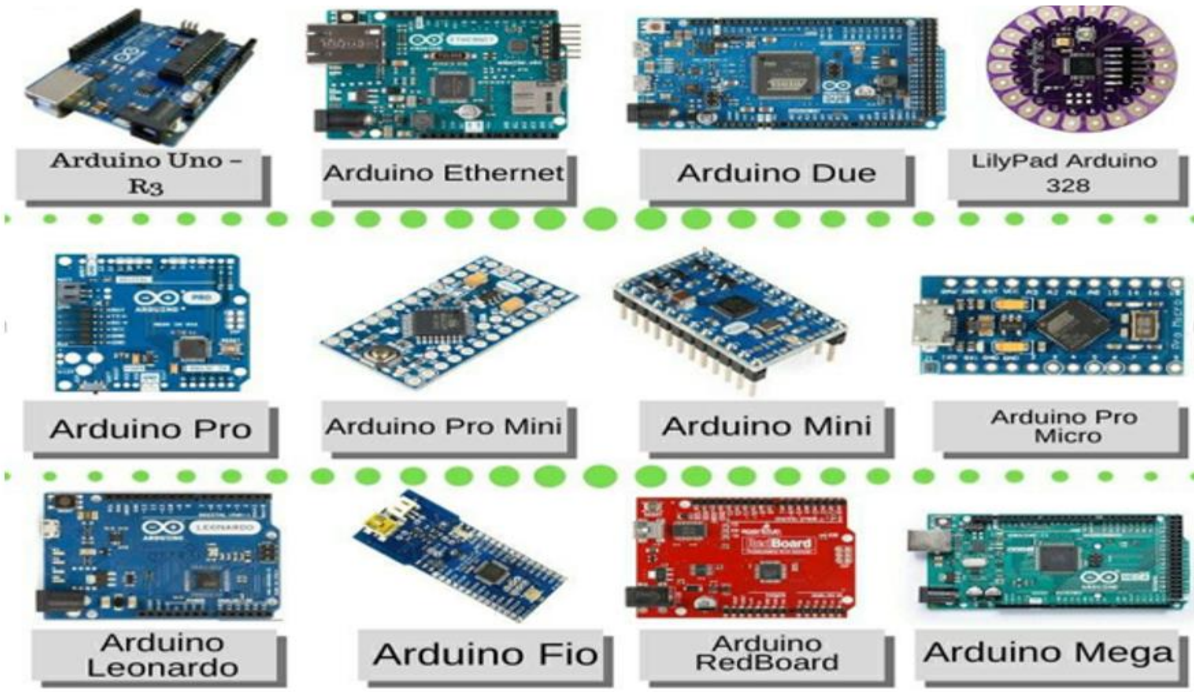


Figure 4: types of Arduinos

Characteristics of Arduino

The following table summarizes all characteristics of Arduino:

Table 1 : Characteristics of Arduino

Arduino Board	Processor	Memory	Digital I/O	Analogue I/O
Arduino Uno	16Mhz ATmega328	2KB SRAM, 32KB flash	14	6 inputs, 0 output
Arduino Due	84MHz AT91SAM3X8E	96KB SRAM, 512KB flash	54	12 inputs, 2 output
Arduino Mega	16MHz ATmega2560	8KB SRAM, 256KB flash	54	16 inputs, 0 output
Arduino Leonardo	16MHz ATmega32u4	2.5KB SRAM, 32KB flash	20	12 inputs, 0 output

2.3.2. Stepper motor

Stepper motors are electromagnetic incremental devices that convert electric pulses to shaft motion (rotation). These motors rotate a specific number of degrees as a respond to each input electric pulse. Typical types of stepper motors can rotate 2°, 2.5°, 5°, 7.5°, and 15° per input electrical pulse. Rotor position sensors or sensors less feedback-based techniques can be used to regulate the output response according to the input reference command (David B. Pritchard, 2021).

Stepper motors offer many attractive features such as:

- Available resolutions ranging from several steps up to 400 steps (or higher) per revolution.
- Several horsepower ratings.
- Ability to track signals as fast as 1200 pulses per second.

Stepper motors have many industrial applications such as:

- Printers.
- Disk Drives.
- Machine Tools.
- Robotics.
- Tape Drives

2.3.2.1 Types of Steppers Motors

Stepper motors are usually classified into three main categories, namely,

- Variable reluctance (single stack and multi stack),
- Permanent Magnet, and 3) Hybrid motors.

Single Stack Variable Reluctance Stepper Motors

Figure below presents the basic circuit configuration of a typical 4-phase, 2-pole, single-stack, variable reluctance stepper motor. The stator is made of a single stack of steel laminations with the phase windings wound around the stator poles. The rotor is made of stack of steel laminations without any windings. The main principle of operation depends on aligning one set only of stator and rotor poles by energizing the stator windings. Therefore, the number of poles in the stator and rotor windings has to be different. The stator windings are energized by a DC source in such a sequence to generate a resultant rotating air-gap field around the rotor in steps.

The rotor is made of ferromagnetic material that provides a tendency to align the rotor axis along the direction of the resultant air-gap field. Therefore, the rotor tracks the motion of this stepped field.

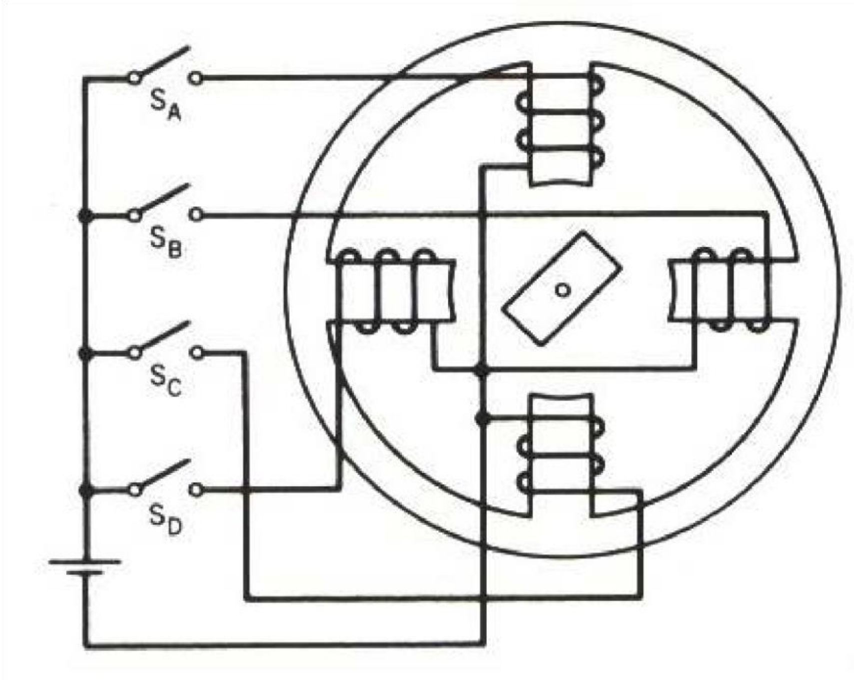


Figure 5: Basic circuit configuration of a typical 4-phase, 2-pole, single-stack, variable reluctance stepper motor

Fig.6 illustrates the different modes of operation of the 4-phase, 2-pole, single-stack, variable reluctance stepper motor for 45° step in the following energizing sequence A, A+B, B, B+C, C, C+D, D, and then D+A. Then this switching sequence is repeated.

- Energizing winding A: The resultant air-gap flux will be aligned along the axis of pole a winding. Consequently, the rotor aligns itself along the phase an axis as shown in the upper part of Fig. 7.
- Energizing windings A and B: The resultant air-gap flux will be oriented in the midway between poles A and pole B i.e., the resultant mmf rotated 45° in the clockwise direction. Consequently, the rotor aligns itself with the resultant mmf (45°) as shown in the middle part of Fig. 7.
- Energizing winding B: The resultant air-gap flux will be aligned along the axis of pole B. Windings. Consequently, the rotor aligns itself along the phase B axis as shown in the lower part of Fig. 7.

The direction of rotation can be reversed by reversing the switching sequence to be A, A+D, D, D+C, C, C+B, B, and then B+A. Then this switching sequence is repeated.

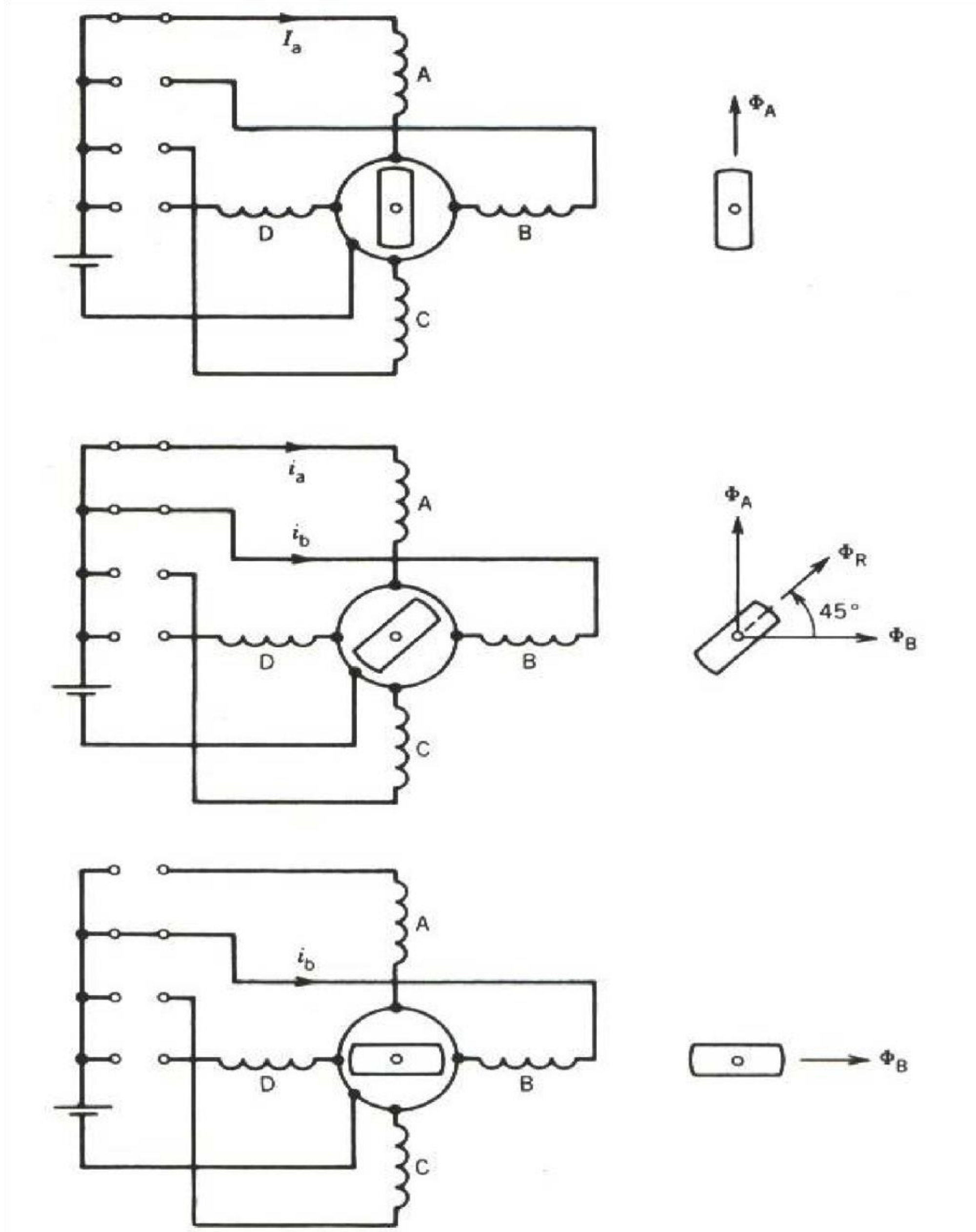


Figure 6: Operation modes of single-stack, 2-poles, and variable reluctance stepper motor with 45° step

Smaller steps can be obtained by using multi-pole rotor configuration such as the one shown in Fig. 7 that rotate in an anticlockwise direction with a 15° step in the following energizing sequence A, A+B, B, B+C, C, C+D, D, and then D+A. Then this switching sequence is repeated.

- Energizing winding A: The resultant air-gap flux will be aligned along the axis of

Pole a winding. Consequently, the rotor pole P1 aligns itself along the phase A axis as shown in the upper part of Fig. 7.

- Energizing windings A and B: The resultant air-gap flux will be oriented in the midway between poles A and pole B i.e., the resultant mmf rotated 45° in the clockwise direction. In this case, the nearest rotor pole to this direction is pole P_2. Consequently, the rotor rotates in an anticlockwise direction to align pole P_2 with the resultant mmf (45°). Therefore, the net rotational step is 15° in an anticlockwise direction.
- Energizing winding B: The resultant air-gap flux will be aligned along the axis of

Pole B windings. In this case, the nearest rotor pole to this direction is pole P_3. Consequently, the rotor rotates in an anticlockwise direction to align pole P_3 with the resultant mmf (90°). Therefore, the net rotational step in this stage is also 15° in an anticlockwise direction.

The direction of rotation can be reversed by reversing the switching sequence to be A, A+D, D, D+C, C, C+B, B, and then B+A. Then this switching sequence is repeated.

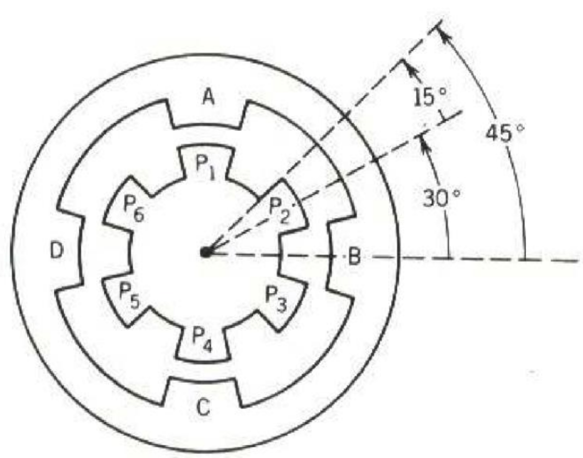


Figure 7: Construction and operation of 4-phase, 6-pole, single-stack, variable reluctance stepper motor

Fig. 8 presents the circuit configuration and different operation modes for a 3-phase, 4pole, single stack, variable reluctance stepper motor that rotate in a clockwise direction with a 30° step. Table 1 and Fig. 5 present each phase switching sequence for one revolution of the rotor.

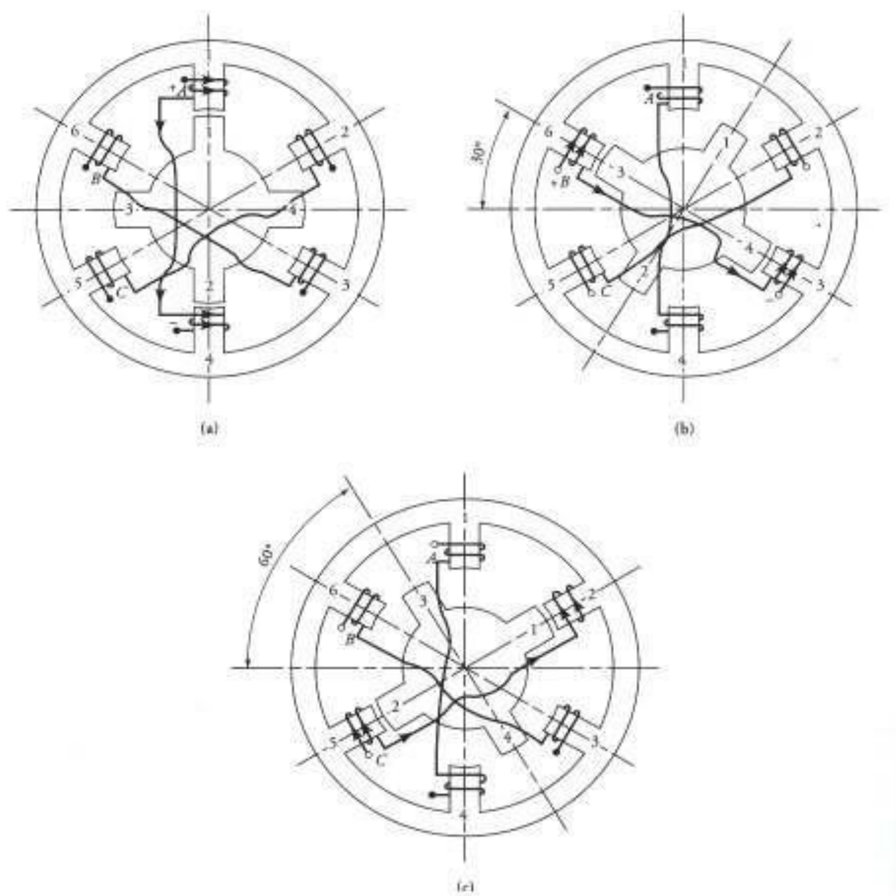


Figure 8: Construction and operation of 3-phase, 4-pole, single-stack, variable reluctance Stepper motor

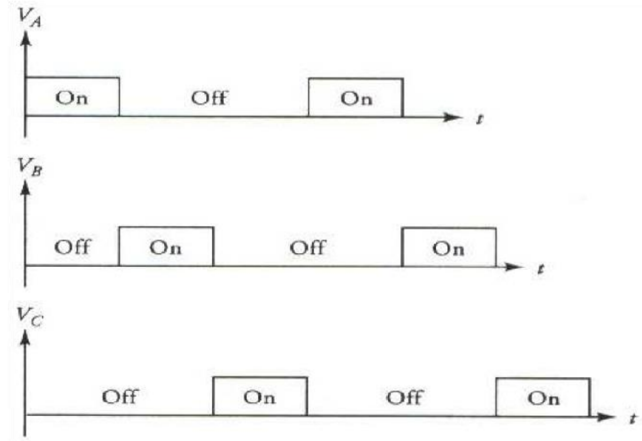


Figure 9*:* Phase switching sequence.

A stepper motor is a type of DC motor that works in discrete steps. It is a synchronous brushless motor where a full rotation is divided into several steps. The rotor is the rotating shaft, and the stator consists of electromagnets that form the stationary part of the motor.

The stepper motor is an electromagnetic device that converts digital pulses into mechanical shaft rotation. Advantages of step motors are low cost, high reliability, high torque at low speeds and a simple, rugged construction that operates in almost any environment.

The speed of the motor is controlled by the frequency of the pulses. The stepper motor is used for precise positioning with a motor, such as hard disk drives, robotics, antennas, telescopes, and some toys. Stepper motors cannot run at high speeds but have a high holding torque. Stepper motors are available in three basic types, which are permanent magnet, variable reluctance, and hybrid.

Variable-reluctance: Variable-reluctance type stepper motors, that are the

simplest type of steppers, consist of a soft iron multi-toothed rotor and a wound stator. Variable-reluctance type stepper motors, that are the simplest type of steppers, consist of a soft iron multi-toothed rotor and a wound stator. When DC is applied to the stator windings, the poles become magnetized. Rotation occurs when the rotor teeth are attracted to the energized stator poles.

Permanent Magnet

As the name implies permanent magnet steppers have permanent magnets added to the motor structure. The rotor no longer has teeth the hybrid stepper motors have the combination of the best properties of variable reluctance and permanent magnet steppers, so they are more expensive than the PM stepper motor.

Working principle of stepper motor: the operation of this motor works on the principle that unlike poles attract each other and like poles repel each other. When the stator windings are excited with a DC supply, it produces magnetic flux and establishes the north and south poles.

Applications of stepper motor: as the stepper motor are digitally controlled using an input pulse, they are suitable for use with computer-controlled systems. They are used in numeric control of machine tools. Used in tape drives, floppy disc drives printers and electric watches. The stepper motor also uses in X-Y plotter and robotics.

Advantages of stepper motors are low cost, high reliability, high torque at low speeds and a simple, rugged construction that operates in almost any environment. The main disadvantages in using a stepper motor are the resonance effect often exhibited at low speeds and decreasing torque with increasing speed. The stepper motors were invented by Paul Coughlin. Paul started his career at sigma instruments.

The difference between servo and stepper motor is that steppers don't require encoders since they can accurately move between their many poles whereas servos, with few poles, require an encoder to keep track of their position.

Figure 10: stepper motor

2.3.3. Light sensor

Before understanding the light sensor, I have first to understand, a light and sensor. A light is the natural agent that stimulates sight and makes things visible. A sensor is a device that detects and responds to some type of input from the physical environment.

Light sensor is a passive device that convert light energy whether visible or in the infra-red parts of the signal output. The light sensors are more commonly known as “photoelectric devices” or “photo sensors” because the convert light energy (photons) into electricity (electrons). It is also to detect light, and it can be use in a robot to detect the current ambient light level (John G. Webster and Halit Eren, 2022).

2.3.3.1. Uses of light sensor.

Light sensors measure illuminance, which can be used to measure more than the brightness of a light source. Because the illuminance decreases as the sensor moves away from a steady light, the light sensor can be used to gauge relative distance from the source. They are also used for devices in vehicles that sound an alarm when the vehicle is close to bumping into an object. Proximity light sensors are common in outdoor lights to detect motion for security purposes.

2.3.3.2. Working principles of LDR sensors

A light dependent resistor works on the principle of photo conductivity. When light falls, it means when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band.

Figure 11: LDR sensor

2.3.4. Pulley

Pulley is a wheel with a groove along its edge that holds a rope or cable, when pulleys are used together in this way, they reduce the amount of force needed to lift a load. A crane uses pulleys to help it lift heavy loads. Pulleys are one of the six simple machines. It is also known as a small, fixed wheel or a group of such wheels with a rope or chain in a grooved rim that is used to lift something up. An example of a pulley is a device for raising a flag. Pulleys are used in window blinds, on ships to raise and lower sales, elevators, exercise equipment, theater curtains, extension ladders, garage doors and more. Rock climbers also use pulleys to help them climb. As with all simple machines like the pulley, they are designed to help make work easier to do., Pulley can reduce the acceleration force required to lift an item, but the total amount of work is the same. Pulley's can also change the direction of force, allowing you to take advantage of the force of gravity to lift things upwards.

Figure 12: pulley

2.3.5. Push button.

Push button is a simple switch mechanism for controlling some aspect of a machine or a process. Buttons are typically made from hard material, usually plastic or metal. A push to make switch allows electricity to flow between its two contacts when held in. when the button is released, the circuit is broken. This type of switch is also known as normally open (NO) switch. (Example: doorbell, computer case power switch, calculator buttons. Individual keys on a keyboard).

2.3.5.1. Work of push button

A push button switch is a small, sealed mechanism that completes an electric circuit when you press on it. When it's on, a small metal spring inside contacts two wires, allowing electricity to flow. When it's off, the spring retracts, contact is interrupted, and current won't flow.

2.3.5.2. Types of push button`

Normally open push button

A normally open (NO) push button is a push button that, in its default state, makes no electrical contact with the circuit. Only when the button is pressed down does it make electrical contact with the circuit (yes). Normally open push buttons are the most common type of push buttons used in devices and circuits.

Normally closed push button

A normally closed (NC) push button is a push button that, in its default state, makes electrical contact with the circuit, when the button is pressed down, the switch no longer makes electrical contact, and the circuit is now open.

Figure 13: push button

2.3.6. Rope

A rope is made by twisting strands of fiber together into a single, sturdy length …as a verb, rope means “catch with a rope” or colloquially, to convince someone to do something: she will try to rope me into helping with the bake sale. When you show someone “the rope” you explain the way things are done. Rope is used for many things in the outdoors. Anchors, rigging, hunting, tie downs…. you name it, rope can probably help you out somehow. What most people don’t realize though is that rope can be used for countless, everyday applications around your house.In the simplest sense, fiber that is twisted or braided is stronger than the same bundle of fibers that are straight because the cord has more capacity so stretch. It won’t stretch to the same length as the straight fibers, but in exchange the fibers (and the spaces between them) can compress.Most twisted rope consists of three strands and is normally right-laid or given a right-handed twist. Typically, their strand laid rope is called a plain or hawser-laid rope. A four-strand rope is usually called shroud-laid, and a rope twisted out of 3 or more ropes is called cable-laid.

Figure 14: Rope

2.3.7. Curtains

A curtain is a piece of cloth intended to block or obscure light, or drafts, or water. A curtain is also the movable screen or drape in a theater that separates the stage from the auditorium or that serves as a backdrop. Drapes usually have a backing on them that gives them structure while hanging on a rod while curtain are made to move in the breeze. Curtains are also used for privacy and security. Curtains are used inside the bathroom, in private bedroom, in kitchen, for most people privacy is a primordial concern. Curtains prevent other people from peeking right into your personal space. The figure below depicts the outlook of curtains:

Figure 15: curtains

Types of curtains

There are many types of Curtains as described below:

i. Voile: is a woven fabric which is soft, lightweight and sheer.
ii. Lace: lace fabric can be used as the sheer curtain, the open weave of this fabric is suitable for the purpose
iii. Nylon net
iv. Eyelet cotton fabric.
v. Muslin
vi. Gauze
vii. Curtain

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The achievement of the objectives of any research project, researchers should often use research through in a particular methodology. In addition, methodologies are different depending on the objectives for achievement and the need of the society and the whole world in general. This chapter depicts all steps and procedures involved from the beginning to the end of our research.

3.2 Simulation

Programming language was used to automate different devices like Arduino and light sensor. In this method, I have done a lot of work of identifying how will be the connection of components and devices required to design my system and for testing them whether they are at a sustainable level of performance. I have used Proteus software to carry out this work.

3.3. Programming

This was achieved by using a software namely Arduino for designing the codes required to control light detection. Then, the next action was to upload the obtained program into Arduino UNO which was achieved by: connecting the Arduino to the USB port through the specific USB cable. Then after that, board type and the serial ports was set to Arduino Program. Therefore, the codes got uploaded in Arduino.

3.4 Research Instrument

3.4.1 Choice of the research instrument

For this study, the primary research instruments used for data collection will be a questionnaire and an observations checklist.

- **Questionnaire:**

This tool will be employed to gather quantitative data from industrial facility personnel, such as engineers and system operators. The questionnaire will include structured questions designed to assess various aspects of the design and implementation automatic curtains opening and closing system, such as their performance, reliability, and user satisfaction. The questionnaire will be developed based on key aspects discussed in the Review of Related Literature to ensure that it covers relevant and important factors.

Prior to its use, the questionnaire will be pre-tested with a small group of 5-10 respondents not included in the actual study to evaluate its reliability and validity. Adjustments will be made based on feedback to improve clarity and effectiveness.

- **Observations Checklist:**

This instrument will be used to collect qualitative data through direct observation of the automatic curtains opening and closing system. The checklist will include specific criteria related to system performance, error rates, and operational efficiency. This tool will help in assessing how the systems perform under actual working conditions.

3.4.2 Validity and Reliability of the Instrument

To ensure validity, the questionnaire and observations checklist will be based on relevant literature and reviewed by experts to confirm they measure the intended aspects automatic curtains opening and closing system. A pilot test with a small group will further validate their accuracy.

For reliability, the questionnaire will be pre-tested with a separate group, and consistency will be analyzed using statistical methods like Cronbach's alpha. The observations checklist will be tested in different settings to ensure consistent data collection. Using both instruments allows for triangulation, enhancing the accuracy and robustness of the findings.

3.5 Data gathering procedures

Producing of data in the study I had focused for various resources like library books, class handout, classmates; some websites on the internet, as well as reports done by other researchers. Also, in this section, different researchers have been consulted for their ideas from the field, as we have been used different ideas from other researchers to collect all information, after collection those data we have implemented an automatic curtain by opening and closing controller system.

3.6 Data analysis and interpretation

To get information on design and implement an automatic curtain by opening and closing controller system. I have used variety documents to examine my project, books of electrical and electronics and other documents from different websites.

To get all the relevant data information to this project, some methods of data collection procedures or techniques have been used for the collection of data, interviewers were carried out. The main respondent to these interviews was coming from the electrical and electronic engineering department.

3.7 Ethical consideration

This research project was be conducted by following the guidelines of ULK. I therefore to have this project being implemented it will require to follow and to analyses the advice from our supervisor, facilitators, instructors and those who are qualified in electrical and electronic engineering with more experiences

CHAPTER 4: SYSTEM DESIGN, ANALYSIS, AND IMPLEMENTATION

4.1 Introduction

This chapter provides a complete account of the design and implementation of the new system, joining innovative concepts to achieve the expected results.

4.2 Block Diagram

The block diagram that follows displays all of the project's specific components.

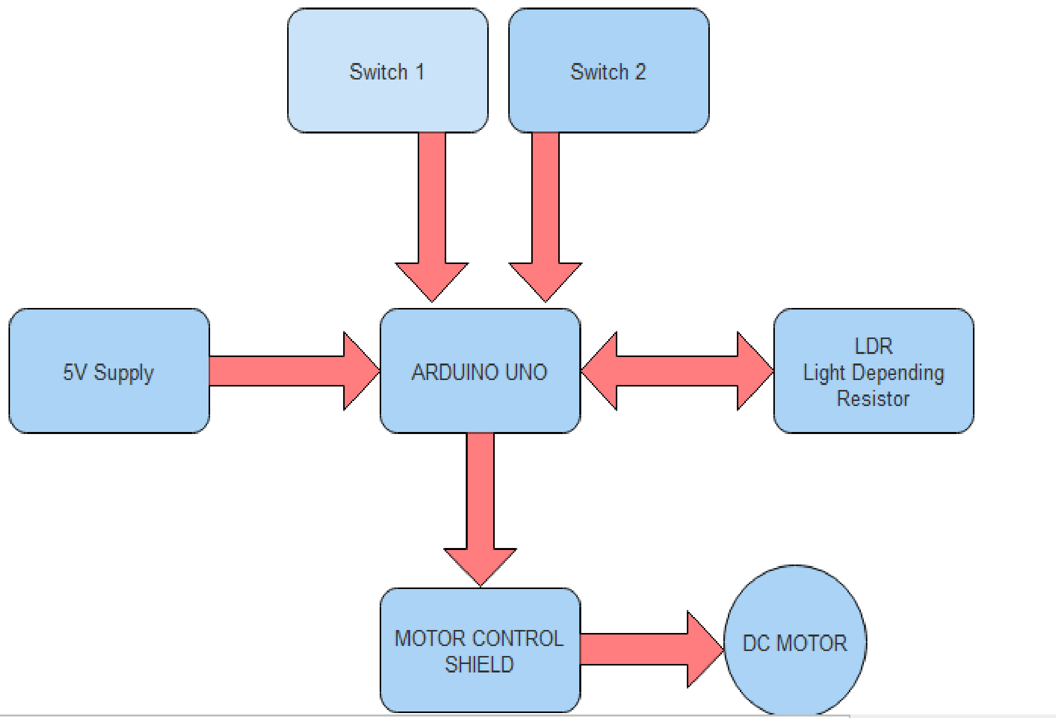


Figure 16: block diagram

The Arduino Uno serves as the core controller for an automatic curtain opening and closing system. Powered by a 5V supply, it receives input from two manual switches and an LDR (Light Dependent Resistor), which detects ambient light levels. The motor control shield, connected to the Arduino, drives the DC motor responsible for moving the curtains. The system allows automatic operation based on light conditions or manual control via switches, offering an efficient, user-friendly solution for managing natural light in a space.

4.3 Circuit diagram

The circuit diagram that follows shows how the project's physical components are connected.

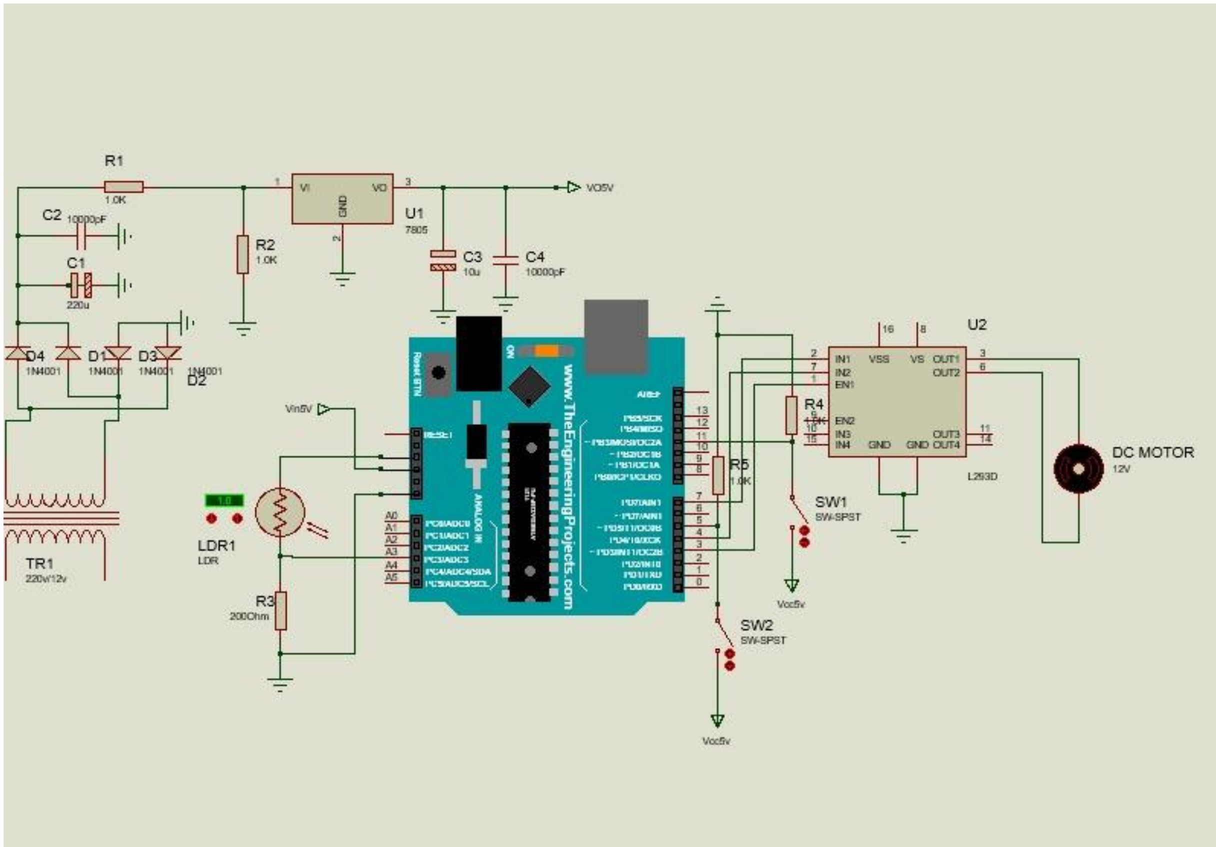


Figure 17: circuit diagram

In this automatic curtain control system, the LDR (Light Dependent Resistor) is connected to Analog Pin A3 of the Arduino, allowing it to detect ambient light levels and adjust the curtain's position accordingly. Two manual switches, SW1 and SW2, are connected to Digital Pins 2 and 3, enabling manual control for opening and closing the curtains, overriding the automatic system if needed. The L298D motor driver is used to control the DC motor, with its IN1 and IN2 connected to Digital Pins 8 and 9, while the motor's enable pin is connected to Digital Pin 10. The motor, which physically moves the curtains, is powered by a 12V supply connected through the motor driver's OUT1 and OUT2. A 7805-voltage regulator ensures a stable 5V supply to the Arduino and other components, while all components share a common ground. This setup allows the Arduino to manage the system both automatically, based on light detection, and manually via switches.

4.4 Flow chart

The flowchart that follows outlines every stage and process involved in implementing a project:

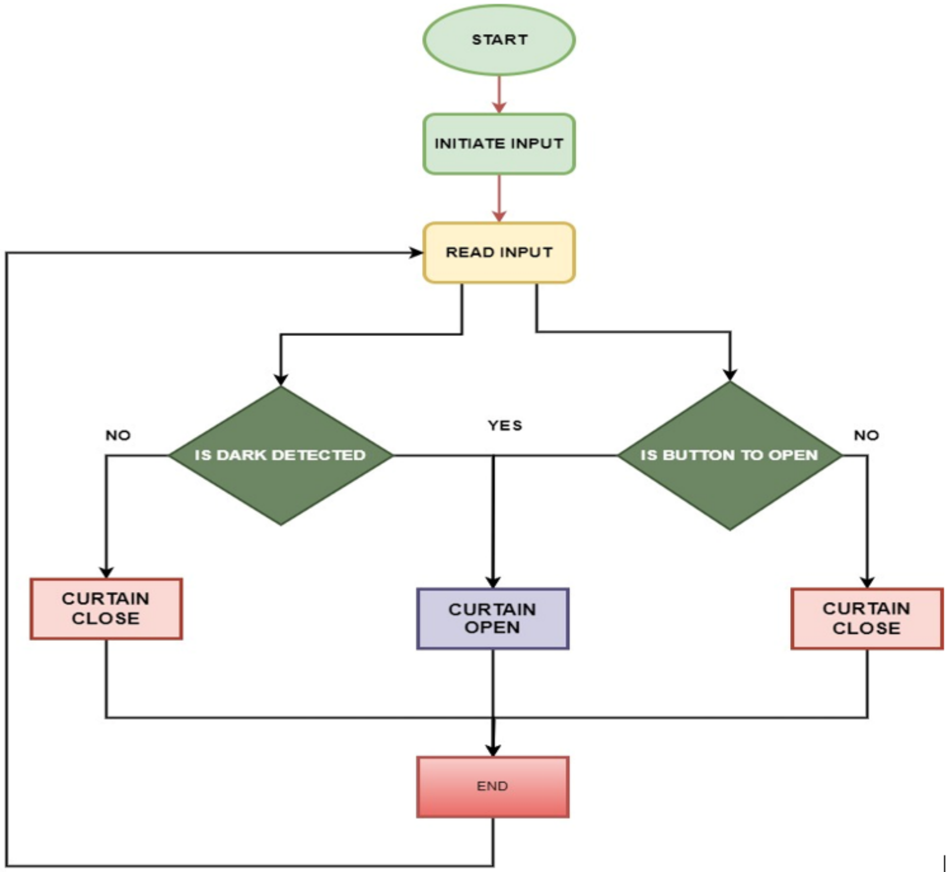


Figure 18: flow chart

The first thing the automatic curtain control system does is examine the condition of the light sensor. In the event that the sensor is damaged, it enters manual mode, which enables push-button control. The sensor controls the curtains by detecting light levels when it is in operation. The mechanism opens the curtains to allow in light if the detected light level exceeds a predetermined threshold. On the other hand, the mechanism draws the curtains to block off light if it is below the threshold. The curtain position is automatically adjusted during this cycle according to the current light conditions. The push button allows the user to manually operate the curtains if the sensor malfunctions, guaranteeing functioning even in the event of sensor problems.

Table 2:Specification

No	name	specification
1.	Arduino uno	• Microcontroller: ATmega328 • Operating Voltage: 5V • Input Voltage (recommended): 7-12V • Input Voltage (limits): 6-20V • Digital I/O Pins: 14 (of which 6 provide PWM output) • Analog Input Pins: 6 • DC Current per I/O Pin: 40 mA • DC Current for 3.3V Pin: 50 mA • Flash Memory: 32 KB (ATmega328) of which 0.5 KB used by bootloader • SRAM: 2 KB (ATmega328) • EEPROM: 1 KB (ATmega328) • Clock Speed: 16 MHz
2	Photo resistor LDR Light	• VCC: 3.3V-5V • GND: GND • DO: digital output interface (0 and 1)
3	Dc motor	• Operating Voltage (VDC) 3 ~ 12 • Shaft Length (mm) 8.5 • Shaft Diameter (mm) 5.5 • No Load Current (mA) 40-180mA. • Rated Speed After Reduction (RPM) 300 • Rated Torque (Kg-Cm) 0.35

		• Weight (gm) 30 • Dimensions in mm (LxWxH) 70x35x22 • Gearbox Shape Straight • Shipment Weight 0.033 kg • Shipment Dimensions 8 × 4 × 4 cm
4	Push Button	• Item Type: Switches • Switch Type: Push Button Switch • Model Number: 19mm Push Button Switch • Features: Momentary Lighting • Material: Aluminium alloy • Brand Name: EARUELETRIC • Item Type: Switches • Voltage: 12V-24V
5	L298N Dual Stepper Motor Driver Controller	• L298N Double H Bridge Motor Driver Module • Control chip: L298N • Logical voltage: 5V • Drive voltage: 5V – 35V • Logical current: 0mA – 36mA • Drive current: 2A (MAX single bridge) • Storage temperature: -20°C to +135°C • Max power: 25W • Size: 43 x 43 x 27mm

4.5. Estimation cost

Table 3: COST ESTIMATION

MATERIALS	QUANTITY	UNIT PRICE	TOTAL PRICE
Arduino (uno)	1	14000frw	14000frw
Stepper Motor	1	15000frw	15000frw
Motor control shield	1	7000frw	7000frw
Light sensor (LDR)	1	1000frw	1000frw
Pulley	1	4000frw	4000frw
Two toggle push buttons	2	2500frw	2500frw
Rope	1	1000frw	1000frw
Curtain	1	2000frw	2000frw
Total		46 500frw	46 500frw

4.6. Implementation

The provided images show a functional prototype of an automatic curtain control system, featuring a wooden frame, a motor, LDR and a push button for manual operation. The motor is responsible for moving the curtain by rolling it up or down, and its direction can be controlled to open or close the curtain. A push button is included to allow manual control, enabling the user to override the automatic system when needed. By integrating an LDR (Light Dependent Resistor) sensor, the system can automate curtain movement based on ambient light conditions. The curtain will open during bright light and close when it becomes darker, offering a convenient and energy-efficient home automation solution. The design is simple yet effective, with room for future enhancements.

4.6.1. Results and Discussions

An automatic curtain system that closed when the LDR sensed nightfall is seen in the image below. A pulley system and an Arduino-controlled motor are employed. The system activates the motor to rotate in the closing side via the pulley when the bright light is reduced, and the LDR sends a signal to the Arduino.

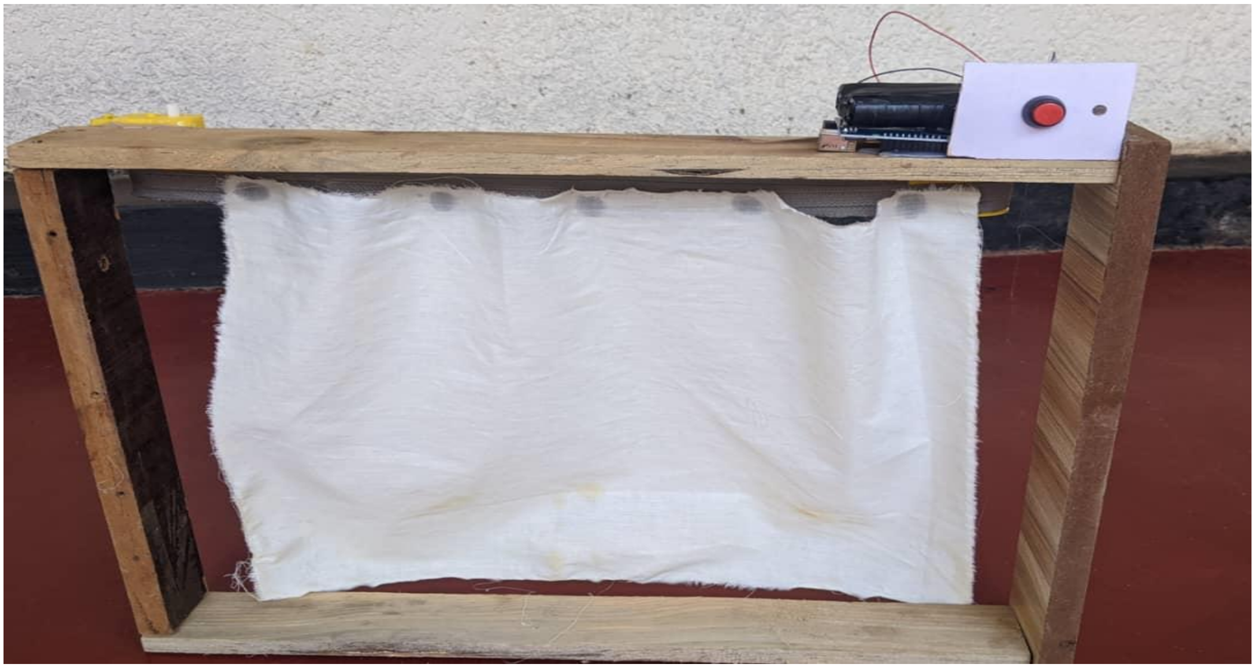


Figure 19: Curtain is closed using LDR.

The automatic curtain system is set up manually with a button in the image below. Users can manually open or close the curtain by pressing the red button on the control circuit, which overrides the automated LDR-based system. When the button is pressed, the Arduino sends signals to the motor, which moves the curtain as necessary. With this flexible manual control option, customers can manually manage the curtains in any lighting situation.

Figure 20: Curtain is open using button.

The image below shows an automatic curtain system opened due to bright light increased, at this time detection of light by an LDR, allow the system to open the curtains automatically.

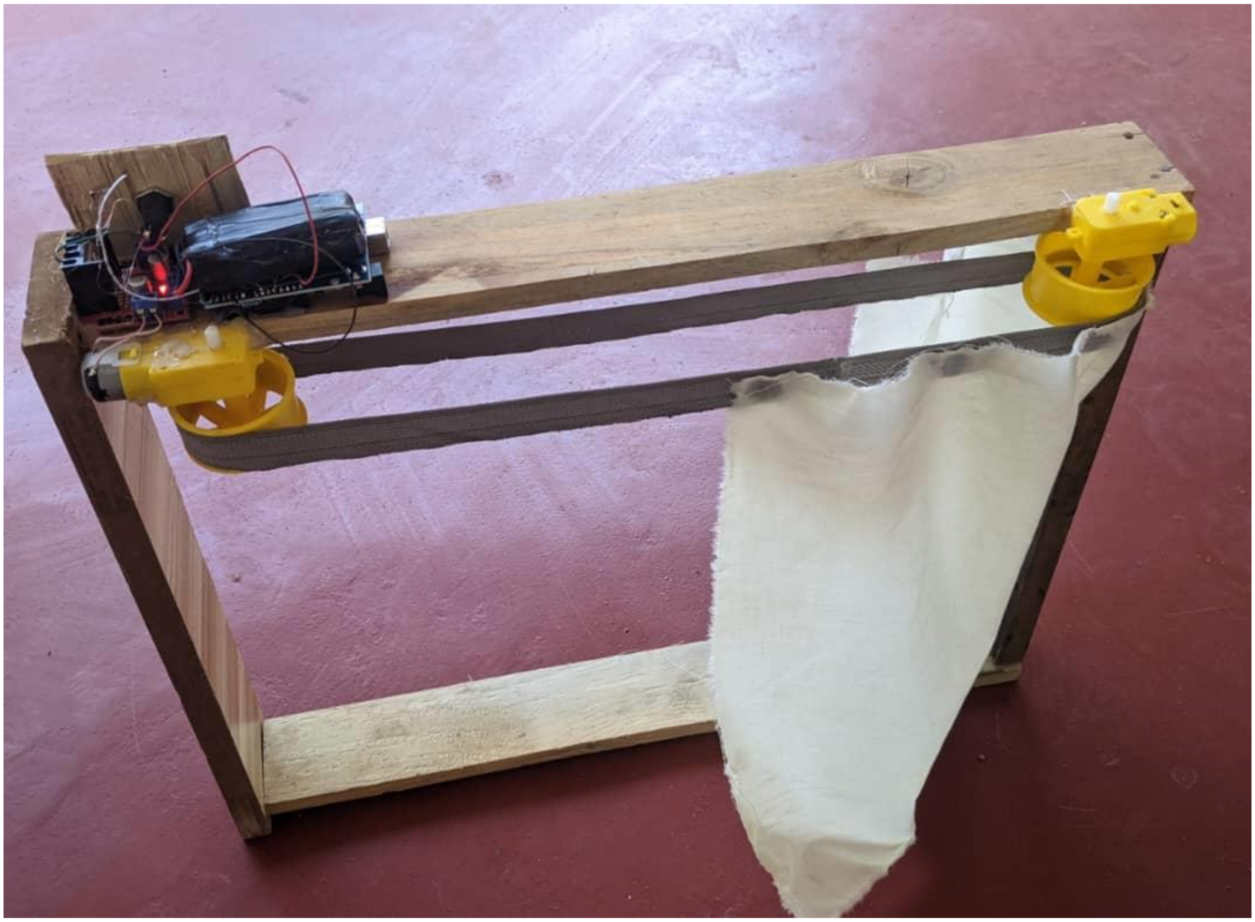


Figure 21: Curtain is open using LDR.

This image above shows a more detailed view of the automated curtain system. The curtain is attached to a belt or string mechanism driven by two yellow pulleys, with one side connected to a DC motor controlled by the Arduino and relay circuit. The belt is used to slide the curtain open or close. The Arduino is powered by a battery pack, and the system includes wiring for control. This setup demonstrates a basic yet effective motorized curtain solution

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter summarizes the research through its findings and challenges and then provides recommendations as well as suggestions for future research.

5.1 Conclusion

This project covers every aspect of automating the opening and closing of a curtain using an Arduino microcontroller. I learn about the components and materials required to comprehend the design and implementation of the curtain automation, including the pulley, Arduino, rope, curtain, stepper motor, and light sensor. I'm also able to understand the purpose of each component and how it operates. These curtains increase accessibility and safety, especially for windows that are difficult to reach. Even though they are more expensive than traditional curtains, their advantages such as increased security, comfort, and energy savings make them a worthwhile addition to contemporary homes.

5.2 Recommendations

- The project's term was too short; thus, my recommendations go to UPI management to expand it to give us more time to do research and obtain the necessary results.
- Based on the challenges met during my research period for completing the project, I request the UPI management to offer students resources or other assistance so they may effectively complete their research without any interruption.

5.3 Suggestions for further study

Here are some recommendations for automated curtain operators that may be of interest to those who would be interested in this project to do more research so that they can make improvements on it:

- To examine the features of various smart curtain types: There are numerous varieties of smart curtains available, each with a unique set of features and capabilities.
- Experiment with various settings: After installing your smart curtain system, try out several settings to see which one best suit your requirements.
- To Stay up to date on the most recent advancements: smart curtain technology is always changing, with new features and functionalities being added on a regular basis.

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APPENDICES

APPENDIX 1. PROGRAMMING CODES

```
#include <AFMotor.h>
AF_DCMotor DCmotor(1); // create motor instance
int lightSensor = A0;    // Pin number of where the light sensor is connected
int manualSelector = 5;     // Pin number of the toggle switch connection
int curtainMover = 2;    // Pin number of the switch to move curtains manually
bool curtainsOpen = false;
bool curtainsClose = false;
bool manualCurtainOpen = false;
bool manualCurtainClose = false;
void setup() {
  Serial.begin(115200);
  DCmotor.setSpeed(200);     // set the speed to 200/255
  pinMode(manualSelector, INPUT);
  pinMode(curtainMover, INPUT);
}
void loop() {
  int sensorValue = analogRead(A0);
  int modeSelector = digitalRead(manualSelector);
  int manualBtn = digitalRead(curtainMover);
  Serial.print("sensor value: ");
  Serial.println(sensorValue);
  delay(10);
  if (modeSelector == LOW){     // In this mode the curtains are controlled with the Light Sensor
(LDR)
    if (sensorValue <= 200) {       // For this value of LDR, curtains should be OPENED
      if (curtainsOpen == false) {
        moveCurtains(1);
        curtainsOpen = true;
```

```
    curtainsClose = false;
   }
  }
  else if (sensorValue >= 500) {  // For this value of LDR, curtains should be CLOSED
   if (curtainsClose == false) {
    moveCurtains(0);
    curtainsClose = true;
    curtainsOpen = false;
   }
  }
 }
 else {    // In this mode curtains are controlled with the push button
  if (manualBtn == HIGH) {       // If the close Curtains variable TRUE then curtains should be
CLOSED
   if (manualCurtainClose == false) {
    moveCurtains(0);
    manualCurtainClose = true;
    manualCurtainOpen = false;
   }
  }
  else {      // Here closeCurtains variable is FALSE then curtains should be OPENED
   if (manualCurtainOpen == false) {
    moveCurtains(1);
    manualCurtainOpen = true;
    manualCurtainClose = false;
   }
  }
 }
}

/****************************************************
```

```
 * Function to move the motor in different direction
 * Without repeating our selfves.
 ***************************************************/
int moveCurtains(int direction) {
  if (direction == 0) {       // For this direction CLOSE the curtains
    DCmotor.run(BACKWARD);
    delay(3000);
    DCmotor.run(RELEASE);
    Serial.println("backward done");
    return 0;
  }
  else if (direction == 1) {  // For this direction OPEN the curtains
    DCmotor.run(FORWARD);
    delay(3000);
    DCmotor.run(RELEASE);
    Serial.println("forward done");
    return 1;
  }
  else {
    return -1;
  }
}
```