IR REMOTE CONTROL LIGHT SWITCH USING CD4017 AND DC MOTOR SPEED CONTROLLER IN ROBOTIC HEAD

20EC5203 ELECTRONIC DESIGN PROJECT I

A PROJECT REPORT

Submitted by

VISHWA G

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY

(An Autonomous Institution, Affiliated to Anna University Chennai and Approved by AICTE, New Delhi)

SAMAYAPURAM– 621 112

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(AUTONOMOUS)

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BONAFIDE CERTIFICATE

Certified that this project report titled **"IR REMOTE CONTROL LIGHT SWITCH USING CD4017 AND DC MOTOR SPEED CONTROLLER IN ROBOTIC HEAD"** is the bonafide work of **MAHALAKSHMI M (811722106048), PARTHI L (811722106072),VISHWA G(811722106125)** who carried out the project under our supervision. Certified further, that to the best of our knowledge the work reported here in does not from part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE	**SIGNATURE**
Dr. S. SYEDAKBAR, M.E.,Ph.D.,	Mr.M.RAJA,M.E.,(Ph.D).,
HEAD OF THE DEPARTMENT	**SUPERVISOR**
Assistant Professor	Assistant Professor
Department of Electronics and Communication Engineering	Department of Electronics and Communication Engineering
K Ramakrishnan College of Technology (Autonomous)	K Ramakrishnan College of Technology (Autonomous)
Samayapuram – 621 112	Samayapuram – 621 112

Submitted for the viva-voce examination held on ………………

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We jointly declare that the project report on **"IR REMOTE CONTROL LIGHT SWITCH USING CD4017 AND DC MOTOR SPEED CONTROLLER IN ROBOTIC HEAD "** is the result of original work done by us and best of our knowledge, similar work has not been submitted to **"ANNA UNIVERSITY CHENNAI"** for the requirement of Degree of **BACHELOR OF ENGINEERING**. This project report is submitted on the partial fulfillment of the requirement of the award of Degree of **BACHELOR OF ENGINEERING**.

Signature

MAHALAKSHMI M

PARTHI L

VISHWA G

Place: Samayapuram

Date:

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LIST OF ABBREVIATION

AC	-	Alternating current
BJT	-	Bipolar Junction Transistor
CAD	-	Computer Aided Design
CMOS	-	Complementary Metal Oxide Semiconductor
DC	-	Direct Current
FET	-	Field Effect transistor
IC	-	Integrated Circuit
JFET	-	Junction Field Effect Transistor
LED	-	Light Emitting Diode
PCB	-	Printed Circuited Board
PWM	-	Pulse With Modulation
RV1	-	Variable Resistance

CHAPTER 1

COMPONENTS

1.1 PRINTED CIRCUIT BOARD

A printed circuit board(PCB) is a vital component in modern electronics, serving as a robust and organized platform for the inter connection of electronic components Typically composed of a substrate material ,such as fiber glassrein force depoxy ,the PCB hosts a complex network of conductive pathways. More intricate electronic devices often utilize multilayer PCBs ,where multiple layers of conductive path ways are stacked atop each other. This design allow s form are compact and sophisticated circuits ,essential for advanced electronics. The fabrication process of a PCB involves several steps. Initially, the circuit design is created using computer-aided design (CAD) software, specifying the arrangement of components and the lay out of conductive pathways They replace traditional point-to -point wiring, reducing the risk of errors and enhancing the overall

Figure 1.1 PCB Board

reliability of the system. Additionally, the compact design of figure1.1 contributes to the miniaturization of electronic devices,making them more portable and efficient. The versatility of PCBs has made them integral to a wide range of applications, from consumer electronics to industrial machinery and aerospace systems technology continues to advance,the development of innovative PCB designs and manufacturing techniques remains crucial for pushing the boundaries of electronic capabilities.

1.2 DIODE

A diode, a fundamental semiconductor device with two terminals known as the anode and cathode, plays a pivotal role in electronic circuits due to its unique electrical properties. The primary function of a diode is to control the flow of electric current by allowing it in one direction while blocking it in the opposite direction. This property is vital in rectification processes, especially in power supply circuits, where diodes are instrumental in converting alternating current (AC) to direct current(DC). The behavior of a diode is characterized byits voltage-current relationship ,described by the Shockley diode equation, which exhibits an exponential relationship between

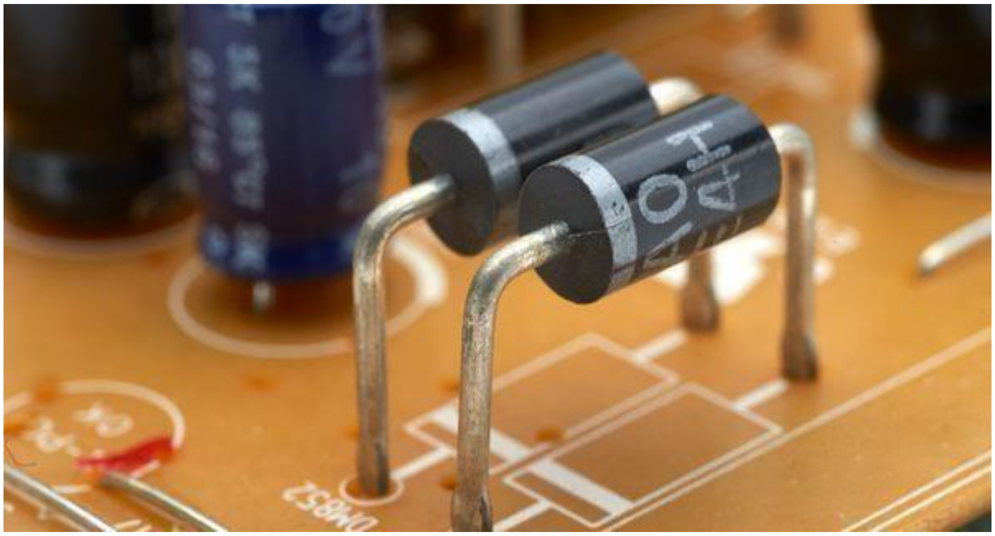

Figure 1.2 Diode

The voltage across the diode and the current flowing throug hit. When the diode is forward-biased, meaning a positive voltage is applied to the anode with respect to the cathode, it conducts current, allowing the flow of electrons. In contrast, when the figure1.2 is reverse-biased (negative voltage applied to the anode), it blocks current, essentially acting as a one-way valve for electric current.A common variant of a diode is a light-emitting diode, which is used as electric lighting and status indicators on electronic devices.

1.3 LED

Light Emitting Diodes (LEDs) represent a ground breaking technology with wide-ranging applications across diverse industries .Functioning on the principle of electroluminescence, LEDs emit light as a result of electrons moving within a semiconductor material .The advantages of LEDs are mani fold .They excelin energy efficiency by converting a significant portion of electrical energy into visible light, Surpassing traditional in can descent bulb that dissipate a substantial amount as heat .This not only contributes to lower electricity bills but also aligns with global efforts towards energy conservation. The durability of LEDs is a key asset, attributed totheir solid-state construction, lacking delicate components like filaments or glassbulbs.

Beyond their use in indicators and displays, LEDs play a pivotal role in driving technological advancements. Their low power consumption makes them

Figure 1.3 LED

Ideal for battery-operated devices, while their contribution to energy efficiency aligns with sustainability goals. In the automotive industry, figure 1.3 are extensively used in head lights and tail lights ,improving visibility and safety .The continual evolution of LED technology underscores its importance in shaping a more sustainable and technologically advanced future. as research and development in this field progress ,LEDs are likely to play an even more central role in addressing global energy challenges and foster in innovation across amyriad of applications.

1.4 POWERSUPPLY

A battery stands as a fundamental component in the realm of portable electronics ,operating as a versatile electro chemical device designed to store and deliver electrical energy through a controlled chemical reaction .Typically composed of one or more electro chemical cells, a battery consists of positive (cathode) and negative(anode) electrodes immersed in an electrolyte solution. The chemical interaction between these components, when a circuit is closed, triggers a reaction that result in the flow of electrons ,generating electrical energy. Alkaline batteries, for instance, are ubiquitous in everyday devices due to their reliability and cost-effectiveness .Lithium-ion batteries, renowned for their high energy density and recharge able nature, are prevalent in various applications, including smart phones and electric vehicles. Nickel-cadmium batteries, also rechargeable, find their niche in portable electronics, offering a balance between efficiency and longevity. Alkaline batteries are ideal for low-drain devices, while lithium-ion batteries shine in applications demanding compact ness and high energy storage.

Figure 1.4 Battery

Rechargeable batteries, a notable category, contribute significantly to sustain ability efforts by minimizing waste and promoting resource efficiency. Particularly economical for devices with frequent usage patterns ,recharge able figure1.4 not only reduce environmental impact but also prove cost-effective over time. Batteries serve as omni present power sources, indispensable for a broad spectrum of electronic devices. Their role extends from powering small everyday gadgets to being the driving force behind electric vehicles .where electronic devices are integral daily life.

1.5 RESISTOR

A resistor is a fundamental electronic component that opposes the flow of electric current. It is a passive two-terminal device with the primary function of controlling or limiting the amount of current passing through a circuit. Resistors are crucial in electronics for adjusting voltage levels, protecting components from excessive currents, and defining time constants in various applications. Resistors come in various types, including fixed resistors with specific resistance values and variable resistors like potentiometer and rheostats that allow manual adjustment. The resistance of a resistor is measured in ohms (Ω) and is governed by Ohm's Law, which relates the voltage (V), current (I), and resistance (R) in a circuit through the equation $V = I \times R$. In electronic circuits, resistors play essential roles in voltage dividers ,signal conditioning, and setting bias point for active devices like transistors.

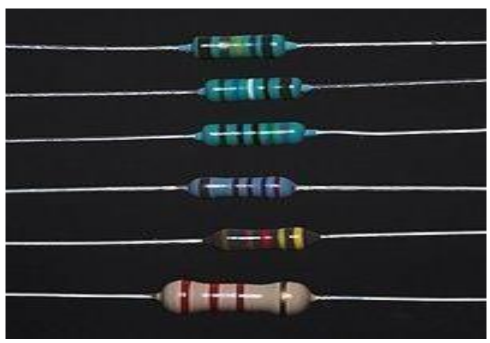

Figure 1.5 Resistor

More over,in setting bias points for active devices like transistors ,resistors contribute to stabilizing and controlling the operation of these components .They are also employed in filters, oscillators, and numerous other applications where precise control of electrical parameter necessary.figure1.5 are foundational components in circuit design, offering control and stability in the flow of electric current ,contributing to the overall functionality and performance of electronic systems. In summary, resistors are foundational components in circuit design, offering control and stability in the flow of electric current.

1.6 CAPACITOR

A capacitor is a fundamental electronic component that stores and releases electrical energy in a circuit. It consists of two conductive plates separated by an insulating material called a dielectric. When a voltage is applied across the plates, an electric field is established, causing the accumulation of positive and negative charges on the respective plates. Capacitors are versatile components with various applications in electronics. They play a crucial role in smoothing voltage fluctuations, filtering signals ,and providing energy storage in circuits.The ability to store electrical energy temporarily makes capacitors valuable in timing circuits, coupling AC and DC signals ,and decoupling power supplies. Capacitors come in different types, including electrolytic capacitors, ceramic capacitors, and tantalum capacitors, each with specific properties suited to different applications. The capacitance of a capacitor ,measured in farads (F),indicates its ability to store

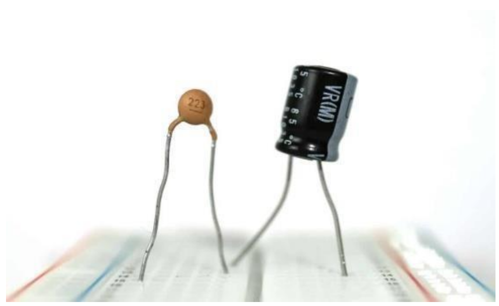

Figure 1.6 Capacitor

charge. In electronic circuits ,figure1.6 are essential for stabilizing power supplies, eliminating noise, and facilitating proper functioning of various electronic components. They play integral roles in audio systems, power amplifiers ,filters ,and numerous other electronic devices, contributing significantly to the efficiency and performance of electrical systems.

1.7 INTEGRATED CIRCUIT

An Integrated Circuit (IC) is a compact arrangement of inter connected electronic components, such as transistors, resistors, capacitors, and diodes, fabricated on a semiconductor material .The miniaturized design of an IC allows for the integration of multiple functions and electronic circuits into a single chip providing a significant advancement in electronic technology. Digital ICs, such as microprocessors and memory chips ,process binary information, enabling the operation of computers and digital devices. Analog ICs ,like operational amplifiers (op-amps) and voltage regulators, are designed for continuous signal processing, common in audio amplifiers and power supplies. The 555 timer IC and the 741 op-amp are not able examples.

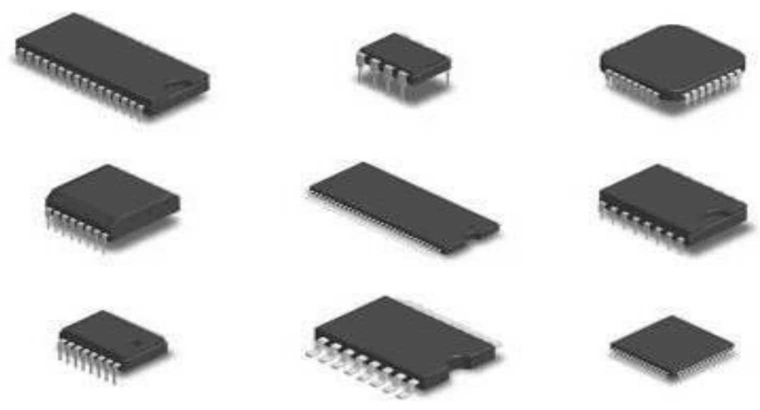

Figure 1.7 Integrated circuit

The 555 timer is widely used for generating time delays, pulse-width modulation ,and oscillations.The741op-amp ,on the other hand, is versatile and commonly used in amplifiers and signal processing applications. The compact nature of ICs enables the creation of complex electronic systems while minimizing space requirements ,power consumption, and manufacturing cost figure1.7 have revolutionized the field of electronics, contributing to the development of count less electronic devices, from computers and smart phones to medical equipment and communication devices.

1.8 DC MOTOR

A DC motor (Direct Current motor) is an electrical machine that converts electrical energy into mechanical motion using the principles of electromagnetism. It operates on the simple idea that when a current passes through a conductor placed in a magnetic field, a force is exerted on the conductor, causing it to move. The motor consists of several key components: the armature (rotor), the commutator, brushes, and the stator. The armature is the rotating part of the motor, while the stator provides the magnetic field, typically produced by permanent magnets or electromagnets. The commutator is a rotating switch that reverses the direction of current flow through the armature windings to ensure

Figure 1.8 DC motor

continuous rotation. The brushes, typically made of carbon, maintain contact with the commutator to allow current flow .When direct current is applied to the motor, it flows through the armature windings, generating a magnetic field that interacts with the stator's magnetic field. This interaction produces a torque, causing the armature to rotate. The direction of rotation can be reversed by changing the direction of the current. DC motors are widely used in applications such as robotics, electric vehicles, fans, and household appliances due to their simplicity, speed control, and ease of operation.

1.9 POTENTIOMETER

A potentiometer is a variable resistor that can be used to control the speed of a DC motor in a simple speed control circuit. By adjusting the potentiometer, the resistance in the circuit changes, which in turn alters the voltage supplied to the motor. This variation in voltage affects the motor’s speed, providing a manual way to control it. When connected to a PWM-based speed controller, the potentiometer can adjust the duty cycle of the PWM signal, thereby regulating the motor’s average power input and allowing for precise speed adjustments. figure1.9 are cost-effective and easy to implement in motor control applications.

Figure 1.9 potentiometer

A potentiometer is a three-terminal variable resistor used to control electrical values, primarily voltage. It consists of a resistive element and a movable wiper that slides along the element. The two fixed terminals are connected to either end of the resistive track, while the third terminal is attached to the wiper. When the wiper is adjusted, the resistance between the wiper and the terminals changes, altering the output voltage across the potentiometer. This ability to vary resistance and control voltage makes potentiometers ideal for applications like volume control in audio equipment, adjusting light brightness, and calibrating electronic circuits.

1.10 TRANSISTOR

A transistor, a pivotal semiconductor device, stands as a cornerstone in the world of electronics due to its remarkable ability to amplify signals and act as a switch .Representing a fundamental building block in electronic circuits, transistors offer versatility and are integral to a broad spectrum of applications ,ranging from amplifiers and oscillators to digital logic circuits.The two primary types of transistors are bipolar junction transistors(BJTs) and field-effect transistors(FETs) ,each with its own variations .BJTs ,categorized as NPN(negative-positive-negative) and PNP (positive-negative-positive), involve the movement of charge carriers between two semiconductor materials. On the other hand, FETs encompass types like MOSFETs (Metal-Oxide-Semi conductor Field-Effect Transistors) and JFETs(Junction Field-Effect Transistors),relying on the modulation of conductivity with in a channel. This ability to amplify signals is harnessed in various devices, including audio amplifiers that drive speakers, radio-frequency amplifiers in communication systems, and operational amplifiers in instrumentation.

Figure 1.10 Transistor

The compact size, low power consumption, and reliability of figure1.10 have been instrumental in them miniaturization and advancement of electronic technology .Transistors have played a transformative role in the evolution of electronic devices ,contributing significantly to the development of computers, communication devices ,and various electronic systems. The continue drefinement and integration of transistors into electronic circuits under score their enduring importance in shaping the land scape of modern technology.

1.11 CONNECTING WIRES

Connecting wires form the in dispensable infrastructure of electronic circuits, serving as the vital conduits that establish electrical pathways and facilitate the seamless flow of electric current. These wires, typically composed of conductive materials like copper or aluminum ,play a fundamental role in ensuring the proper functioning of circuits ,both on bread boards and with in complex electronic systems. The primary function of connecting wires is to link various components with in a circuit ,creating the necessary electrical connections for the circuit to operate as intended. Their conductivity allows for the transmission of electrical signals between different elements, forming the essential links that enable communication and cooperation among circuit components .Beyond their basic role in establishing electrical connections, connecting wires contribute significantly to the organization and structure of circuit layouts .Their flexibility allows for the creation of specific signal paths ,aiding in the systematic arrangement of components.

Figure 1.11 Connecting wires

Different lengths accommodate diverse circuit layouts, while distinct colors aid in visually distinguishing between various connections. This visual clarity becomes particularly crucial during the prototyping and experimentation stages of electronic system development, where designers an need to trouble shoot and optimize circuit configurations. In essence, figure1.11 are not just functional components; they are integral to the design, organization, and functionality of electronic circuits.

1.12 IR RECEIVER

An IR (infrared) receiver is an electronic component designed to detect and decode infrared signals transmitted by an IR remote. It is commonly used in devices like TVs, home automation systems, and DIY projects. A typical IR receiver, such as the TSOP1738, operates at a specific frequency (e.g., 38 kHz) to filter and process modulated IR signals while rejecting ambient light interference. The receiver converts these signals into electrical pulses, which are then decoded by a microcontroller or other circuitry to perform desired actions. Compact, efficient, and reliable, IR receivers are essential for enabling wireless control in modern electronics The IR receiver is designed to detect light in the infrared spectrum, usually around 940 nm, which is invisible to the human eye. It is equipped with a photodiode or photo transistor that reacts to infrared light. The light

Figure 1.12 IR receiver

signal is often modulated at a frequency, typically 38 kHz, to minimize interference from ambient light sources, like sun light or indoor lighting. The receiver has a built-in demodulator that extracts the modulated signal and processes the information. When the signal is received, the IR receiver converts it into a digital signal, which is sent to a microcontroller or processor for further action. This allows devices like TVs, air conditioners, and other home electronics to respond to remote commands.IR receivers are widely used in consumer electronics, offering a simple, cost-effective way to implement wireless communication for controlling devices over Shortest distance.

CHAPTER 2

IR REMOTE CONTROL LIGHT SWITCH WITH CD4017

2.1 ABSTRACT

This project presents the design and implementation of an infrared (IR) remote-controlled switch using the CD4017 decade counter IC. The system allows for wireless control of electrical devices using a standard IR remote, enabling convenience and energy efficiency. The circuit utilizes an IR receiver module (e.g., TSOP1738) to detect IR signals transmitted from the remote. The decoded signals are fed into the CD4017 IC, which functions as a counter and provides sequential outputs to control the state (ON/OFF) of connected devices. A relay module interfaces the low-power control circuit with high-power devices, ensuring safe operation.This compact, cost-effective project is ideal for home automation applications, allowing users to operate appliances remotely. The design highlights the integration of basic digital electronics and IR technology, making it a practical introduction to remote control systems for hobbyists and students. Key features include simplicity of design, low power consumption, and adaptability to control multiple devices with minor modifications.The system leverages an IR receiver module to detect signals from a standard remote control. Upon receiving the IR signal, the CD4017 IC, configured as a counter, interprets the pulses and toggles the output to control the connected light. Each pulse from the IR remote advances the CD4017 output to the next state, enabling the light to turn on or off depending on the desired configuration.This project highlights key benefits such as reduced energy consumption, enhanced convenience, and easy integration into existing electrical systems. The compact design and low power consumption make this system an ideal choice for modern homes and offices aiming to implement basic automation. The project also demonstrates the potential for expansion by incorporating multiple channels to control various appliances.

2.2 INTRODUCTION

In today's world, remote-controlled devices have become an integral part of modern living, offering convenience and energy efficiency. This mini project focuses on designing an IR (infrared) remote switch using the CD4017 [1].decade counter IC, providing a simple and effective solution for wireless control of electrical appliances. The system is based on an IR receiver module, such as the TSOP1738, which detects signals transmitted from a standard IR remote. The detected signals are processed by the CD4017 IC, which produces sequential outputs to control the ON/OFF states of connected devices. By integrating a relay module, the circuit ensures safe interaction between the low-power control signals and high-power appliances.This project is particularly appealing due to its simplicity, affordability, and practical applications. It demonstrates the effective use of digital electronics and IR technology, making it an excellent learning tool for students and hobbyists. The circuit's modular design allows for easy modifications, enabling control of multiple devices with minor adjustments. With increasing interest in home automation[2]. and energy management, this project serves as a stepping stone for exploring advanced remote control systems, making it both educational and practical for real-world applications.

The growing demand for automation and convenience in our daily lives has led to the development of innovative technologies, one of which is the IR (Infrared) remote control light [3].switch. This project demonstrates a simple and cost-effective way to control electrical appliances, specifically lights, using an IR remote and a CD4017 IC. The design provides users with the ability to turn lights on and off remotely without needing direct physical interaction with a switch.Infrared remote control technology is widely used in consumer electronics due to its simplicity, low cost, and reliability. In this project, an IR receiver module captures the signal sent from a remote control[4]. and processes it to toggle the state of a light. The system employs the CD4017 decade counter IC, which acts as a control mechanism to interpret the IR signals and perform the desired action.

The CD4017 is a versatile digital IC capable of dividing and counting pulses. It operates as a Johnson decade counter that produces outputs sequentially based on input clock pulses. This feature is leveraged in the circuit to switch[5]. the light on and off with alternating signals from the IR remote. The circuit requires minimal components, making it an efficient and user-friendly solution.The IR receiver module used in this project typically consists of a photodiode and supporting circuitry that detects IR signals and converts them into electrical pulses. The output of the receiver is fed to the clock input of the CD4017 IC. With each pulse from the IR remote, the IC toggles between its output states, effectively controlling the connected light..

2.3 COMPONENTS USED

- LED - 1
- IC - Cd4017
- Capacitor - 1
- PCB board - 1
- Battery - 1
- IR receiver - 1
- Capacitor - 0.1
- Transistor - Bc547
- Diode - 1N4007
- Resistor - 220 ohm 100 ohm 10 ohm
- Wires - Bc 557

2.4 CIRCUIT DIAGRAM

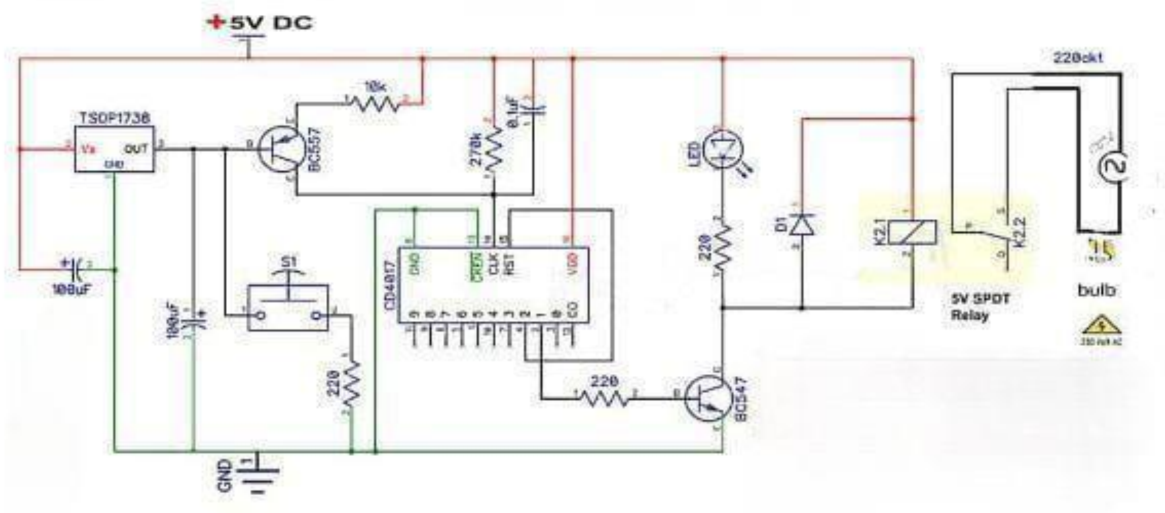

Figure 2.1 Circuit Diagram of IR remote switch with 4017

2.5 WORKING MODEL

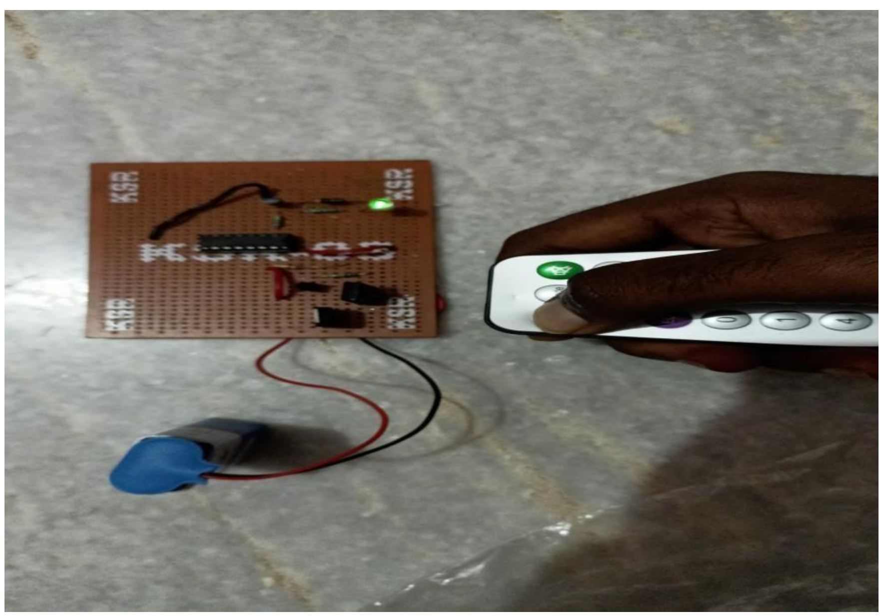

Figure 2.2 Working Model

The IR Remote Control Switch project utilizes infrared technology to remotely control an electrical appliance, such as a light bulb, using a TV or universal remote. The circuit is primarily built around the TSOP1738 IR receiver module, a CD4017 decade counter IC, and a relay mechanism to control the appliance. This system demonstrates the convenience of wirelessly operating household devices, highlighting its practicality and wide-ranging applications in home automation. The following explains the circuit's working in detail.At the heart of the project is the TSOP1738 infrared receiver module, which detects infrared signals transmitted from a remote control. This module is highly sensitive to IR signals of a specific frequency, typically 38 kHz, ensuring that it responds only to signals from the intended remote control. When an IR signal is transmitted by pressing a button on the remote, the TSOP1738 converts the signal into an electrical pulse. This output is connected to the base of a BC557 PNP transistor, which amplifies the received signal. The amplified pulse is then processed further to trigger the desired action. The CD4017 decade counter IC plays a critical role in decoding and processing the received IR signals. The IC operates as a counter and sequentially activates one of its output pins (Q0–Q9) in response to clock pulses received at its clock input (pin 14). In this circuit, the pulses generated by the TSOP1738 and amplified by the transistor are fed into the clock input of the CD4017. Each valid pulse toggles the state of the IC, enabling it to sequentially move through its output pins. For this project, only two outputs of the CD4017 (Q0 and Q1) are used to control the relay, enabling ON/OFF operation of the connected appliance.When the system is powered, the CD4017 is initialized, and its Q0 output is HIGH by default, ensuring that the connected appliance is initially off. Upon receiving the first pulse from the remote, the IC transitions to the next state, making the Q1 output HIGH and activating the relay. The relay, which acts as an electrically operated switch, closes its contacts and powers the connected appliance, such as a light bulb. When another pulse is received, the IC toggles back to its initial state, deactivating the relay and turning off the appliance. This toggling mechanism enables the user to control the appliance's ON/OFF state remotely.

To ensure smooth operation, several supporting components are included in the circuit. Resistors and capacitors are used for debouncing and noise filtering, ensuring that only clean, valid pulses are processed by the IC. For example, a 100 µF capacitor connected to the TSOP1738 ensures that spurious signals or noise do not trigger false pulses. Similarly, the resistor-capacitor network at the reset pin (pin 15) of the CD4017 ensures that the IC initializes correctly when powered on.The relay used in the circuit is a 5V SPDT (Single Pole Double Throw) relay, capable of switching higher voltage loads such as a 220V AC light bulb. A BC547 NPN transistor is used to drive the relay, as the output from the CD4017 alone cannot supply enough current to activate the relay coil. When the Q1 output of the CD4017 is HIGH, it triggers the BC547 transistor, allowing current to flow through the relay coil. This closes the relay contacts and powers the connected appliance. A diode (D1) is connected across the relay coil to protect the circuit from voltage spikes generated when the relay is switched off, a phenomenon known as back-EMF.An LED indicator is included in the circuit to visually display the state of the appliance. When the relay is activated and the appliance is ON, the LED lights up, providing a simple yet effective visual cue. This feature is particularly useful in situations where the appliance is not directly visible to the user.This project demonstrates the simplicity and effectiveness of using IR technology for wireless control of household devices. The system is user-friendly, requiring only a standard TV or universal remote to operate. It is also highly versatile and can be expanded to control multiple appliances by utilizing additional outputs of the CD4017 IC. Furthermore, the low power consumption and cost-effectiveness of the components make this project accessible for both hobbyists and professionals.In practical terms, this project has numerous applications. It can be used to control lights, fans, or other electrical appliances in a home, making it a valuable addition to any home automation system It is particularly beneficial for elderly or physically challenged individuals, providing them with an easy and convenient way to operate devices remotely. Additionally, it serves as a foundation for more advanced remote-control systems, such as those integrating multiple channels or feedback mechanisms.

2.6 BLOCK DIAGRAM

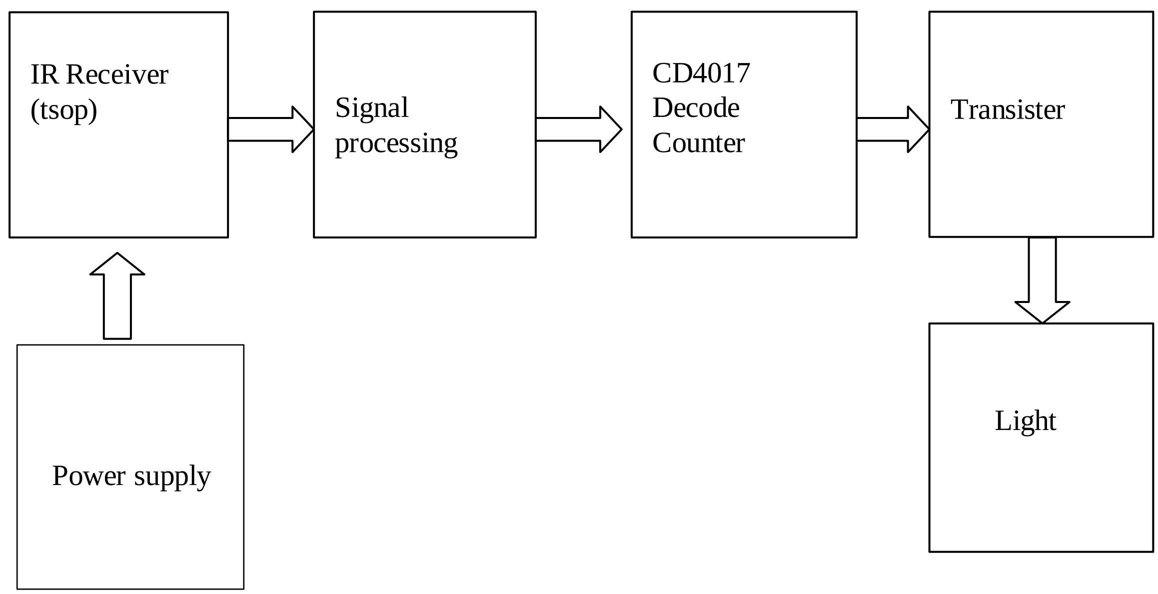

Figure 2.3 Block diagram of IR remote control

An IR (infrared) remote is a device used for wireless control of electronic appliances like TVs, air conditioners, and home automation systems. It transmits modulated infrared signals through an IR LED, typically at a frequency of 38 kHz, to a receiver such as the TSOP1738, which decodes these signals into commands. This modulation minimizes interference from ambient light, ensuring reliable communication. IR remotes are cost-effective, simple to use, and widely implemented in DIY projects like switches and robots. Their versatility and efficiency make them a fundamental tool in modern electronics and automation technologies.

2.6.1 IR Receiver

An IR (infrared) receiver is an electronic component designed to detect and decode infrared signals transmitted by an IR remote. It is commonly used in devices like TVs, home automation systems, and DIY projects. A typical IR receiver, such as the TSOP1738, operates at a specific frequency (e.g., 38 kHz) to filter and process modulated IR signals while rejecting ambient light interference. The receiver converts these signals into electrical pulses, which are then decoded by a microcontroller or other circuitry to perform desired actions.Compact, efficient, and reliable, IR receivers are essential for enabling wireless control in modern electronics.

2.6.2 CD4017 Decade Counter

The CD4017 is a CMOS decade counter/divider IC widely used in digital electronics for sequential counting and control applications. It features 10 decoded outputs (Q0 to Q9), which are sequentially activated in response to input clock pulses. The IC also includes a clock enable input, a reset input, and a carry-out pin for cascading multiple counters.Key features of the CD4017 include low power consumption, wide operating voltage range (3V to 15V), and high noise immunity. It is commonly used in LED chasers, light sequencers, frequency dividers, and other control circuits. Its versatility and simplicity make it ideal for both educational and practical applications in electronics.

2.6.3 Light

Light is a form of electromagnetic radiation visible to the human eye, essential for life and various technologies. It travels in waves and exhibits dual properties, behaving as both particles (photons) and waves. The speed of light in a vacuum is approximately 300,000 kilometers per second. Light enables vision and drives natural processes like photosynthesis. It can be emitted naturally, such as sunlight, or artificially through sources like bulbs and LEDs. Light also interacts with materials through reflection, refraction, and absorption and energy. Its versatility makes it fundamental in science and daily life.
The electromagnetic spectrum is very broad, ranging from radio waves with low energy to gamma rays with high energy. Light as a wave or particleLight behaves like a wave with properties like wavelength and frequency, but can also be considered to behave like a particle called a photon.

2.7 ADVANTAGES

- **Simplicity:** The circuit design is straightforward and easy to understand, making it ideal for beginners.
- **Cost-Effective:** Uses inexpensive and readily available components.
- **Low Power Consumption:** The CD 4017 IC operates efficiently with low power requirements.
- **Versatility:** Can be used to control various devices like lights, fans, and other household appliances**.**
- **No Programming Required:** Unlike microcontroller-based projects, this setup does not require any programming skills.

2.8 APPLICATIONS

- Home Automation: Provides a convenient and wireless method for controlling household lights, enhancing user comfort and accessibility.
- Energy Management: Enables remote control of lights to easily turn them off when not in use, potentially reducing energy consumption.
- Accessibility Enhancement: Assists individuals with mobility issues by allowing them to control lights without physical interaction with switches. DIY Projects and Learning..

CHAPTER -3

DC MOTOR SPEED CONTROLLER IN ROBOTIC HEAD

3.1 ABSTRACT

This project presents the design and implementation of a DC motor speed controller using a Pulse Width Modulation (PWM) technique. The objective is to regulate the speed of the DC motor by adjusting the duty cycle of the PWM signal, thereby controlling the amount of power supplied to the motor. The controller uses a microcontroller to generate the PWM signal, which is fed to a motor driver circuit to control the motor's speed. The system allows precise and efficient speed control, making it suitable for applications such as robotics, conveyor systems, and automation. The project also includes safety features such as overcurrent protection and an adjustable speed range. The results demonstrate the system's ability to maintain stable motor operation across various speeds, providing a cost-effective and reliable solution for DC motor speed control.In modern robotics, precise motor speed control is essential for achieving accurate motion and dynamic performance. This project focuses on the design and implementation of a DC motor speed controller tailored for a robotic head. The robotic head features servomotor-driven joints for realistic and synchronized movements, demanding efficient and responsive speed regulation. The speed controller uses a pulse-width modulation (PWM) technique for smooth acceleration, deceleration, and precise position control.An advanced microcontroller forms the core of the system, providing seamless integration of speed control algorithms with sensor feedback. Hall-effect sensors or encoders monitor motor speed and position, enabling real-time adjustments to compensate for load variations. The robotic head mimics human-like movements, supporting applications such as humanoid robots, interactive assistants, and animatronics.

3.2 INTRODUCTION

DC motors are widely used in various applications due to their simplicity, controllability, and efficiency. The speed of a DC motor is a critical parameter in many systems, such as robotics, automation, and conveyors, where precise speed control is necessary for optimal performance. In this mini-project, we focus on developing a DC motor speed controller[6].that adjusts the motor's speed according to desired parameters.Traditional methods of controlling the speed of DC motors often involve varying the input voltage or using resistors, but these techniques can be inefficient and generate excess heat. A more efficient method is to use Pulse Width Modulation (PWM), which involves varying the duty cycle of a square wave signal to control the average voltage supplied to the motor. By adjusting the duty cycle, we can regulate the speed of the motor without the losses associated with voltage control methods.In this project, a microcontroller is used to generate the PWM signal, which is then sent to a motor driver to control the motor's speed. The controller can be adjusted to provide a wide range of speeds, offering flexibility in its applications. Additionally, safety mechanisms such as overcurrent protection are integrated into the system to prevent damage to the motor and other components.The goal of this project is to design[7]. a low-cost, efficient, and easily adjustable system for controlling the speed of a DC motor[8]. suitable for educational purposes and practical applications.The rapid evolution of robotics and automation has made precise motor control essential for creating intelligent, efficient, and functional systems. A DC motor speed controller robotic head is a sophisticated device designed to manipulate motor speeds and directional movement with exceptional accuracy, enabling versatile applications in robotics, automation, and mechatronics.The controller's design revolves around key principles of pulse-width modulation (PWM)[9].and feedback loops. PWM ensures fine control of motor speed by varying the duty cycle of the voltage applied to the motor, while feedback loops, enabled by encoders or other sensors, help maintain the desired speed or position by correcting deviations.

The robotic head's capability extends to multi-axis control, allowing it to adjust its orientation and movements fluidly. Such technology finds applications in advanced fields like humanoid robotics, surveillance, medical systems, and interactive AI, where replicating natural motions and enhancing operational precision are crucial**.**In robotic systems, particularly humanoid or animatronic robots, the head is a critical component for interaction, communication, and expression. Achieving natural and accurate head movements—such as nodding, tilting, or rotating—requires a sophisticated motor control system, typically utilizing DC motors[10]. for their efficiency, simplicity, and ease of control. These motors convert electrical energy into mechanical motion, and their controllers are responsible for regulating speed, direction, and torque to meet the specific demands of the robotic application.

3.3 COMPONENTS USED

- DC Motor - 12v/6000-10000RPM
- IC - NE555 Timer
- Darlington transistor - TIP122
- Potentiometer – 100k
- Diode – 1N4007
- Capacitor - 100Nf
- Resistor – 1k
- Dc battery - 12v
- Battery clips - 1

3.4 CIRCUIT DIAGRAM

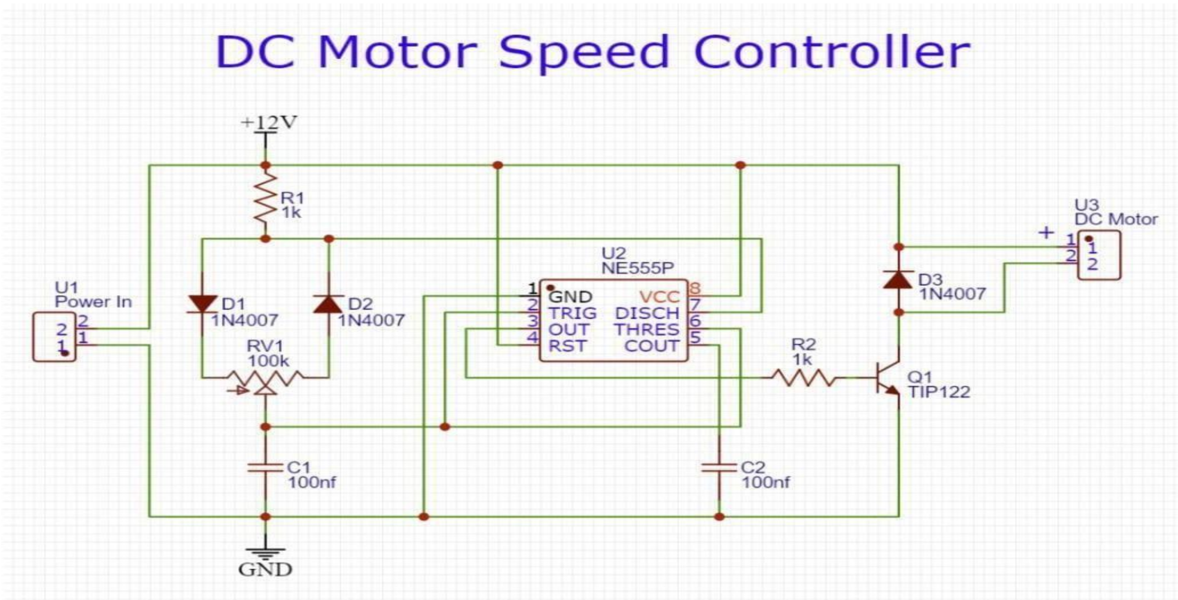

Figure 3.1 Circuit Diagram of DC motor speed controller.

3.5 WORKING MODEL

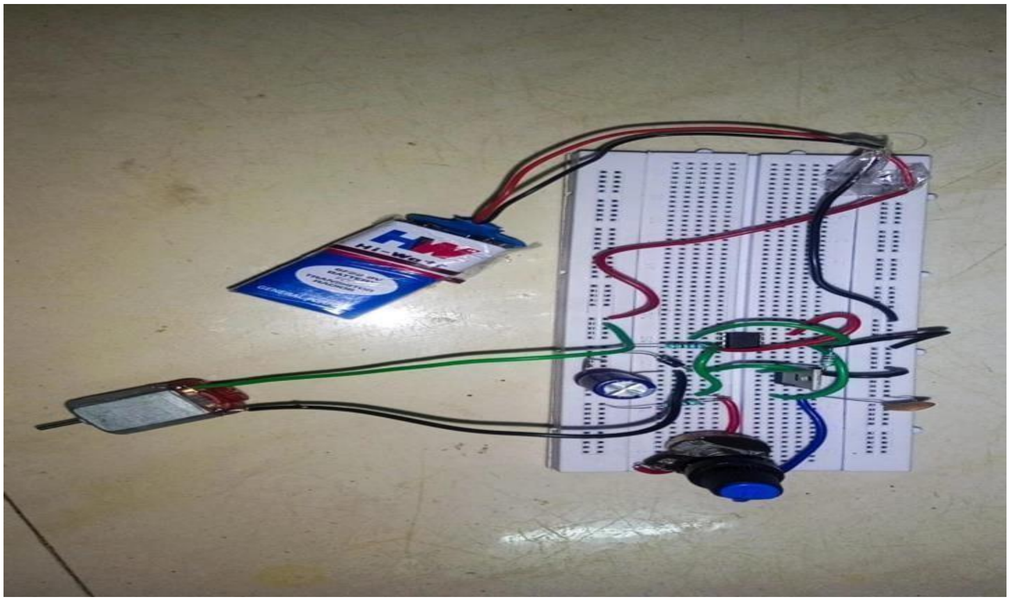

Figure 3.2 Working Model

In this DC Motor Speed Control, IC 555 is working as a square pulse generator depending on the value of the potentiometer. The output pulse width or duty cycle can get changed through that potentiometer. Someone immediately gave the output from IC 555 to the base of the wired transistor. We have connected the motor to the collector of the transistor through the diode. Now, you can adjust the speed by adjusting the potentiometer in the circuit.The DC Motor Speed Controller circuit depicted in the diagram is designed to control the speed of a DC motor using Pulse Width Modulation (PWM). PWM is an efficient technique that allows precise control of motor speed by varying the duty cycle of a square wave signal. This circuit is centered around the NE555 timer IC, configured in astable mode, and utilizes a TIP122 NPN Darlington transistor to drive the motor. Key components include resistors, capacitors, diodes for protection, and a variable resistor (RV1) to adjust the motor's speed. The operation of the circuit and its role in speed control are explained in detail below.The circuit is powered by a 12V DC source, which supplies the necessary voltage for the motor and other components. The NE555 timer (U2) is the heart of the circuit, generating a continuous train of PWM pulses at its output (pin 3). The frequency and duty cycle of these pulses are determined by the resistors R1, RV1 (variable resistor), and capacitor C1. The variable resistor RV1 plays a crucial role in adjusting the duty cycle. The duty cycle refers to the ratio of the ON time of the signal to its total period. By varying RV1, the user can increase or decrease the ON time of the PWM signal, thereby controlling the amount of power delivered to the motor. This control allows smooth and precise speed adjustment without significant energy loss.When the circuit is powered on, the 555 timer begins generating the PWM signal. During the charging phase, capacitor C1 charges through R1 and RV1. The time it takes to charge determines the ON time of the PWM signal. Once the capacitor's voltage reaches a certain threshold, the 555 timer switches states, and capacitor C1 begins discharging through RV1 and the discharge pin (pin 7) of the IC. The discharging time sets the OFF time of the PWM signal. This continuous charging and discharging create the square wave output at pin 3 of the NE555. By adjusting RV1, the charging and discharging times are altered, resulting in a change in the duty cycle.

The PWM signal from the 555 timer is fed to the base of the TIP122 transistor through a current-limiting resistor R2. The TIP122 acts as a switch to control the motor. When the PWM signal is HIGH (ON state), the TIP122 conducts, allowing current to flow from the power supply through the motor. This powers the motor, causing it to rotate. When the PWM signal is LOW (OFF state), the transistor is in cutoff mode, preventing current flow and momentarily stopping the motor. The average voltage supplied to the motor is directly proportional to the duty cycle of the PWM signal. A higher duty cycle means the motor is powered for a longer duration, resulting in higher speed. Conversely, a lower duty cycle reduces the motor's speed by decreasing the average power.To ensure the circuit operates safely and reliably, several protection mechanisms are incorporated. Diode D3, connected across the motor, acts as a flyback diode to handle the back-EMF generated by the motor. DC motors are inductive loads and produce voltage spikes when switching occurs. Without this diode, the back-EMF could damage the TIP122 transistor. Additionally, diodes D1 and D2 provide reverse polarity protection. They safeguard the circuit from damage in case the power supply connections are accidentally reversed. Capacitor C2 stabilizes the power supply, ensuring smooth operation and protecting the timer IC from noise or voltage fluctuations.This circuit offers a practical and energy-efficient way to control motor speed. Traditional speed control methods, such as using resistors, waste energy in the form of heat. In contrast, PWM minimizes energy loss by switching the motor on and off rapidly, controlling the average voltage without dissipating excess power. This makes the circuit ideal for battery-powered applications, as it extends battery life while delivering precise speed control.The DC motor speed controller is versatile and can be used in a wide range of applications. It is suitable for robotics, small machines, fans, and other devices that require variable speed control. The design is simple and cost-effective, making it accessible for DIY enthusiasts and professionals alike. By incorporating a few additional components, such as an H-bridge, this circuit can also be adapted for bidirectional motor control.

3.6 BLOCK DIAGRAM

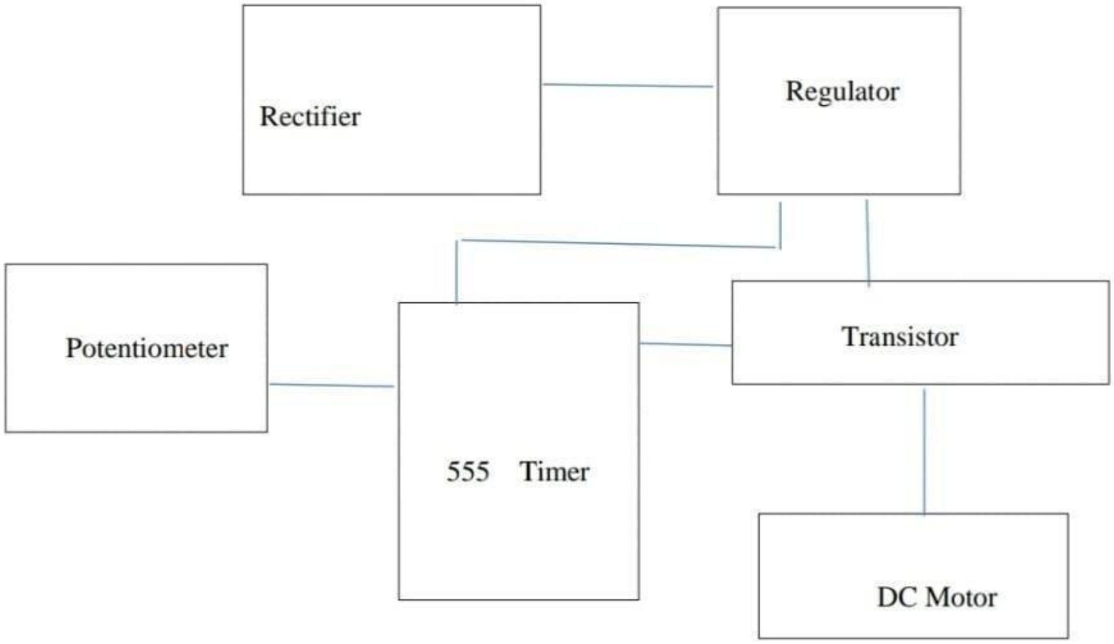

Figure 3.3 Block diagram

3.6.1 Potentiometer

A potentiometer is a variable resistor that can be used to control the speed of a DC motor in a simple speed control circuit. By adjusting the potentiometer, the resistance in the circuit changes, which in turn alters the voltage supplied to the motor. This variation in voltage affects the motor's speed, providing a manual way to control it. When connected to a PWM-based speed controller, the potentiometer can adjust the duty cycle of the PWM signal, thereby regulating the motor's average power input and allowing for precise speed adjustments. Potentiometers are cost-effective and easy to implement in motor control .

3.6.2 555timer IC

The 555 timer IC is an integrated circuit used in a wide range of electronic applications, including timing, pulse generation, and waveform generation. It is a versatile and reliable device, commonly used in both monostable and astable modes. In monostable mode, it functions as a one-shot timer, producing a single output pulse when triggered. In astable mode, the 555 operates as an oscillator, generating a continuous square wave output, which can be used for clock pulses or frequency generation.The 555 timer has three main pins for timing control: the threshold, trigger, and discharge pins. Its output can drive other electronic components such as LEDs, relays, or transistors, making it ideal for control and signal generation tasks. Its low cost, ease of use, and wide availability have made it a staple in hobbyist and professional electronics projects. The 555 timer is also commonly used in frequency generators, pulse width modulation (PWM), and timers.

3.6.3 Transistor

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It has three main components: the emitter, base, and collector. Transistors are classified into two main types: bipolar junction transistors (BJTs) and field-effect transistors (FETs). In a BJT, a small current at the base controls a larger current between the emitter and collector, enabling amplification. In a FET, a voltage applied to the gate controls the current flow between the source and drain. Transistors are essential in digital circuits, amplifiers, and signal processing, playing a crucial role in modern electronics, including computers, radios, and power systems.

3.6.4 Dc motor

A DC motor (Direct Current motor) is an electromechanical device that converts electrical energy into mechanical motion using the interaction between magnetic fields and electric current. It consists of key components such as the armature (rotating part), stator (stationary part), brushes, and commutator. When a direct current is supplied to the motor, the electric current flows through the armature windings, creating a magnetic field that interacts with the fixed magnetic field of the stator, producing rotational force (torque).The commutator and brushes work together to reverse the direction of current flow in the armature windings, ensuring continuous rotation. The speed of a DC motor can be controlled by adjusting the input voltage or using techniques like Pulse Width Modulation (PWM), while the torque can be regulated by the armature current.DC motors.

3.7 ADVANTAGES

- Cost-Effective
- Reliable
- environments.Simplicity

3.8 APPLICATIONS

- Manufacturing automation .
- Educational robotics
- Pick and place system .

CHAPTER 4

CONCLUSION

The IR remote control light switch using the CD4017 IC offers an efficient, cost-effective, and user-friendly solution for controlling lights remotely. This system employs a simple yet reliable design, where the CD4017, a decade counter IC, works in tandem with an IR receiver module to decode signals from an IR remote control. Upon receiving an infrared signal, the CD4017 advances its output states sequentially, enabling or disabling the connected light in response to user commands. This circuit eliminates the need for manual operation of switches, providing convenience, especially in scenarios where physical access to switches is limited. The use of common, low-cost components makes the circuit affordable and accessible for hobbyists and professionals alike, while its straightforward design ensures ease of construction and troubleshooting. Furthermore, the integration of IR technology ensures a wireless operation with minimal interference, enhancing the system's practicality for home automation. In summary, this project exemplifies an innovative application of digital electronics to simplify everyday tasks, demonstrating the potential for integrating modern technology into traditional systems for improved efficiency and convenience.

The DC motor speed controller is an essential and versatile tool that allows precise regulation of motor speed to meet specific application requirements. By utilizing techniques such as Pulse Width Modulation (PWM), the controller adjusts the average power delivered to the motor, enabling efficient speed variation without compromising torque. This ensures optimal performance in a wide range of applications, from robotics and industrial machinery to household appliances. The design of the speed controller, often involving components like transistors, diodes, and potentiometers, emphasizes both efficiency and ease of implementation. Moreover, its ability to protect the motor from overcurrent and voltage spikes enhances the overall reliability and lifespan of the system. This innovative approach to motor control not only improves energy efficiency but also offers users greater flexibility and precision in operation systems.

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