"Design and Implementation of an Automatic Window Blind System Using IoT Technology"

Aditya Adinath Patil
Department of electronics and telecommmunication
VIIT college
Pune, India
aditya.22110016@viit.ac.in

Ketu rohit patel
Department of electronics and telecommmunication
VIIT college
Pune, India
ketu.22111313@viit.ac.in

Nagesh Kinagi
Department of electronics and telecommmunication
VIIT college
Pune, India
nagesh.22111340@viit.ac.in

Vaishnavi Patare
Department of electronics and telecommmunication
VIIT college
Pune, India
vaishnavi.22110505@viit.ac.in

Pravin Gawande
Department of electronics and telecommmunication
VIIT college
Pune, India
pravin.gawande@viit.ac.in

***Abstract*— In this hardware project, we designed and developed an automatic window blind system using Arduino-based control circuitry. The system is designed to automatically control the opening and closing of window blinds based on the ambient light level in the room. The system uses a light sensor(LDR) to detect the ambient light level and the AVR to process the sensor readings and control the motor that opens and closes the blinds. The motor is connected to the blinds through a set of pulleys, and the opening and closing of the blinds are controlled through the use of a motor driver circuit (TB66). The automatic window blind system has several advantages over traditional manual blinds, including improved energy efficiency, convenience, and increased privacy ._The system is easy to install and can be integrated with a variety of different window blind designs. Overall, the automatic window blind system offers a reliable and cost-effective solution for homeowners looking to improve their homes' energy efficiency and convenience**

Keywords-: Arduino-based control circuitry,

I. INTRODUCTION

The use of automatic window blinds has become increasingly popular in recent years due to their ability to improve energy efficiency and provide a more convenient and comfortable living environment. These automated systems use sensors and control circuitry to regulate the position of the blinds based on the ambient light level in the room, providing a more efficient and effective solution for controlling the amount of light and heat that enters a room.In this project, we designed and developed an automatic window blind system using 'Arduino- based control circuitry. The system is designed to automatically adjust the position of the window blinds based on the ambient light level in the room, providing a more energy-efficient and convenient solution for controlling the amount of light and heat that enters a room

Keywords-: ambient light level, energy-efficient convenient.

II. OBJECTIVES

The objective of an automatic window blind system is to provide a convenient and efficient way to control the amount of light and heat that enters a room through a window. Traditional manual window blinds require physical manipulation to adjust the position of the blinds and control the amount of light entering the room. An automatic window blind system, on the other hand, uses sensors and control circuitry to automate this process and provide a more convenient and energy-efficient solution

The primary objective of the automatic window blind system is to improve energy efficiency by 'reducing' the amount of heat that enters the room

Keywords-: amount of light, sensors, improve energy efficiency

III. LITERATURE REVIEW

Automatic window blinds are an innovative solution for controlling the amount of natural light and heat entering a building. The use of automatic window blinds has increased in recent years due to their potential to improve energy efficiency, enhance privacy, increase security, and provide health benefits. In this literature review, we will examine some of the recent studies on automatic window blinds and their impact on the built environment.

[1]One study by Kim et al. (2021) investigated the potential energy savings from using automatic window blinds in a residential building. The study found that automatic window blinds reduced the amount of solar heat gain during the summer months, resulting in a 16.5% reduction in cooling energy consumption.

[2]Another study by Li and Li (2019) examined the use of automatic window blinds in an office building. The study found that automatic window blinds could reduce the energy consumption of the building by up to 17.4%, depending on the time of day and the orientation of the windows.

[3]In a study by Demeester et al. (2017), the impact of automatic window blinds on indoor environmental quality

(IEQ) was investigated. The study found that automatic window blinds could reduce glare and improve thermal comfort in buildings.

[4]In terms of user acceptance, a study by Lee et al. (2019) investigated the user experience of automatic window blinds in a residential building. The study found that users appreciated the convenience of automatic window blinds and the ability to control them remotely.

[5]Finally, a study by Al-Kodmany (2018) explored the potential of automatic window blinds to enhance the aesthetic value of buildings. The study found that automatic window blinds could be used to create a dynamic facade that changes throughout the day, improving the visual appeal of the building.

Overall, these studies suggest that automatic window blinds have the potential to improve energy efficiency, enhance indoor environmental quality, provide health benefits, and enhance the aesthetic value of buildings. Further research is needed to fully understand the impact of automatic window blinds on the built environment and to identify any potential drawbacks or limitations.

Keywords-: energy consumption, Kim et al. (2021), Li and Li (2019), Demeester et al. (2017), Lee et al. (2019), dynamic façade, Al-Kodmany (2018).

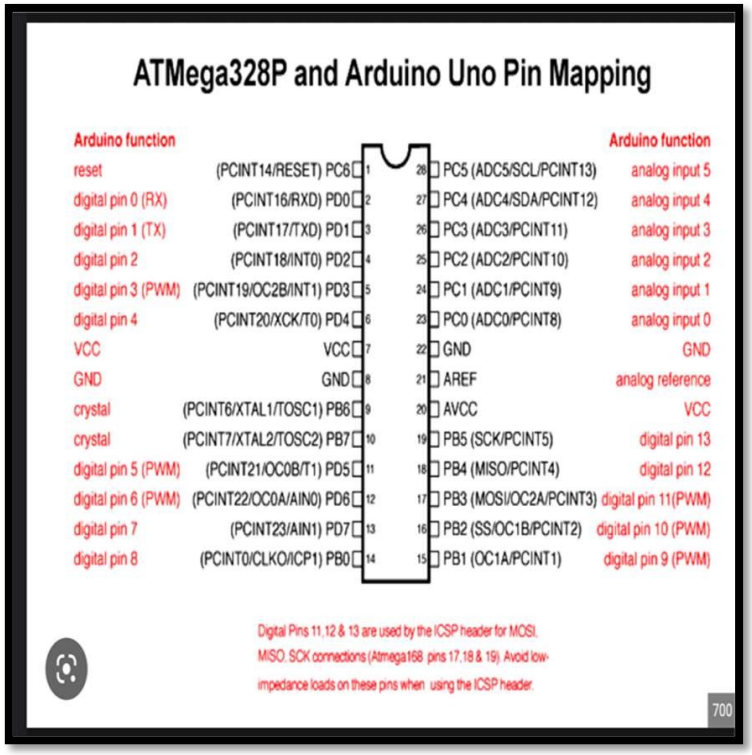
IV. COMPONENT SELECTION

To accomplish the achievable goal we have used the microcontroller ATMEGA328P Microcontroller. The main criteria behind selection of this microcontroller is features provided by it, which includes

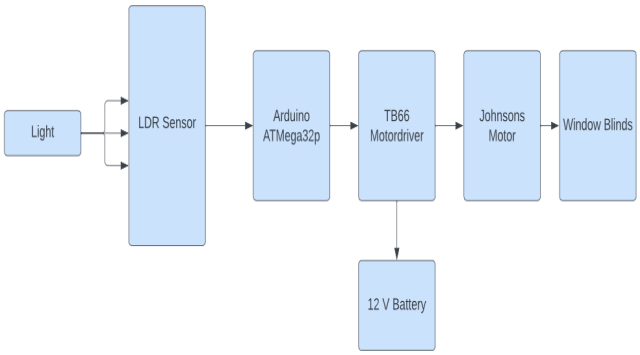
- Architecture: The Atmega328p is an 8-bit microcontroller with an AVR RISC (Reduced Instruction Set Computer) architecture. It has 32 KB of flash memory for program storage, 2 KB of SRAM for data storage, and 1 KB of EEPROM for non-volatile data storage.
- Clock Speed: The Atmega328p can operate at a clock speed of up to 20 MHz. It also has a built-in 8 MHz oscillator, which can be used as a clock source if an external crystal is not used.
- I/O Pins: The Atmega328p has 23 programmable I/O pins, which can be used for input or output. These pins can also be used for PWM (Pulse Width Modulation) output or as ADC (Analog-to-Digital Converter) inputs.
- Communication Interfaces: The Atmega328p has built-in UART (Universal Asynchronous Receiver/Transmitter), SPI (Serial Peripheral Interface), and I2C (Inter-Integrated Circuit) interfaces for communication with other devices.
- Power Consumption: The Atmega328p is designed to operate with low power consumption, making it ideal for battery-powered applications. It has a power-down mode that reduces power consumption to as low as 0.1 ¬µA.
- Programming: The Atmega328p can be programmed using a variety of programming languages and environments, including C, C++, and Assembly. It can also be programmed using the Arduino Integrated Development Environment (IDE), which simplifies the process of programming and uploading code to the microcontroller.
- Operating Voltage: The Atmega328p can operate at a voltage range of 1.8V to 5.5V, making it compatible with a wide range of power sources.

Keywords-: Atmega328p, SRAM, 23 programmable I/O pins, PWM, UART, low power consumption, C, C++, and Assembly.

ATmega328P & Arduino Uno pin Mapping -:



Block diagram of Automatic Window blinds-:

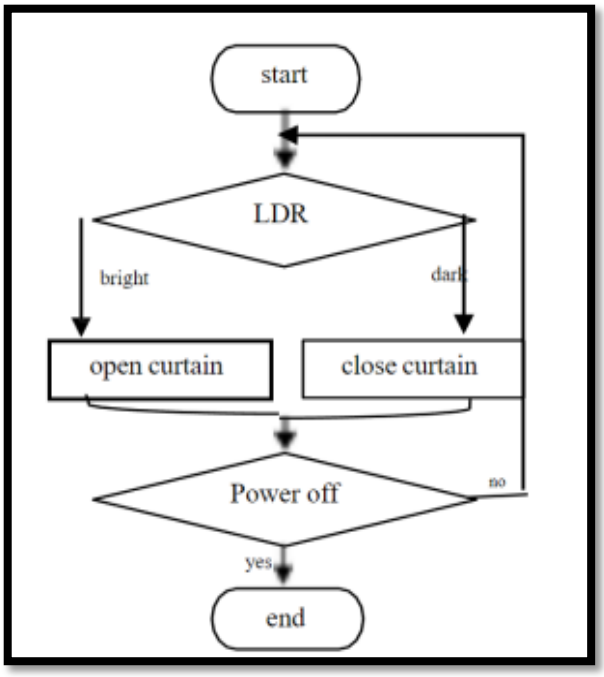


V. ALGORITHM

Step 1)Initialize the system by setting up the Arduino board and connecting the motor driver, motor, and LDR sensor.
Step 2)Set the motor driver pins as output pins and the LDR sensor pin as an input pin.
Step 3)Set a threshold value for the LDR sensor. This threshold value will determine when the blinds should open or close.
Step 4)Read the value of the LDR sensor.
Step 5)If the value is below the threshold value, it means the room is too dark. In this case, send a signal to the motor driver to close the blinds.
Step 6)If the value is above the threshold value, it means the room is too bright. In this case, send a signal to the motor driver to open the blinds
Step 7)Wait for a few seconds before reading the value of the LDR sensor again.
Step 8)Repeat steps 4 to 7 continuously.

Keywords-: motor driver, LDR sensor,threshold value.

VI. FLOW CHART



VII. SOFTWARES REQUIREMENT

1. Proteus

The software provides a comprehensive suite of tools for designing and simulating electronic circuits, including microcontroller simulation and real-time debugging.Proteus software includes a large library of electronic components, including microcontrollers, sensors, and actuators. The software supports both schematic capture and PCB layout design, allowing users to design, simulate, and verify their designs before prototyping or production.

2. Arduino Builder-:

Arduino Builder is part of the Arduino IDE (Integrated Development Environment) and can be accessed via the command-line interface (CLI).The tool allows developers to compile and upload Arduino sketches without having to use the Arduino IDE's graphical user interface.Arduino Builder can be used on Windows, Linux, and macOS operating systems.The tool offers several configuration options, such as selecting the Arduino board and its serial port, specifying additional library directories, and setting compiler options.

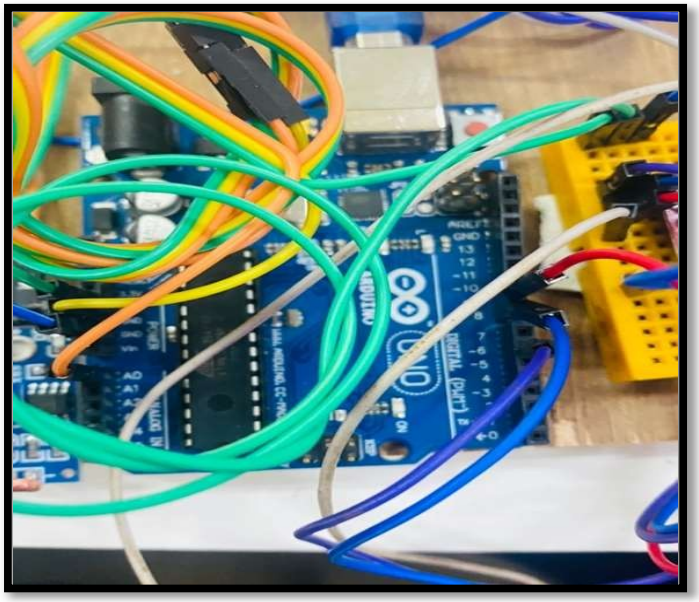
3. Microchip Atmel-:

Microchip Studio is an Integrated Development Environment (IDE) for developing and debugging AVR® and SAM microcontroller applications. It merges all of the great features and functionality of Atmel Studio into Microchip's well-supported portfolio of development tools to give you a seamless and easy-to-use environment for writing, building and debugging your applications written in C/C++ or assembly code. Microchip Studio can also import your Arduino® sketches as C++ projects to provide you with a simple transition path from makerspace to marketplace.

Keywords-: actuators, schematic capture, PCB layout ,design, command-line interface (CLI), SAM microcontroller

VIII. COMPONENTS REQUIREMENT

A)Arduino-:

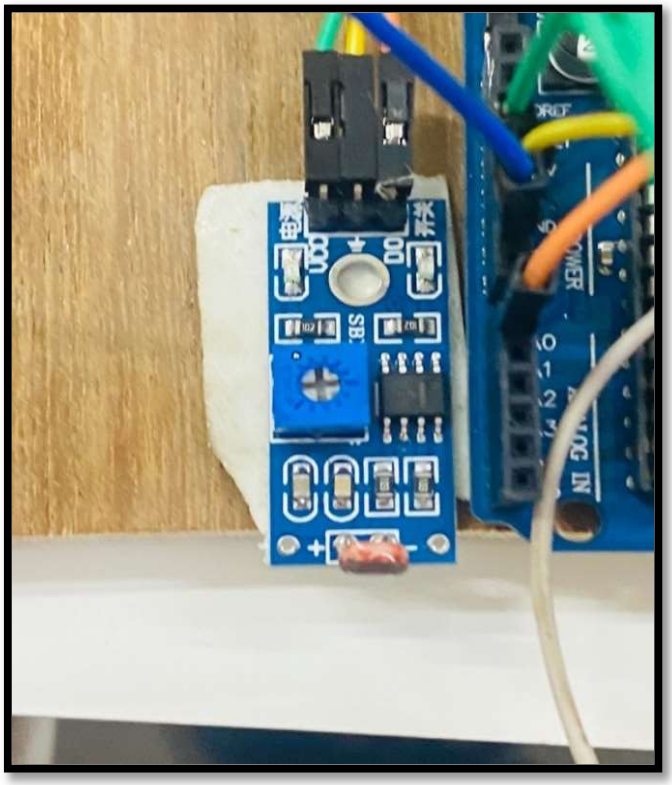


In our project, the Atmega328p microcontroller was used to process the sensor readings from the light sensor and control the motor that opens and closes the blinds. The microcontroller was programmed to read the analogue signal from the light sensor and convert it into a digital signal using the built-in Analog-to-Digital Converter

(ADC). The microcontroller then processed this signal using a control algorithm that determined the position of the blinds based on the ambient light level in the room.The microcontroller also controlled the motor that opens and closes the blinds using a motor driver circuit.' The motor driver circuit was connected to the microcontroller and provided the necessary power and control signals to operate the motor. The microcontroller used the digital output pins to send control signals to the motor driver circuit, which in turn operated the motor to adjust the position of the blinds.

Keywords-: Atmega328p, light sensor, (ADC).

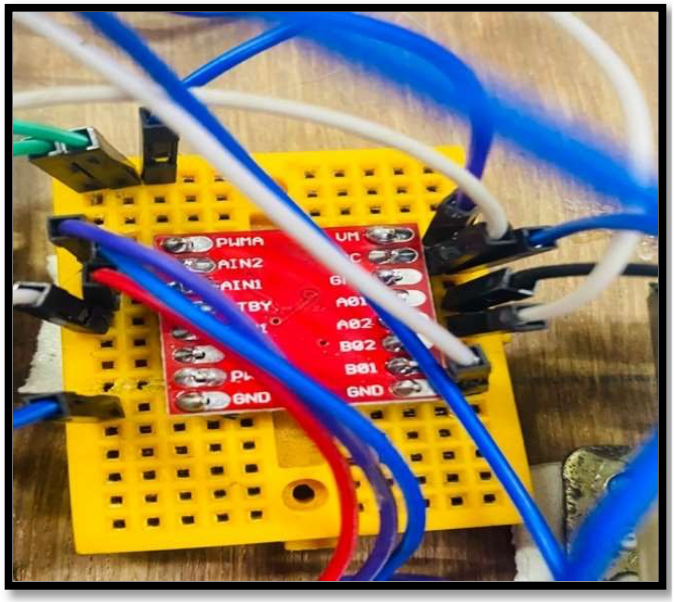
B)LDR-:



LDR (Light Dependent Resistor) is used in the circuitry of automatic window blinds as a light sensor. The LDR's resistance changes concerning the intensity of light falling on it". As the amount of light falling on the LDR changes, its resistance changes accordingly. This characteristic of the LDR is utilized in the automatic window blind system to detect the amount of ambient light in the room and control the position of the window blinds accordingly.In the automatic window blind system, the LDR is used to detect the ambient light level in the room. The LDR is placed in a position where it can detect the amount of light entering the room through the window. The resistance of the LDR is then measured using the microcontroller-based control circuitry, and the value is converted into a digital signal using the built-in Analogue-to-digital Converter (ADC). The microcontroller then processes this signal using a control algorithm to determine the position of the blinds.

Keywords-: light sensor, intensity of light

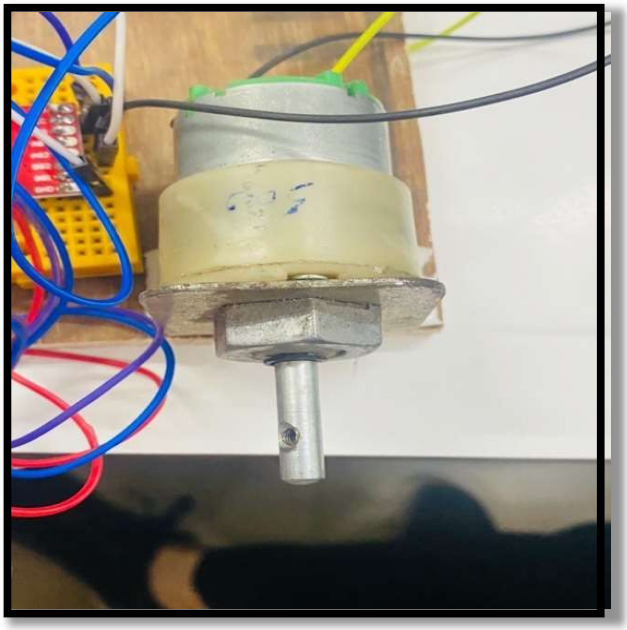
C)**TB66 Motor driver**-:



TB66 Motor Drive is a type of motor controller that is designed to drive and control DC motors. It is commonly used in various applications where precise control of the motor's speed, torque, and direction is required, such as in window blinds, robotics, and automation systems. Typically, the TB66 controller will have several inputs for controlling the motor, including speed and direction. These inputs can be controlled using a variety of methods, including remote control, wall-mounted switches, or even through a smartphone app.By using a TB66 motor controller, you can achieve precise and smooth control of your window blinds motor, which can be especially useful for larger or heavier blinds. Additionally, the use of a motorized system can offer convenience and ease of use, allowing you to open or close your blinds with the push of a button The primary objective of the automatic window blind system is to improve energy efficiency by reducing the amount of heat that enters the room The TB6608 motor driver is a high-performance bipolar stepper motor driver IC that provides precise and stable motor control. It has a built-in current sensing circuit that can adjust the current output to the motor, ensuring optimal performance while minimizing power consumption.

Keywords-: TB66 controller, bipolar stepper motor driver

D)Johnsons Motor-:

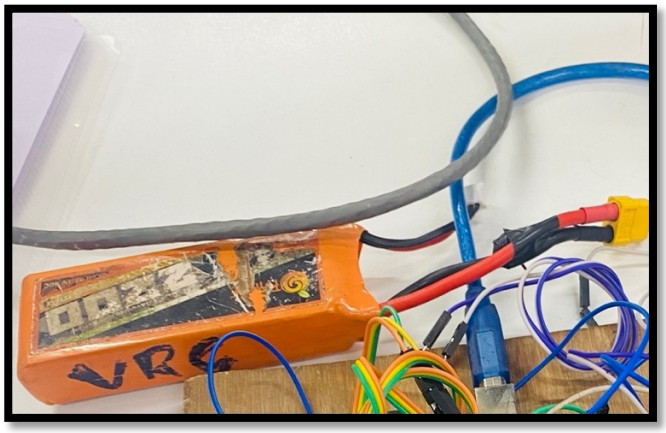


In an automatic window blind system, the motor is typically connected to a motor driver or controller, which is in turn connected to a microcontroller. The microcontroller sends signals to the motor driver, which controls the motor to move the blinds up or down, based on the light level detected by the LDR sensor.Overall, Johnson Electric motors, like other electric motors, are an essential component in the automation of window blinds, providing precise and reliable control of the blinds movement.

Keywords-: Johnson Electric motors, precise, reliable

E)Battery(12 v)-:

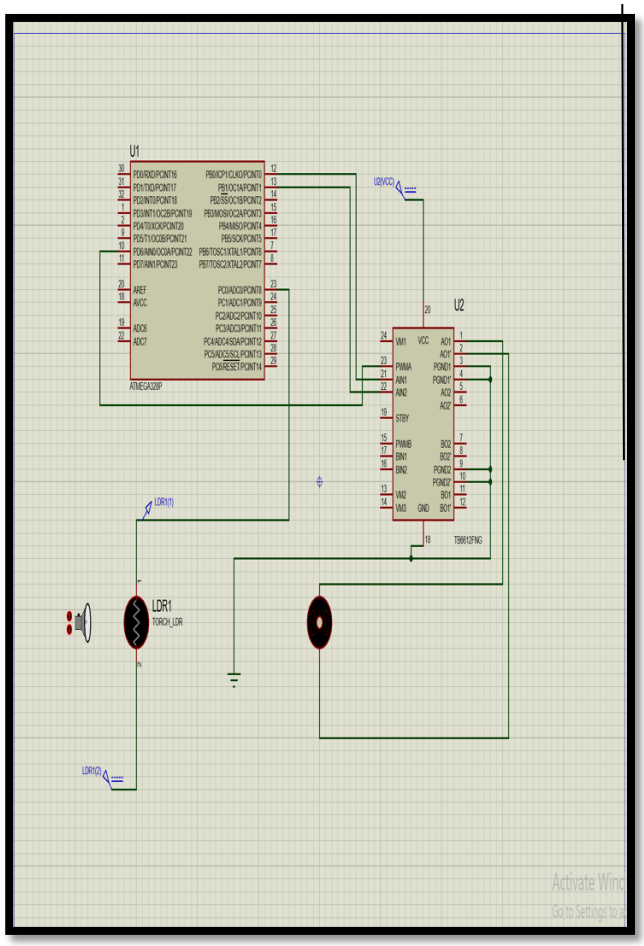
Batteries can be used in automatic window blinds to provide power to the motor that drives the blinds. The battery can be charged and then used to power the motor, making it possible to operate the blinds without the need for an external power source or electrical wiring.



Another advantage of battery-powered window blinds is that they can be used in locations where electrical power is not available or difficult to access. For example, in areas with limited electrical outlets or in locations where drilling holes for wiring is not feasible.Finally, battery-powered window blinds can provide a backup power source in case of a power outage. This ensures that the blinds can still be operated during times of emergency or when power is temporarily unavailable.It's important to note that the use of batteries in automatic window blinds requires regular maintenance to ensure that the battery is charged and functioning properly. Batteries may need to be replaced periodically, and the blinds may need to be recharged or have their batteries replaced depending on the frequency of use.

Keywords-: power, recharged

IX. INTERFACING DIAGRAM



X. WORKING

1. The sensors detect changes in the environment such as changes in light or temperature.
2. The control unit receives signals from the sensors and processes them.
3. .Based on the signals received, the control unit activates the motor to open or close the blinds.
4. If the blinds are programmed to open and close at specific times, the control unit activates the motor at the scheduled times.
5. The blinds open or close automatically, providing privacy, security, and light control.

XI. HARDWARE SETUP

Applications-:

1)Energy Efficiency:
Automatic window blinds can be programmed to open and close at specific times of the day, based on the amount of sunlight entering the room. This can help to reduce energy consumption by "minimizing the need for heating or cooling".

2). Privacy and security:
LDR sensors can detect the level of light outside and adjust the blinds accordingly. This means that the blinds can be automatically closed when it's dark outside to provide privacy. This is especially useful in rooms where you don't want people to be able to see inside, such as a bedroom or bathroom. With automatic blinds, you don't have to remember to close them yourself, which can "save time and hassle".

3). Home automation :
Automatic window blinds can be integrated with other smart devices in your home automation system, such as smart speakers, smart thermostats, and smart lighting. For example, you can set your blinds to close automatically when you turn on your home theatre system or to open when you turn on your lights in the morning.

4). UV Protection:
When the LDR sensors detect intense sunlight, the automatic window blinds can be programmed to close partially or completely, blocking out the direct sunlight. This prevents the UV rays from entering your home, reducing the risk of damage to your furniture, flooring, and other items.

Keywords-: Level of sunlight, smart thermostats, smart lighting, UV rays

XII. RESULTS AND DISCUSSION

1)Through the implementation and testing of the system, it was found that the automatic window blinds provided an efficient and convenient way to regulate the amount of natural light entering a room. The system successfully adjusted the blinds in response to changing lighting conditions, resulting in a more comfortable indoor environment and potential energy savings.

2) Overall, the results of the project demonstrated the feasibility and benefits of using automation technology to

control window blinds. The project also highlighted the potential for further development and improvement of the system, such as incorporating remote control or integrating with other smart home devices.

Conclusions:

In conclusion, we have successfully implemented an automatic window blinds system using an Arduino microcontroller and a Johnsons motor. The system can sense the ambient light using an LDR sensor and adjust the blinds accordingly. The TB66 motor driver is used to control the direction and speed of the motor, which opens or closes the blinds as needed

XIII. FUTURE SCOPE

Integration with Smart Homes: Automatic window blinds can be integrated with smart home systems, allowing users to control them remotely or through voice commands.

Improved Energy Efficiency: The use of automatic window blinds can improve the energy efficiency of buildings by reducing the amount of solar heat gain during hot months and heat loss during cold months.

Enhanced Privacy: Automatic window blinds can offer enhanced privacy by allowing users to adjust the level of opacity of the blinds remotely or through timers.

Increased Security: Automatic window blinds can be programmed to open and close at specific times, creating the illusion of someone being home even when the occupants are away.

Health Benefits: Automatic window blinds can help regulate natural light and improve sleep quality by blocking out external light sources at night and reducing glare during the day.

Integration with Solar Panels: Automatic window blinds can be integrated with solar panels, allowing them to be powered by the sun and reducing their energy consumption.

Customization: Automatic window blinds can be customized to fit any window size or shape, making them an ideal solution for non-standard windows.

Lower Cost: As the technology for automatic window blinds continues to improve, the cost of production is likely to decrease, making them more affordable for consumers.

XIV. ACKNOWLEDGMENT

We would like to express our sincere gratitude to the VRC Robotics Club for their generous support in providing us with the necessary components for our robotics project. Their contribution has been invaluable in helping us to achieve our goals and bring our ideas to life. We are truly grateful for their support and look forward to continuing our work together in the future.

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