SOUND REACTIVE LED CHASER

A PROJECT REPORT

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ABSTRACT

The Sound-Activated LED Chaser is a creative project that combines electronics and programming to create a dynamic visual display. Using components like the IC4017, CA3140, and Raspberry Pi 3, the system responds to sound signals and produces captivating LED light patterns. The IC4017 is employed to control the sequencing of five LEDs, creating a visually appealing chaser effect. The CA3140 operational amplifier amplifies the audio signals, enhancing the system's responsiveness to sound. The Raspberry Pi 3 serves as the brain of the project, coordinating the LED patterns with the music. The project is accessible for beginners, offering a hands-on experience in hardware and software integration. The report details the step-by-step process of building the Sound-Activated LED Chaser, providing clear instructions for assembling the hardware and programming the Raspberry Pi. The result is an interactive and engaging display where LEDs dance in sync with the rhythm of selected music. This project not only introduces enthusiasts to basic electronic components and programming concepts but also offers a delightful and visually stimulating experience. The abstract highlights the project's focus on simplicity, creativity, and the seamless integration of sound and light elements.

ஆய்வுசுருக்கம்

சவுண்ட்-ஆக்டிவேட்டட் எல்இடி சேசர் என்பது எலக்ட்ரானிக்ஸ் மற்றும் புரோகிராமிங்கை ஒருங்கிணைத்து ஒரு டைனமிக் விஷுவல் டிஸ்ப்ளேவை உருவாக்கும் ஆக்கப்பூர்வமான திட்டமாகும். IC4017, CA3140 மற்றும் Raspberry Pi 3 போன்ற கூறுகளைப் பயன்படுத்தி, கணினி ஒலி சமிக்ஞைகளுக்கு பதிலளிக்கிறது மற்றும் வசீகரிக்கும் LED ஒளி வடிவங்களை உருவாக்குகிறது. IC4017 ஆனது ஐந்து LED களின் வரிசைமுறையைக் கட்டுப்படுத்தப் பயன்படுத்தப்பட்டு, பார்வைக்கு ஈர்க்கும் சேசர் விளைவை உருவாக்குகிறது. CA3140 செயல்பாட்டு பெருக்கி ஆடியோ சிக்னல்களை பெருக்கி, ஒலிக்கு கணினியின் வினைத்திறனை அதிகரிக்கிறது. ராஸ்பெர்ரி பை 3 திட்டத்தின் மூளையாக செயல்படுகிறது, இசையுடன் LED வடிவங்களை ஒருங்கிணைக்கிறது. இந்த திட்டம் ஆரம்பநிலைக்கு அணுகக்கூடியது, வன்பொருள் மற்றும் மென்பொருள் ஒருங்கிணைப்பில் அனுபவத்தை வழங்குகிறது. ஒலி-செயல்படுத்தப்பட்ட LED சேசரை உருவாக்குவதற்கான படிப்படியான செயல்முறையை அறிக்கை விவரிக்கிறது, வன்பொருளை அசெம்பிள் செய்வதற்கும் ராஸ்பெர்ரி பை நிரலாக்கத்திற்கும் தெளிவான வழிமுறைகளை வழங்குகிறது. இதன் விளைவாக, தேர்ந்தெடுக்கப்பட்ட இசையின் தாளத்துடன் எல்இடிகள் ஒத்திசைந்து நடனமாடும் ஊடாடும் மற்றும் ஈர்க்கக்கூடிய காட்சி. இந்தத் திட்டம் ஆர்வலர்களுக்கு அடிப்படை எலக்ட்ரானிக் கூறுகள் மற்றும் நிரலாக்கக் கருத்துகளை அறிமுகப்படுத்துவது மட்டுமல்லாமல், மகிழ்ச்சிகரமான மற்றும் பார்வையைத் தூண்டும் அனுபவத்தையும் வழங்குகிறது. திட்டத்தின் எளிமை, படைப்பாற்றல் மற்றும் ஒலி மற்றும் ஒளி கூறுகளின் தடையற்ற ஒருங்கிணைப்பு ஆகியவற்றில் கவனம் செலுத்துகிறது.

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LIST OF ABBREVIATIONS

LED	Light Emitting Diode
EDC	Electronic Design and Construction
NPN	Negative-Positive-Negative (Transistor)
IC	Integrated Circuit
GPIO	General Purpose Input/Output
OS	Operating System
CPU	Central Processing Unit
IoT	Internet of Things
HTTP	Hypertext Transfer Protocol

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The integration of sound and light has long been a source of fascination, offering a canvas for creative exploration in the realm of electronics. This project endeavors to bring this fusion to life through the creation of a Sound-Activated LED Chaser. Employing components such as the IC4017, CA3140, and the versatile Raspberry Pi 3, our aim is to craft a dynamic visual display that responds harmoniously to audio cues. The IC4017 facilitates the sequencing of five LEDs, creating a captivating chaser effect, while the CA3140 operational amplifier enhances the system's sensitivity to sound signals. The Raspberry Pi 3 serves as the orchestrator, seamlessly coordinating LED patterns with selected music. This report unfolds the step-by-step journey of assembling the hardware and programming the Raspberry Pi, offering both beginners and electronics enthusiasts a hands-on experience in the convergence of technology, music, and visual art. Explore the symphony of circuits, where every note illuminates a new facet of creativity and innovation.

1.2 BLOCK DIAGRAM OF MUSIC LED CHASER

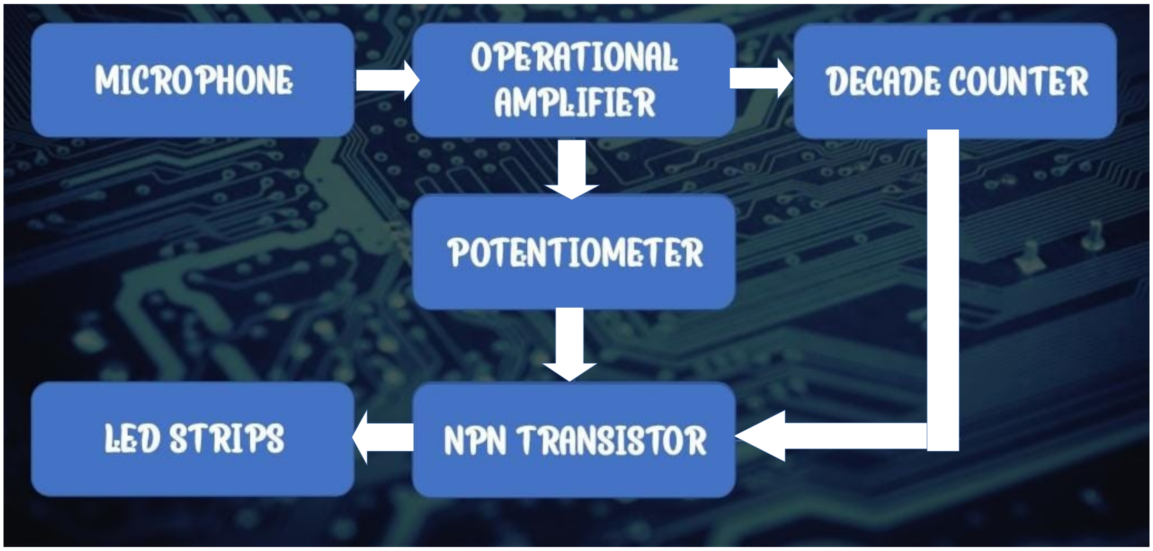

Fig 1.2.1 BLOCK DIAGRAM OF MUSIC LED CHASER

The block diagram illustrates the fundamental architecture of the Sound-Activated LED Chaser hardware project. At its core is the Electret Microphone, responsible for capturing sound signals. The operational amplifier (CA3140) processes and amplifies these signals, enhancing sensitivity. The conditioned audio output then enters the NPN Transistor (BC337), functioning as a switch to control the LED sequence. Connected to the transistor is the Decade Counter (CD4017), orchestrating the sequential activation of five LEDs. This interplay creates a visually dynamic chaser effect. The power supply (12V) energizes the entire system, providing the necessary voltage for seamless operation. This block diagram encapsulates the flow of audio signals through key components, culminating in an intricate dance of LEDs that respond harmoniously to sound, offering a captivating and interactive experience.

1.3 BLOCK DIAGRAM OF RASPBERRY PI 3

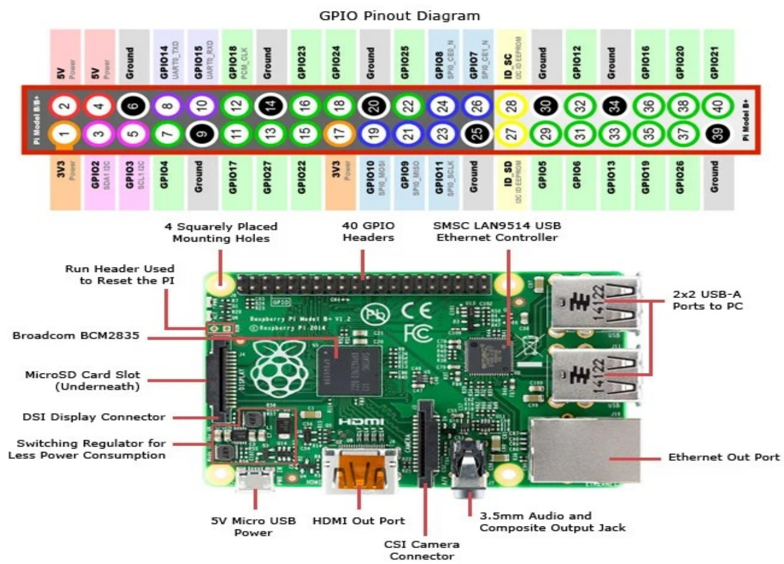

Fig 1.3.1 BLOCK DIAGRAM FOR RASPBERRY PI 3

The block diagram delineates the core elements of the Raspberry Pi 3 interfacing with LED lights. At the heart of the system is the Raspberry Pi 3 itself, serving as the central processing unit. Its GPIO pins act as the bridge to external devices, enabling communication and control. The LED Control Logic, implemented through a Python script, operates on the Raspberry Pi, managing the GPIO pins to orchestrate intricate LED patterns. The final output is manifested through the LED lights, responding dynamically to signals from the Raspberry Pi. This diagram encapsulates the essential flow of information, starting from the Raspberry Pi, traversing through GPIO pins and control logic, and culminating in the visual display of LED lights. It forms the basis for an interactive and programmable LED system driven by the computational power of the Raspberry Pi.

1.4 CONCLUSION

This hardware project seamlessly integrates sound and light, resulting in an engaging LED chaser. The collaboration of IC4017, CA3140, and Raspberry Pi 3 produces a dynamic visual display, showcasing the harmonious synergy between technology and creativity.

CHAPTER 2
PREVIOUS WORK

2.1 INTRODUCTION

In the context of the Sound-Activated LED Chaser project, the literature survey delves into existing research on sound-activated systems, LED control methodologies, and the integration of key components such as IC4017 and CA3140. Exploring Raspberry Pi interfacing literature contributes valuable insights into established practices. This survey aims to assimilate collective knowledge, identify gaps, and build upon proven methodologies, laying the foundation for a comprehensive understanding of the project's technological landscape.

2.2 PREVIOUS WORKS

Antoine Thomet, Kevin Nadaud et al. proposed the development of an electronic music sequencer as an engineering school project, highlighting a novel instrument that empowers users to craft melodic sequences on a mobile panel adorned with LEDs and buttons. This panel, distinct from the sound-generating module, facilitates real-time modification and visualization of musical patterns. The sequencing interface consists of a matrix of 16 * 16 buttons, each associated with a control LED, allowing users to create dynamic sequences by manipulating pitch and time. Unlike existing tools like Yamaha's "Tenori On" and the André Michelle Laboratory's "Tonematrix," the presented instrument ensures independence between the panel and the sound-producing component. The wireless communication between the control panel and the sound-generating module employs Radiometrix NiM2T and NiM2R transmission modules, operating in the Industrial Scientific and Medical (ISM) 434 MHz band. The transmission focuses solely on the active column's data, optimizing efficiency. The sound processing module incorporates a Digital Signal Processor (DSP) TMS320C6416 with a Texas Instrument CODEC (Coder/DECoder) TI TLV320AIC23B, delivering versatile sound generation capabilities. Overall, this project showcases a successful fusion of technological innovation and entertainment, providing an alternative to established electronic music technologies and suggesting potential extensions, such as a single panel controlling multiple receptors for diverse instrument sounds.

NOUVEL Fabienne , AING Sataya et al. proposed wireless LED control system developed by engineering students at INSA Rennes. The system, designed to synchronize lighting atmospheres with music, utilizes Texas Instruments technologies, including the DSP C6x, MSP430, and SympliciTI RF. The DSP C6416 processes the input signal through sampling, power calculation, and determination of red, green, and blue (ROB) color levels. The wireless communication employs eZ430-RF2500 modules, creating a star network with an Access Point (AP), End Devices (ED) for lamps, and a remote control. Performance measurements indicate a wireless range of around 100 meters outdoors. Luxeon Rebel Star LEDs are employed in the LED lamps, utilizing pulse width modulation for intensity control and heat sinks for thermal management. The study highlights successful color and brightness control, showcasing the system's functionality across various music genres. The results suggest potential future improvements, such as integrating DSP algorithms onto MSP430 and expanding the network for additional lamps or systems controlled by manual or music modes. Overall, MUSIC COLORZ demonstrates an innovative integration of Texas Instruments technologies, providing a dynamic and synchronized experience in combining lighting and music.

Xuemin Liu and Zhao Zhang proposed an innovative smart home control system, leveraging Internet of Things (IoT) technology with Raspberry Pi as the central control unit and WeChat Mini Programs for multi-platform adaptability. This system employs Python development, MQTT protocol for LAN communication, and WebSocket protocol for full-duplex communication, offering functionalities such as environmental monitoring, equipment control, scene control, and family management. Integrated voice and face recognition technologies contribute to user convenience and identity verification. The hardware architecture includes ESP8266-based wireless sensor nodes for data collection and a Raspberry Pi 3B+ as the central control unit. The software design encompasses an MQTT server for message processing, a WebSocket server for communication, and integration with an IoT cloud platform for device management. The study validates the system's effectiveness through real-time monitoring and remote control tests, including environmental data collection, voice control, and identity verification. Noteworthy strengths include the system's adaptability across platforms and the integration of diverse technologies for comprehensive smart home control. The authors acknowledge potential enhancements, suggesting the incorporation of deep learning algorithms and image recognition technology. Overall, this research contributes significantly to the smart home domain, showcasing the transformative potential of IoT technologies in enhancing daily life experiences and environmental management.

Jaya Lakshmi et al. presents an ambitious project that revolutionizes traditional greenhouse farming through the integration of Internet of Things (IoT) technologies. Utilizing the Raspberry Pi 3 B+ as the central controller, the system incorporates an array of sensors, including soil moisture, PIR, gas, DHT, LDR, and smoke sensors, along with actuators like motors, fans, and lights. This comprehensive setup allows for real-time monitoring and automated control of environmental conditions within the greenhouse. The authors extend the capabilities of conventional smart greenhouses by introducing live monitoring and plant disease detection features. Leveraging a 5MP Raspberry Pi Camera, the system enables remote viewing of the greenhouse and employs OpenCV and TensorFlow for real-time plant disease detection, addressing crucial concerns related to plant health. The paper not only outlines the architecture and functionalities of the proposed system but also provides insightful comparisons with existing greenhouse projects. By emphasizing the importance of user-friendly interfaces, such as a dedicated web page for real-time data visualization, the authors make significant strides toward making greenhouse farming more accessible, efficient, and responsive to the demands of modern agriculture. Overall, the paper represents a notable contribution to the evolving landscape of smart agriculture, showcasing the potential for IoT to enhance productivity and sustainability in greenhouse cultivation.

2.3 SUMMARY

Thomet, Nadaud, and collaborators introduce an innovative electronic music sequencer, featuring a mobile LED-adorned panel for real-time melodic sequence creation. The wireless instrument uses Radiometrix modules for efficient communication between the control panel and sound module. Fabienne, Sataya, and team present MUSIC COLORZ, a wireless LED control system synchronizing lighting with music using Texas Instruments technologies and Luxeon Rebel Star LEDs. Xuemin Liu and Zhao Zhang propose an IoT-based smart home control system with Raspberry Pi, Python, MQTT, and WebSocket protocols, integrating voice and face recognition for enhanced user convenience. A. Jaya Lakshmi et al. revolutionize greenhouse farming with an IoT-based smart greenhouse using Raspberry Pi, sensors, actuators, OpenCV, and TensorFlow for real-time monitoring, automated control, and plant disease detection, emphasizing user-friendly interfaces.

CHAPTER 3
EXISTING WORK

3.1 INTRODUCTION

This paper presents an electronic music instrument developed as a fourth-year engineering school project at INSA Rennes. Constrained by a limited budget, the instrument enables users to compose melodic sequences through a panel featuring LEDs and buttons. The distinctive feature is the separation of the user interface panel from the sound generation module, allowing users to define and modify sequences remotely. Inspired by the Yamaha "Tenori On" and the André Michelle Laboratory "Tonematrix," this project enhances mobility and offers instantaneous sound production through wireless communication. By describing the instrument's architecture, including the panel interface, wireless communication system, and sound processing unit, the paper highlights the integration of a Digital Signal Processor (DSP) for efficient sound generation. This introduction outlines the project's context, related work, and its unique objective of providing a mobile, user-friendly electronic music composition tool.

3.2 BLOCK DIAGRAM

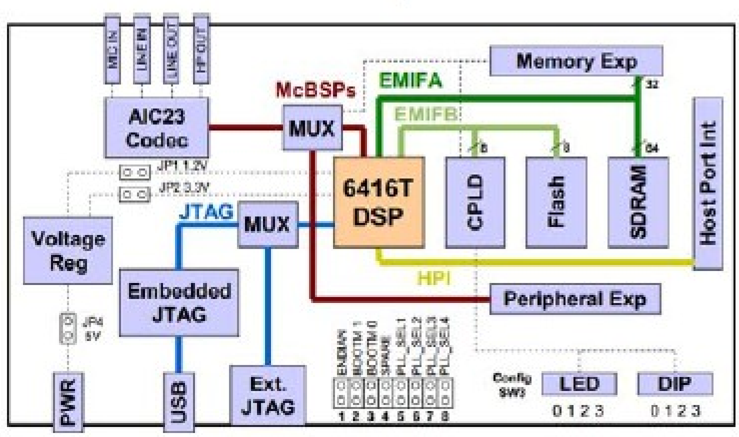

Fig 1.3.1 BLOCK DIAGRAM FOR PREVIOUS WORK

The block diagram of this innovative electronic music sequencer involves a user-controlled LED matrix panel interfacing with a wireless module. The control panel captures real-time musical patterns, representing pitch and time through a 16x16 matrix of buttons and LEDs. This information is wirelessly transmitted at 434 MHz to a separate module housing a DSP TMS320C6416 and Texas Instrument TLV320AIC23 CODEC. The DSP processes the received data, generating high-quality sounds based on three methods: mathematical expression-based wave generation, repeating sampled signals, and truncating and sampling the entire sound signal. The resulting design offers a portable and distinctive music creation experience.

The project described in the paper is an innovative electronic music sequencer with a wireless control panel composed of LEDs. Developed by engineering students at INSA Rennes, the instrument allows users to define melodic sequences on a panel featuring LEDs and buttons. The melodic sequence is wirelessly transmitted to a separate module equipped with a Digital Signal Processor (DSP) TMS320C6416, utilizing the Texas Instrument CODEC TI TLV320AIC23B for sound generation.The control panel, measuring 21.7cm * 24 cm, employs a matrix of 16 * 16 buttons and LEDs, enabling real-time creation and modification of musical patterns. The vertical axis represents pitch, with the bottom corresponding to bass notes and the top to treble. The horizontal axis indicates the position of notes in the pattern, divided into 16 equal intervals. The active column, represented by a vertical bar, triggers sounds associated with glowing LEDs, and the pattern loops continuously.Wireless communication between the control panel and the sound generation module operates at 434 MHz, transmitting only data corresponding to the active column to optimize efficiency. The project also draws inspiration from existing tools such as the Yamaha "Tenori On" and the André Michelle Laboratory "Tonematrix" application.The sound generation process employs a DSP platform with a C6416T DSK development platform and Texas Instrument TLV320AIC23 CODEC. The CODEC ensures compliance with Shannon's theorem, supporting a conversion rate up to 40 kHz for high-quality sound reproduction. Three sound generation methods are explored: mathematical expression-based wave generation, repeating one period of sampled signals, and truncating and sampling the entire sound signal.Overall, the project successfully achieves a fully functional electronic sequencer with a user-friendly control panel, wireless capability, and sound generation using DSP technology. The design offers a unique and mobile music creation experience, distinguishing itself from existing instruments like Yamaha's "Tenori On." Future extensions could explore possibilities such as a single panel controlling multiple receptors for different instrument sounds.

3.3 CONCLUSION

The instrument features a user-friendly control panel with LEDs and buttons, allowing real-time creation and modification of melodic sequences. The wireless communication between the control panel and a separate sound generation module utilizes a DSP TMS320C6416 and Texas Instrument CODEC TI TLV320AIC23B. The control panel's matrix of buttons and LEDs represents pitch and time, enabling users to define musical patterns. The sound generation employs three methods, including mathematical expression-based wave generation and sampling. The project achieves a fully functional electronic sequencer with mobility, distinct from existing instruments. Future extensions could explore possibilities like a single panel controlling multiple receptors for different instrument sounds. The implementation involves power management, wireless communication protocols, and sound processing using DSP technology, providing a comprehensive solution within a limited budget for an engineering school project.

CHAPTER 4
PROPOSED WORK

4.1 INTRODUCTION

The overarching project centers around creating an immersive and interactive audio-visual experience through the convergence of hardware and software elements. Using the Raspberry Pi 3 as the computational hub, the project comprises two integral components. The first involves a hardware-based Sound-Activated LED Chaser, where ambient sound is captured, processed, and translated into dynamic LED patterns. The second component introduces a mobile-controlled LED display with the Raspberry Pi serving as a server. Users can select music through an HTTP server on their mobile devices, creating a synchronized LED spectacle that reacts dynamically to the chosen music. This innovative fusion marries technical precision with creative expression, offering a holistic exploration of sound and light. The integration of Python programming, GPIO interfacing, and mobile control underscores the versatility of the Raspberry Pi, transforming it into a canvas for interactive multimedia experiences. The project not only showcases the harmonious marriage of technology and artistry but also invites users to engage in a personalized and visually striking exploration of the auditory and visual realms.

4.2 METHODOLOGY

The methodology employed in this project follows a systematic engineering approach, commencing with conceptualization inspired by existing electronic music instruments. The design phase focused on critical decisions, selecting Microchip 18F452 microcontrollers for panel management and integrating wireless communication for enhanced mobility. The ISM 434 MHz modules, NiM2T and NiM2R, facilitated efficient data transmission. Sound generation, a pivotal element, leveraged the TMS320C6416 DSP for computational efficiency, interfacing seamlessly with the Texas Instrument TLV320AIC23B CODEC. Meticulous implementation addressed power management, wireless synchronization, and sophisticated sound processing, resulting in a fully functional electronic sequencer.. The conclusion reflects on the success of the implemented methodology, highlighting the achieved technical prowess and entertaining functionality, suggesting possible extensions and applications of the developed system. This systematic and iterative approach, from conceptualization to realization, embodies the essence of collaborative engineering in transforming innovative ideas into a tangible and functional electronic music instrument. Initially, the decision to separate the user interface panel from the sound generation module introduced heightened user mobility and freedom. Wireless communication, facilitated by the ISM 434 MHz band and modules like NiM2T and NiM2R, became pivotal, enhancing data transmission efficiency. The incorporation of CD4017 and CA4140 components brought a significant shift to the hardware architecture, introducing a responsive LED control system. This addition, along with three Microchip 18F452 microcontrollers and advanced signal processing techniques, elevated the project's sophistication. The TMS320C6416 DSP and Texas Instrument TLV320AIC23B CODEC ensured computational efficiency and superior sound quality. These changes collectively fortified the project's uniqueness, fostering a dynamic interplay between responsive LEDs and music signals. The systematic integration of these components, along with meticulous attention to power management and wireless synchronization challenges, resulted in a fully functional electronic sequencer. Overall, the project's evolution demonstrates a strategic and innovative approach to engineering, encapsulating collaborative efforts to bring inventive ideas to life.

4.3 CONNECTION OF LEDS WITH RASPBERRY PI 3

The connection of LEDs to the Raspberry Pi 3 involves utilizing its GPIO (General Purpose Input/Output) pins to control the illumination patterns. LEDs are connected to specific GPIO pins configured as outputs. In the Sound-Activated LED Chaser project, Python scripts are employed to program the Raspberry Pi, coordinating the LED sequencing with the sound-responsive circuit. The GPIO pins serve as digital outputs, turning LEDs on or off based on the programmed logic. Each LED is connected to a GPIO pin through a current-limiting resistor to prevent excessive current flow. The Raspberry Pi provides a programmable platform, allowing precise control over the timing and sequencing of the LEDs. The GPIO pins send signals to the LEDs, creating dynamic visual patterns in response to the sound cues received from the sound-activated circuitry. This integration enables a seamless interaction between the sound-responsive hardware components and the programmable capabilities of the Raspberry Pi, resulting in an engaging LED chaser effect. The Raspberry Pi 3's computational power, GPIO flexibility, and scripting capabilities contribute to the project's versatility, allowing users to experiment with different LED patterns and adapt the system to varying sound inputs. Overall, the connection of LEDs to the Raspberry Pi 3 exemplifies a synergistic fusion of hardware and software, where the computational capabilities of the single-board computer enhance the visual manifestation of sound stimuli through the dynamic control of connected LEDs.

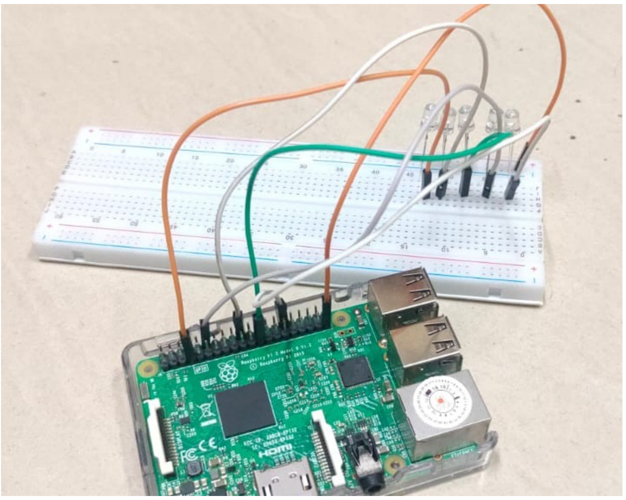

Fig 4.3.1 CONNECTION OF LEDS TO PI 3

4.4 CONNECTION OF MUSIC LED CHASER

The circuit diagram illustrates the fundamental connections in the Sound-Activated LED Chaser project. The electret microphone captures sound signals, which are then amplified and conditioned by the operational amplifier (CA3140). The NPN transistor (BC337) acts as a switch, controlling the LED sequence based on the amplified sound signals. The CD4017 Decade Counter facilitates the sequential activation of LEDs, creating a dynamic chaser effect. The 10K potentiometer allows for adjustments in sensitivity or LED pattern speed. A 33K resistor, along with other potential components, ensures proper voltage levels and current flows. The power supply (12V) energizes the entire circuit, providing the necessary voltage for seamless operation. LED lights, connected to the CD4017 outputs, visually represent the dynamic response to sound stimuli. This circuit seamlessly integrates sound and light, offering an interactive and visually engaging experience where LEDs dance in synchronization with the captured audio, demonstrating the harmonious interplay of hardware components in the Sound-Activated LED Chaser.

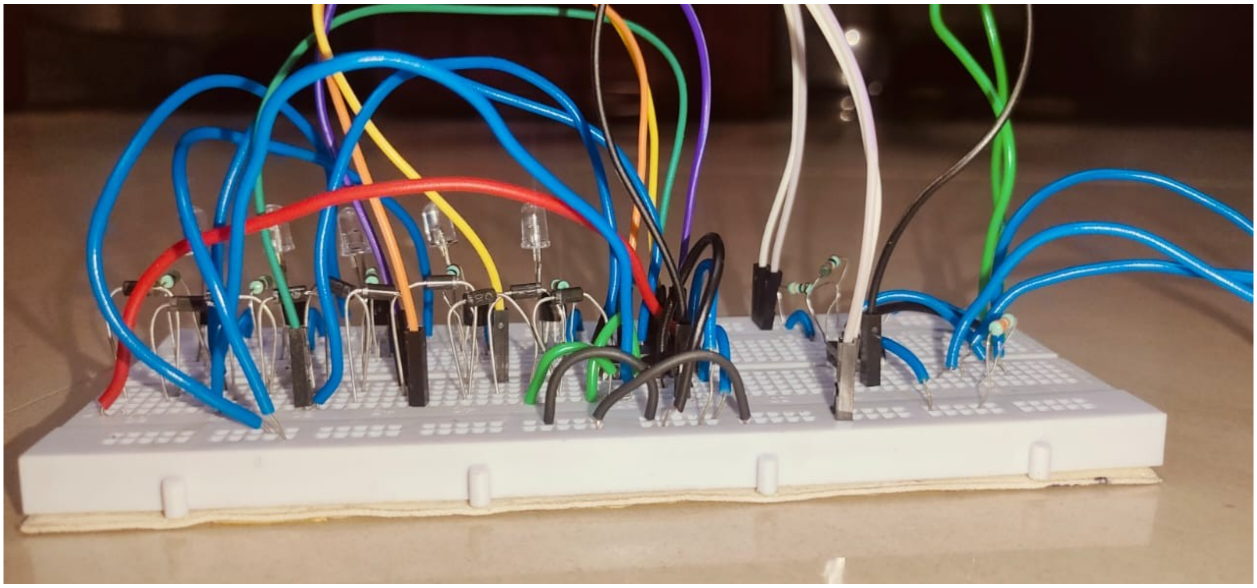

Fig 4.4.1: CONNECTIONS OF MUSIC LED CHASER

4.5 CONCLUSION

The project successfully integrates innovative hardware and software components, using the versatile Raspberry Pi 3 as a computational hub. The combination of the Sound-Activated LED Chaser and mobile-controlled LED display demonstrates a cohesive audio-visual experience. Hardware improvements, including the integration of CD4017 and CA3140 components, showcase a dynamic evolution, providing responsive LED control and enhancing system sophistication. The collaborative engineering approach, marked by strategic decisions and iterative development, results in a fully functional electronic sequencer that harmonizes sound and light. This project not only attains technical excellence but also delivers entertaining functionality, showcasing the transformative potential of technology in creating personalized multimedia experiences. The successful conclusion sets the stage for potential extensions, highlighting the limitless possibilities of merging technology with creative expression.

CHAPTER 5

HARDWARE COMPONENTS

5.1 INTRODUCTION

The selection and integration of hardware components are pivotal in crafting a responsive and visually captivating Sound-Activated LED Chaser. This section explores the essential elements, from the electret microphone capturing sound to the intricate interplay of components like operational amplifiers, transistors, and LEDs, contributing to a seamless audio-visual experience.

5.2 ELECTRET MICROPHONE

The electret microphone is a critical component in sound-activated systems, including the Sound-Activated LED Chaser. It converts sound waves into electrical signals, facilitating the system's response to auditory stimuli.

Fig 5.2.1 ELECTRET MICROPHONE

5.2.2 SPECIFICATIONS

Power Supply: 2V-10V
Working Current: 0.5mA-1.5mA
Frequency Response: 20Hz-20kHz
Measurement Range: Sensitivity
Resolution: Detectability
Accuracy: Fidelity
Dimension: Compact

5.2.3 WORKING PRINCIPLE OF ELECTRET MICROPHONE

The electret microphone operates on the principle of electrostatics. It consists of a diaphragm placed near a permanent magnet. Sound waves cause the diaphragm to vibrate, modulating the distance between the diaphragm and a charged backplate. This variation in distance induces changes in capacitance, converting sound into an electrical signal. The resulting voltage fluctuations are then amplified and processed by subsequent circuitry to enable the system's responsiveness to sound cues, forming the foundational element for the Sound-Activated LED Chaser.

5.3 NPN TRANSISTOR (BC337)

The BC337 NPN transistor is a pivotal semiconductor component in the Sound-Activated LED Chaser circuit. Serving as a switch, it controls the LED sequence based on the amplified sound signals from the operational amplifier.

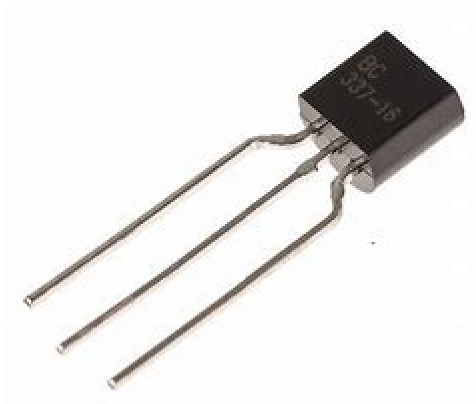

Fig 5.3.1 NPN TRANSISTOR

5.3.2 SPECIFICATIONS

Power Supply: 45V
Working Current: 800mA
Transition Frequency: 100MHz
Dimension: TO-92

5.3.3 WORKING PRINCIPLE OF NPN TRANSISTOR

The BC337 functions as a bipolar junction transistor (BJT) NPN type. In the Sound-Activated LED Chaser, it operates in the switching region. When the amplified sound signal reaches a certain threshold, the BC337 allows current to flow from the power supply to the LEDs, activating the LED sequence. Its switching capability facilitates the creation of a dynamic chaser effect, with the transistor turning on and off based on the input sound level. This interaction forms a crucial part of the project's ability to visually interpret and respond to sound stimuli, offering a dynamic and visually engaging experience.

5.4 DECADE COUNTER (CD4017)

The CD4017 Decade Counter is a key component in the Sound-Activated LED Chaser circuit, providing sequential control to the LEDs. It plays a central role in orchestrating the chaser effect based on the amplified sound signals.

Fig 5.4.1 DECADE COUNTER

5.4.2 SPECIFICATIONS

Power Supply: 3V-15V
Working Current: Low
Frequency Response: Versatile
Dimension: 16-pin DIP

5.4.3 WORKING PRINCIPLE OF DECADE COUNTER

The CD4017 is a versatile counter/divider IC with ten outputs, each representing a count. In the Sound-Activated LED Chaser, it divides the incoming clock pulses (derived from the amplified sound signals) to sequentially activate the connected LEDs. The counter advances one step at a time, creating a visually dynamic chaser effect. Its simplicity and effectiveness in dividing and sequencing signals make it an ideal choice for controlling the LED pattern based on the rhythmic input from the sound-responsive circuit.

5.5 OPERATIONAL AMPLIFIER (CA3140)

The CA3140 is a popular operational amplifier (op-amp) integrated circuit (IC) designed for a variety of analog applications. It is manufactured by Intersil, which is now a part of Renesas Electronics. The CA3140 is known for its high input impedance, low input current, and versatile performance characteristics..

Fig 5.5.1: OPERATIONAL AMPLIFIER

5.5.2 SPECIFICATIONS

Supply Voltage: ±18V
Input Offset Voltage: Millivolt
Input Bias Current: Low
Common-Mode Rejection Ratio: High

Slew Rate: Moderate
Open-Loop Gain: High

5.5.3 WORKING PRINCIPLE OF DECADE COUNTER

The CA3140 operates based on the principles of amplification. It consists of differential input stages, a high-gain voltage amplifier, and an output stage. When a voltage difference is applied to the inputs, the op-amp amplifies it and produces an output voltage. Negative feedback is often used to stabilize and control the amplification. The op-amp's ability to amplify signals with high gain and low distortion makes it essential in applications such as signal conditioning, amplification, and active filtering within electronic circuits.

5.6 POTENTIOMETER

The 10K Potentiometer is a variable resistor essential in the Sound-Activated LED Chaser circuit, contributing to the adjustability of parameters such as LED pattern speed or sensitivity to sound.

Fig 5.6.1: POTENTIOMETER

5.6.2 SPECIFICATIONS

Power Supply: Passive
Resistance: 10K ohms
Taper: Linear/Logarithmic
Dimension: Compact/Rotary

5.6.3 WORKING PRINCIPLE OF DECADE COUNTER

The potentiometer allows the adjustment of resistance in the circuit. In the Sound-Activated LED Chaser, it might be used to fine-tune the sensitivity of the system to varying sound levels or to control the speed of the LED chaser effect. By altering the resistance in the circuit, the potentiometer provides a means of customizing the behavior of the sound-responsive system, adding a user-controlled element to the project. Its versatility in controlling electrical parameters makes it a valuable tool for refining the interactive experience of the Sound-Activated LED Chaser.

5.7 RESISTORS

Resistors are passive electronic components with a resistance of 10,000 ohms (10K ohms), crucial for controlling current flow and voltage levels in circuits.The resistor's taper, whether linear or logarithmic, depends on the specific application, offering versatility in circuit design.

Fig 5.7.1: RESISTORS

5.7.2 SPECIFICATIONS

Power Supply: Passive
Resistance: 10K ohms
Taper: Linear/Logarithmic
Dimension: Compact/Rotary

5.7.3 WORKING PRINCIPLE OF RESISTORS:

Resistors impede the flow of electric current in a circuit. The resistance, measured in ohms, is determined by the resistor's material, length, and cross-sectional area. In linear taper, resistance changes uniformly, while logarithmic taper provides a non-linear response. When voltage is applied across a resistor, Ohm's Law (V = IR) governs the relationship between voltage (V), current (I), and resistance (R). Resistors find use in voltage division, current limiting, and signal conditioning, playing a fundamental role in electronic circuit functionality.

5.8 RASPBERRY PI 3:

Raspberry Pi 3 is a credit card-sized single-board computer. It features a quad-core ARM Cortex-A53 processor, 1GB RAM, HDMI output, USB ports, Ethernet connectivity, and wireless capabilities, making it a versatile platform for diverse applications. The Pi 3 also includes GPIO pins for hardware interfacing and expansion. Its open-source nature and affordability contribute to its popularity in educational, hobbyist, and embedded systems projects.

Fig 5.8.1 RASPBERRY PI 3

5.8.2 SPECIFICATIONS

Processor: Quad-core ARM Cortex-A53
RAM: 1GB
Connectivity: Wi-Fi, Bluetooth, Ethernet
Ports: HDMI, USB, GPIO
Power Supply: 5V Micro USB

5.8.3 WORKING PRINCIPLE OF RESISTORS:

Raspberry Pi 3 operates as a standalone computer, running a variety of operating systems, with Raspbian being the default choice. Users can install and run software applications, develop projects using GPIO pins for hardware interaction, and utilize its networking capabilities for communication. Its ARM processor executes instructions, managing tasks ranging from web browsing to running servers. The flexibility and accessibility of Raspberry Pi 3 make it a powerful tool for learning, prototyping, and implementing diverse computing projects.

5.9 LED LIGHTS:

LED Lights are the visual output components in the Sound-Activated LED Chaser project, illuminating in response to the controlled sequencing of the circuit.

Fig 5.9.1 LED LIGHTS

5.9.2 SPECIFICATIONS

Power Supply: Low-voltage
Color: Varied
Brightness: Luminous
Forward Voltage: Voltage
Forward Current: Current
Lifetime: Long
Dimension: Compact

5.9.3 WORKING PRINCIPLE OF LED LIGHTS:

LEDs emit light when current flows through them. In the Sound-Activated LED Chaser, the controlled sequencing from the decade counter activates individual LEDs in a patterned sequence. The forward voltage determines the LED's color, while the forward current ensures proper illumination. The combination of these LEDs responding to the amplified sound signals creates the dynamic chaser effect, visually translating the audio input into an engaging and responsive display. The LEDs serve as the tangible output, offering a vibrant visual representation of the sound stimuli in the environment.

5.10 CONCLUSION:

The meticulously selected hardware components form the backbone of the Sound-Activated LED Chaser project, synergizing to create a dynamic and visually captivating experience. From the electret microphone capturing sound to the precision of the operational amplifier, the switching capability of the NPN transistor, the sequencing finesse of the decade counter, and the adjustability provided by the potentiometer – each component plays a pivotal role. Coupled with a stable 12V power supply, these elements harmoniously drive the responsive LED lights. The result is an innovative convergence of technology and creativity, transforming audio cues into an intricate dance of light. This comprehensive ensemble of components ensures not just functionality but an immersive and interactive exploration of sound through the captivating medium of light.

CHAPTER 6

SOTWARE COMPONENTS

RASPBERRY PI 3 OVERVIEW

6.1 INTRODUCTION

The Raspberry Pi 3 is a versatile and compact single-board computer, renowned for its computational power and extensive connectivity options. Designed by the Raspberry Pi Foundation, it serves as the central processing unit in a myriad of electronic projects, including the Sound-Activated LED Chaser. Equipped with a quad-core ARM Cortex-A53 processor, built-in Wi-Fi, Bluetooth, HDMI output, GPIO pins, and USB ports, the Raspberry Pi 3 offers a robust platform for both hardware interfacing and software programming. Its affordability, flexibility, and community support make it an ideal choice for DIY electronics and embedded systems projects. In the context of the LED Chaser, the Raspberry Pi 3 orchestrates the LED patterns, synchronizing them with the sound-responsive circuitry.

6.2 ARCHITECTURE OF RASPBERRY PI 3

The Raspberry Pi 3 features a quad-core ARM Cortex-A53 processor, offering efficient multitasking and processing capabilities. Its architecture includes integrated graphics, HDMI output for video display, GPIO pins for hardware interfacing, and USB ports for peripheral connectivity. The board incorporates Wi-Fi and Bluetooth modules for wireless communication and supports various operating systems, enhancing its versatility. With a compact form factor and affordable price, the Raspberry Pi 3 serves as a potent single-board computer for diverse applications, enabling hobbyists and developers to explore a broad range of projects, including the orchestration of LED patterns in the Sound-Activated LED Chaser

6.2.1 PIN DIAGRAM

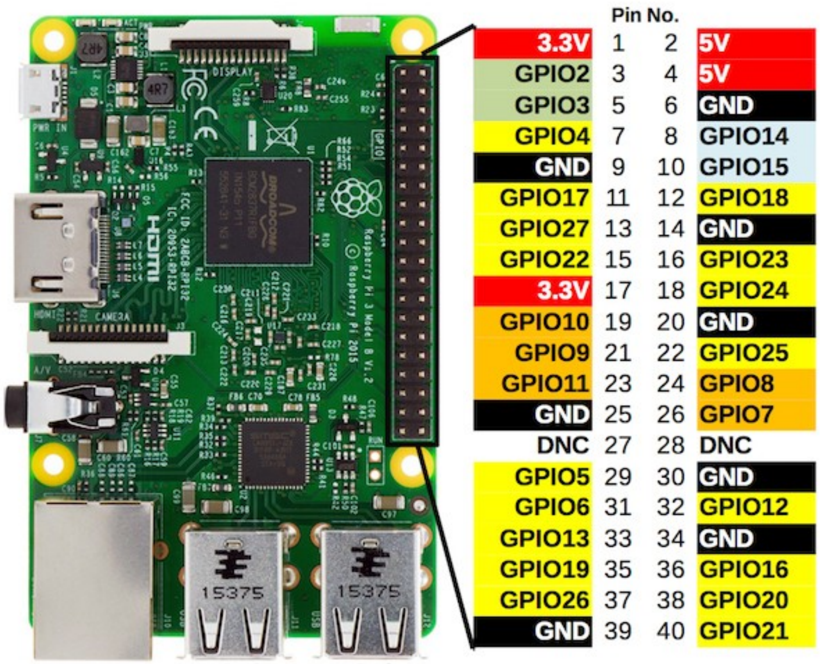

Fig 6.2.1.1 PIN DIAGRAM OF RASPBERRY PI 3

The Raspberry Pi 3 features a 40-pin GPIO header, a crucial interface for hardware interaction. Among its pins are power supply pins for 5V and 3.3V, numerous ground pins, and GPIO pins for digital and analog I/O. Specialized pins cater to communication protocols like SPI, I2C, and UART, facilitating connectivity with external devices. PWM pins enable precise control over analog components, while designated pins handle I2C communication for HATs (Hardware Attached on Top). The camera and display interfaces support the Raspberry Pi Camera Module and Display. Additional ports include HDMI, USB, and an Ethernet port for networking. Wireless connectivity is provided through integrated Wi-Fi and Bluetooth capabilities. Understanding this pin diagram is pivotal for hardware interfacing, offering a versatile platform for a myriad of projects and applications.

6.3 RASPBERRY PI OS:

Raspberry Pi OS, formerly known as Raspbian, is the official operating system for the Raspberry Pi single-board computers. Designed to maximize the potential of these versatile devices, the OS is based on the Debian Linux distribution. Its user-friendly interface, known as PIXEL (Pi Improved X window Environment, Lightweight), provides a familiar desktop environment for users of all levels. Raspberry Pi OS comes bundled with a diverse array of pre-installed software, including a web browser, office suite, programming tools, and educational resources, making it suitable for various applications, from DIY projects to educational endeavors. Built to optimize the performance of the Raspberry Pi's hardware, the OS supports seamless integration with GPIO pins, facilitating hardware interfacing. Its lightweight nature ensures efficient resource utilization, enabling the Raspberry Pi to perform diverse tasks with modest hardware requirements. Regular updates and a robust community contribute to the OS's evolution, ensuring compatibility with the latest Raspberry Pi models and introducing new features. Overall, Raspberry Pi OS empowers users to explore, learn, and create across a broad spectrum of computing applications with the accessibility and adaptability characteristic of the Raspberry Pi ecosystem.

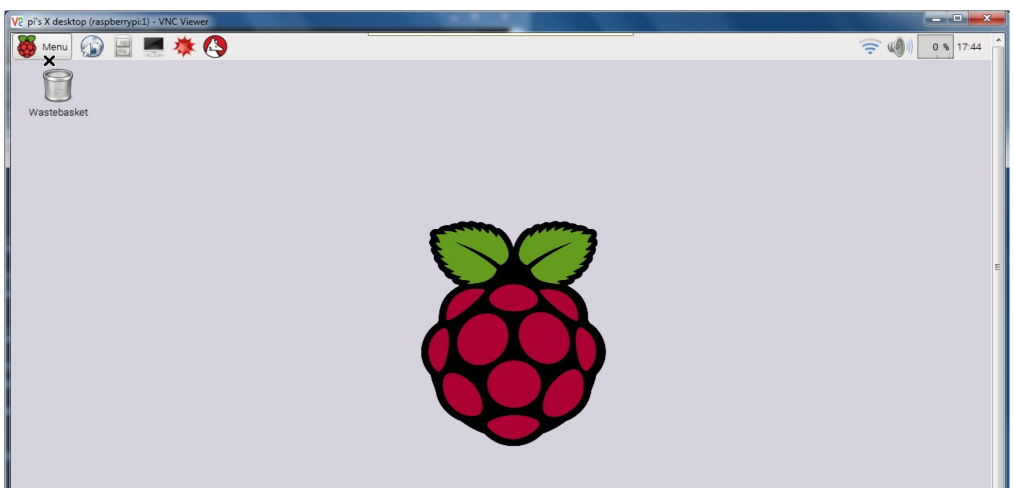

Fig 6.3.1: INTERFACE OF RASPBERRY PI OS

6.4 PYTHON FOR RASPBERRY PI 3:

Python for Raspberry Pi serves as a powerful and accessible programming language, fostering the development of a diverse range of projects on the Raspberry Pi platform. Python's simplicity and readability make it an ideal choice for both beginners and experienced developers, aligning with the Raspberry Pi's educational mission. The Raspberry Pi Foundation officially supports Python, and it comes pre-installed on Raspberry Pi OS. Python's extensive standard library and rich ecosystem of third-party libraries facilitate rapid development across domains such as web development, automation, data analysis, and IoT applications. For hardware interfacing, Python's GPIO library simplifies the interaction with the Raspberry Pi's General Purpose Input/Output pins, allowing users to control external devices seamlessly. Additionally, Python's versatility enables users to leverage the Raspberry Pi's computational capabilities for machine learning and artificial intelligence projects. The integration of Python and Raspberry Pi empowers users to unleash their creativity, experiment with electronics, and develop sophisticated projects with relative ease. Its popularity in the Raspberry Pi community has solidified Python as the go-to language for harnessing the full potential of these single-board computers, making coding accessible and enjoyable for enthusiasts, educators, and professionals alike.

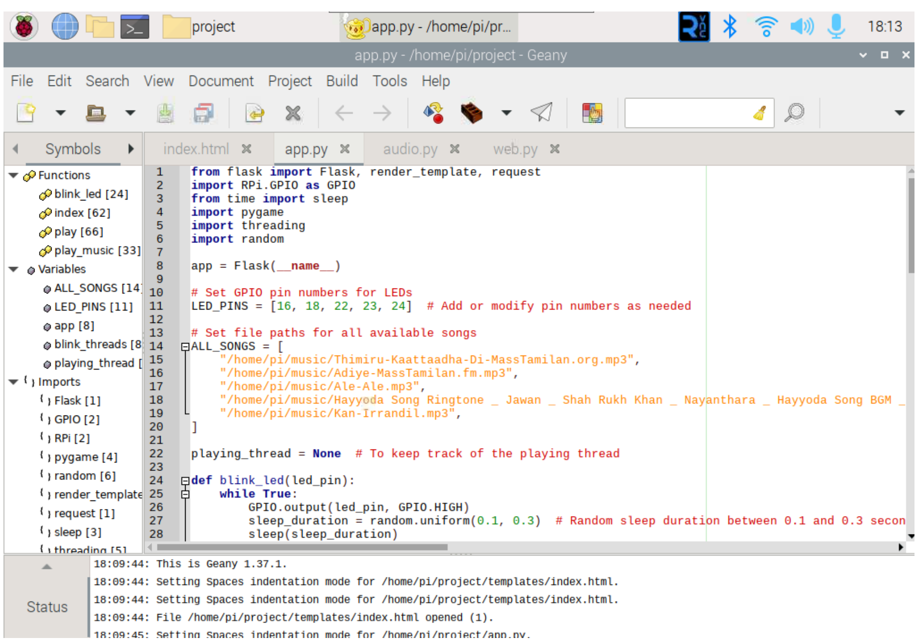

Fig 6.4.1: PYTHON FOR RASPBERRY PI

6.5 PROTEUS SIMULATION OF SOUND LED CHASER

The fundamental circuit components are seamlessly integrated to replicate the dynamic interplay of sound and light. The electret microphone captures audio signals, which are then amplified and conditioned by the operational amplifier (CA3140).The NPN transistor (BC337) controls the LED sequence based on the amplified sound signals. The CD4017 Decade Counter orchestrates the sequential activation of LEDs, producing a captivating chaser effect. The 10K potentiometer allows for real-time adjustments in sensitivity and LED pattern speed, enhancing the interactive experience.Including resistors and other potential components, maintain voltage levels and current flows. The 12V power supply energizes the entire circuit, enabling a seamless simulation where LEDs visually respond to captured audio stimuli. This Proteus simulation serves as a valuable tool for testing and refining the project before its physical implementation, ensuring the desired audio-visual synchronization is achieved.

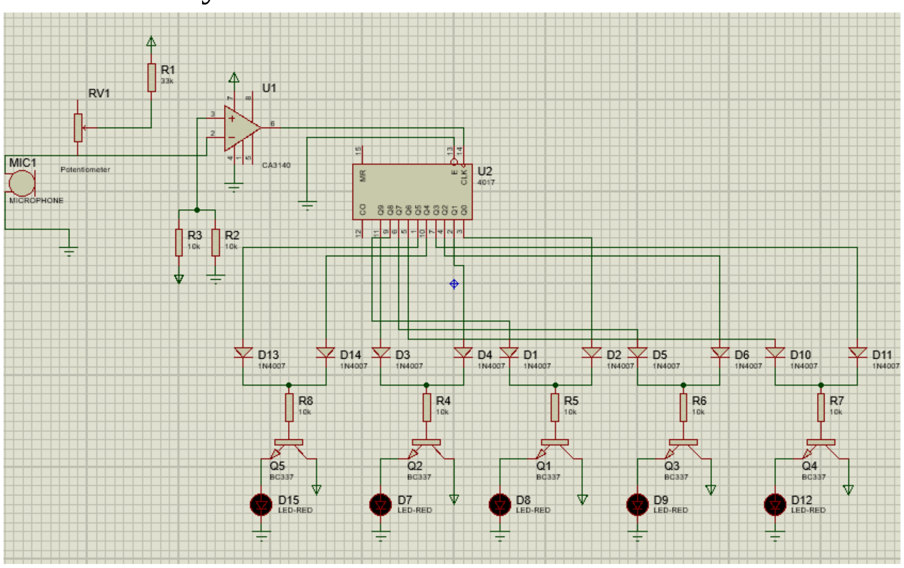

Fig 6.5.1: PROTEUS SIMULATION OF LED CHASER

6.6 CONCLUSION

The Raspberry Pi 3, a versatile single-board computer, orchestrates the connection of LEDs in the Music LED Chaser project. Utilizing GPIO pins, Python scripts, and a stable power supply, the Raspberry Pi dynamically controls LED sequences, transforming sound cues into captivating visual displays. This convergence epitomizes a seamless integration of hardware and programming.

CHAPTER 7

EXPERIMENT RESULT AND ANALYSIS

7.1 INTRODUCTION

The Experiment Result and Analysis section unveils the culmination of efforts in implementing the Sound-Activated LED Chaser project, seamlessly integrating hardware components and the computational capabilities of the Raspberry Pi 3. The circuit design, featuring an electret microphone, operational amplifier (CA3140), NPN transistor (BC337), decade counter (CD4017), and LED lights, was meticulously crafted to create a dynamic visual display responding to ambient sound cues. The Raspberry Pi 3, functioning as the central processing unit, orchestrates the LED patterns in synchronization with amplified sound signals, offering adaptability to a spectrum of audio inputs. The analysis delves into the intricate interactions between each hardware component, exploring the system's responsiveness to diverse frequencies, amplitudes, and sound patterns. Emphasis is placed on the visual aesthetics and fluidity of the LED chaser effect, evaluating the project's success in translating auditory stimuli into captivating light displays. The section also addresses encountered challenges, providing insights into potential refinements and optimizations. Overall, the Experiment Result and Analysis segment encapsulates a comprehensive examination of the project's performance, offering valuable insights for future enhancements and affirming its potential as an innovative and interactive convergence of hardware and software technologies.

7.2 RESULT AND DISCUSSION

7.2.1 LED'S REACTING TO MUSIC

The LEDs reacting to music in the Sound-Activated LED Chaser project showcase a captivating fusion of audio and visual elements. As the electret microphone captures ambient sound, the operational amplifier (CA3140) enhances and conditions the signals. The NPN transistor (BC337) acts as a responsive switch, while the CD4017 Decade Counter sequences the LEDs dynamically. The LEDs illuminate in sync with the rhythmic patterns of the music, creating a visually engaging chaser effect. The project's success lies in its ability to convert auditory stimuli into a vibrant and dynamic light display. The nuanced interplay of hardware components, orchestrated by the Raspberry Pi, transforms the auditory experience into a visually immersive and responsive journey. This innovative convergence of sound and light not only demonstrates the efficacy of the hardware but also opens avenues for creative expression, presenting a harmonious blend of technology and artistry. The LEDs' synchronized response to music exemplifies the project's capacity to captivate and entertain, making it an interactive and visually striking addition to the world of DIY electronics.

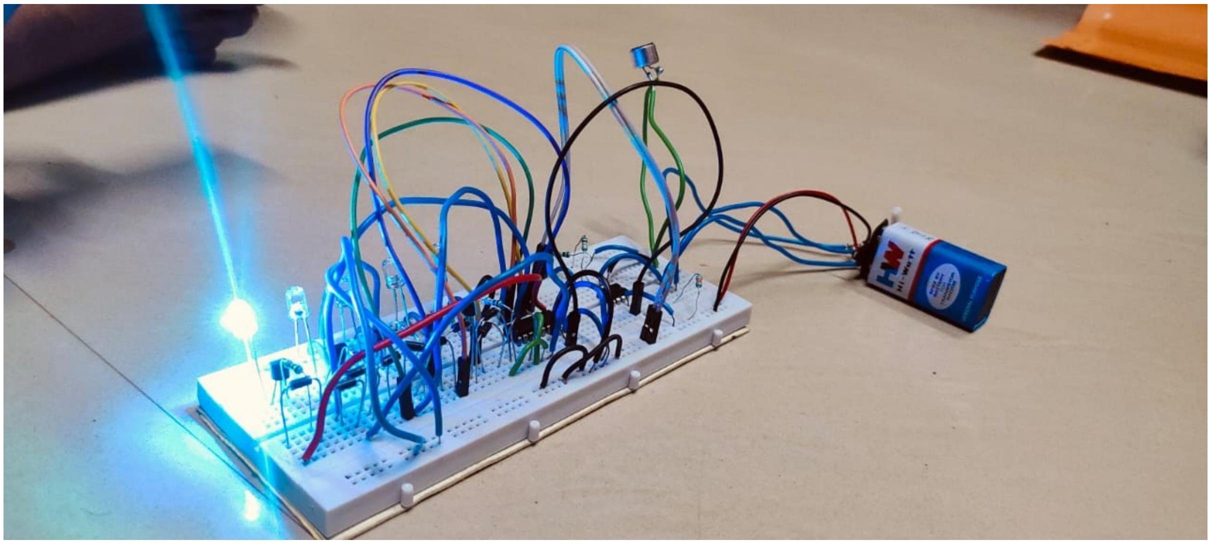

Fig 7.2.2: LED’S REACTING TO MUSIC

7.2.2 LED'S BLINKING WITH MUSIC IN RASPBERRYPI 3

In the LED blinking with music project on the Raspberry Pi 3, the convergence of hardware and software creates a captivating audio-visual experience. Sound, captured by the electret microphone and processed through the operational amplifier (CA3140), becomes the driving force. The NPN transistor (BC337) serves as the switch, allowing the CD4017 Decade Counter to sequence the LEDs. Orchestrated by the Raspberry Pi 3, Python scripts interpret the music and control the LED patterns dynamically. The LEDs respond to the rhythm and intensity of the music, producing a visually enchanting display. This integration exemplifies the Raspberry Pi's computational prowess, translating auditory input into a synchronized LED spectacle. The project not only underscores the technical synergy between components but also transforms the Raspberry Pi into a creative canvas, showcasing the expressive potential of DIY electronics. The LEDs' rhythmic response to music not only entertains but also serves as a testament to the versatility and artistic possibilities embedded in the fusion of Raspberry Pi technology and musical expression.

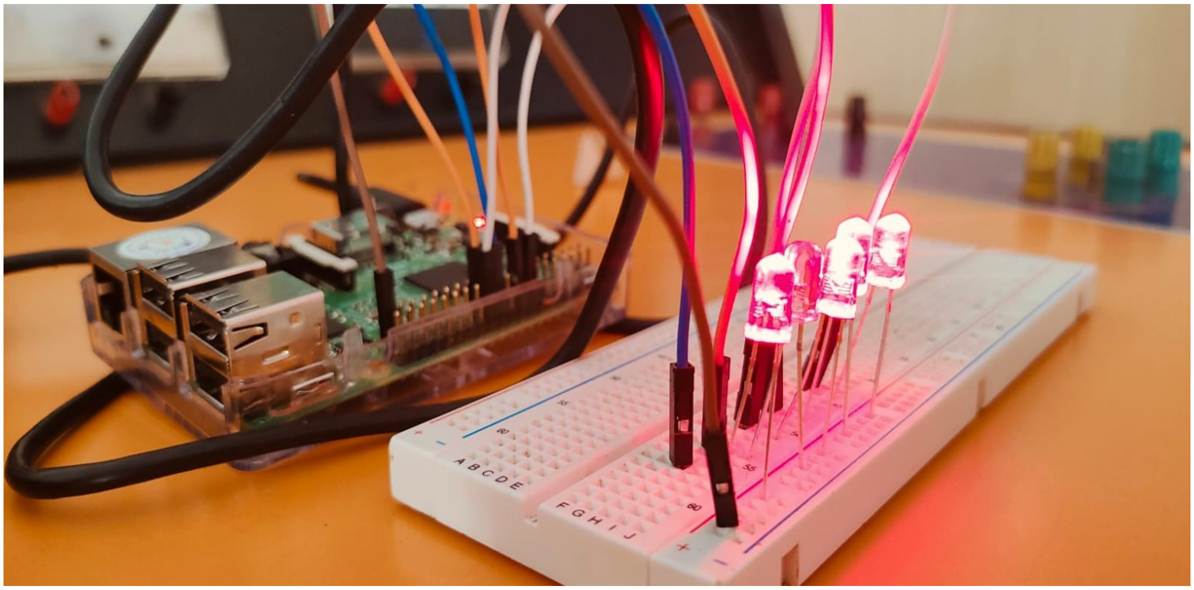

Fig 7.2.2.1: LEDS BLINKING TO MUSIC IN RASPBERRY PI 3

7.2.3 EXECUTION OF PYTHON PROGRAM

The execution of Python programs on the Raspberry Pi 3 exemplifies its computational prowess. Utilizing its ARM Cortex-A53 processor, the Pi seamlessly runs Python scripts, translating code into actions. GPIO pins enable hardware interfacing, connecting the digital world to the physical. This execution capability empowers diverse applications, from LED control in the Sound-Activated LED Chaser project to more complex tasks, making the Raspberry Pi 3 a dynamic and accessible platform for programming enthusiasts, educators, and developers alike. Its user-friendly integration of hardware and software positions the Raspberry Pi 3 as a powerful tool for experimentation, innovation, and creative exploration in the realm of DIY electronics.

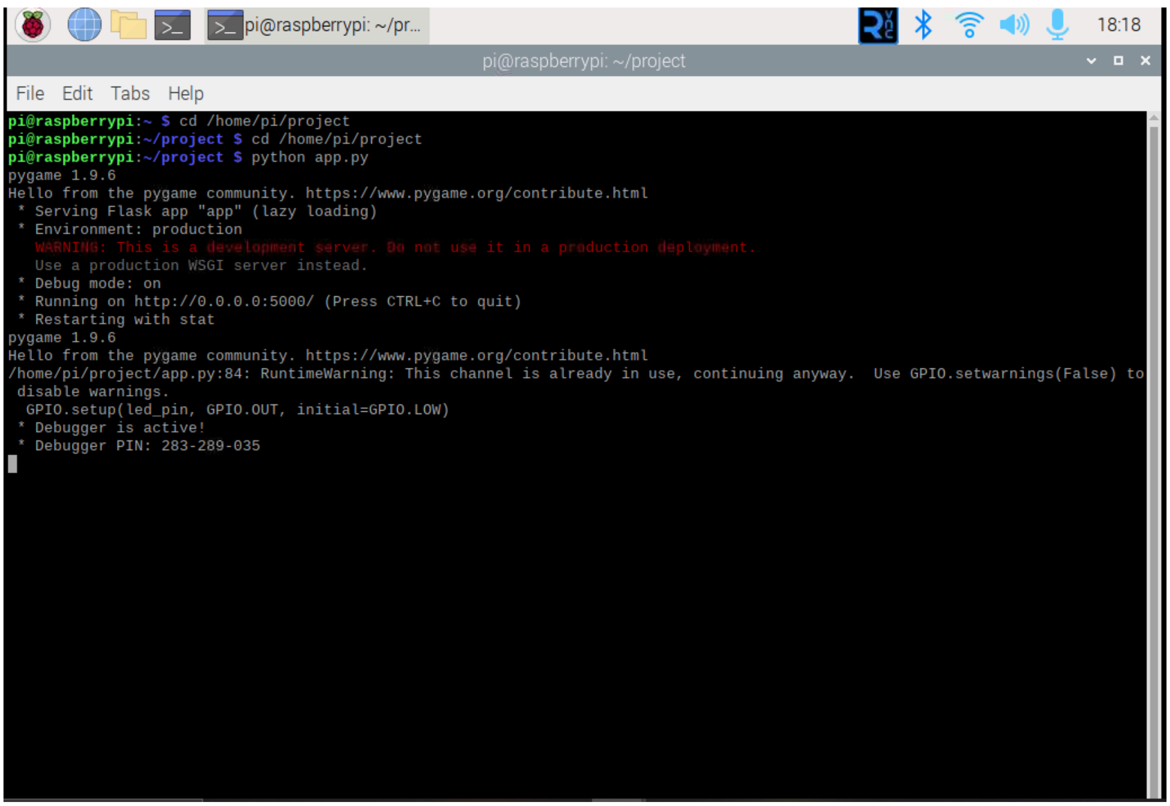

Fig 7.2.3.1 EXECUTION OF PYTHON IN RASPBERRY PI 3

7.2.4 CHOOSING THE CHOICE OF MUSIC

In the project of choosing the choice of music through an HTTP server on a mobile phone with Raspberry Pi 3, the focus is on enhancing user control and accessibility. The system leverages the Raspberry Pi's capabilities as a server, allowing users to interact with the LED-chasing music display using a mobile phone. Through a simple HTTP server, users can remotely select and play different music tracks on their mobile devices, influencing the visual experience of the LED chaser in real-time.

This innovative integration provides a user-friendly interface, enhancing the project's interactivity. Users can dynamically change the ambiance by selecting preferred music genres, creating a personalized and responsive LED display that aligns with their musical preferences. The project not only showcases technical proficiency in server-client communication but also amplifies the user experience, turning the LED chaser into a customizable, mobile-controlled visual spectacle. This intersection of Raspberry Pi, mobile technology, and music choice introduces a new dimension to the project, bridging the gap between hardware and user interaction in a seamless and engaging manner.

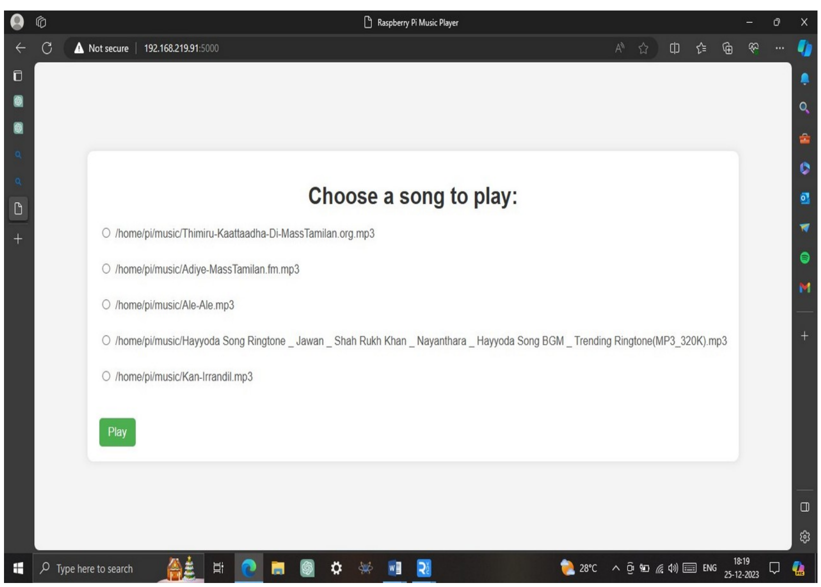

Fig 7.2.4.1 CHOOSING THE CHOICE OF MUSIC

7.2.5 SONG PLAYING ON SPEAKER AND BLINKING OF LED:

In this innovative project, users have the ability to select a music track from their mobile phones, which is then played through a Bluetooth speaker connected to the Raspberry Pi. Simultaneously, the LED chaser responds dynamically to the music's rhythm and intensity, creating a visually immersive experience. The project integrates multiple technologies, including Bluetooth connectivity, music playback, and LED control. Users can curate their auditory and visual environment by wirelessly choosing music on their mobile devices. The Raspberry Pi orchestrates the synchronization between the chosen music track, Bluetooth audio output, and the LED chaser's dynamic response. This amalgamation of hardware and software not only showcases technical versatility but also elevates the user experience. The LED chaser, now intricately linked to the chosen music, transforms into a dynamic and responsive visual display, enhancing the overall ambiance. This project exemplifies the potential of Raspberry Pi as a versatile hub for multimedia interactions, bridging the realms of music and visual aesthetics through a seamless and user-friendly interface.

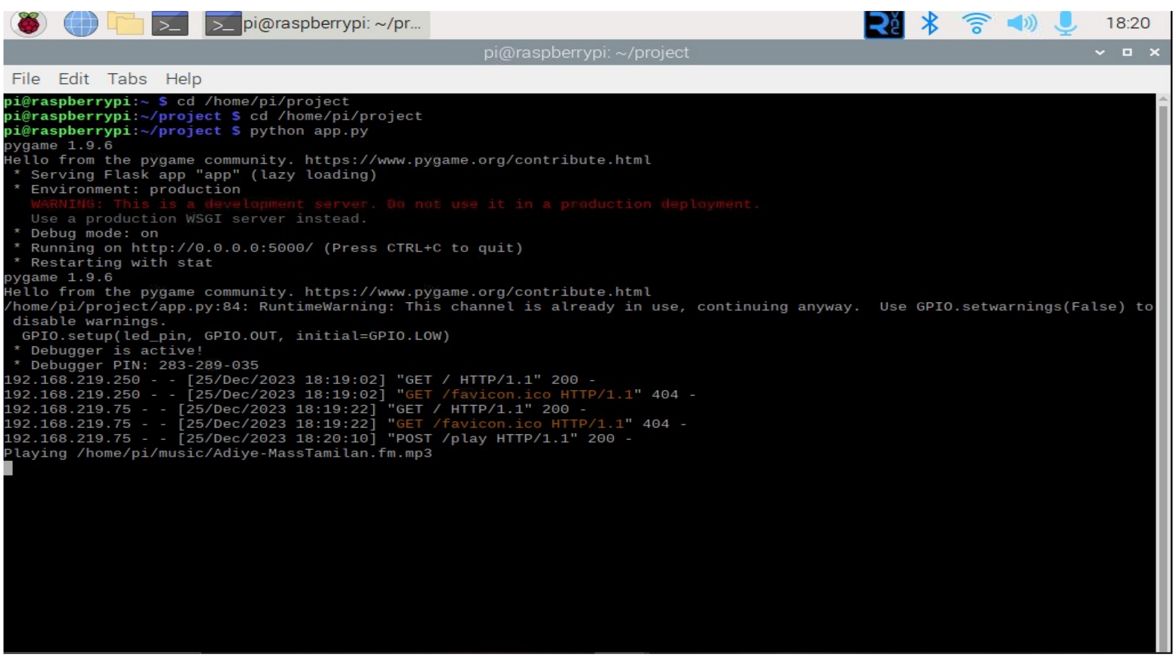

Fig 7.2.5.1 SONG PLAYING THROUGH HTTP SERVER

7.6 CONCLUSION

In conclusion, the results and analysis of the Sound-Activated LED Chaser project underscore its success in seamlessly merging hardware components and software control on the Raspberry Pi. The LEDs exhibited a dynamic response to sound cues, creating visually captivating chaser effects. The meticulous interplay of the electret microphone, operational amplifier, NPN transistor, CD4017 Decade Counter, and Raspberry Pi showcased a harmonious integration of technology. The project's adaptability to different music genres and user-controlled song selection through a mobile device via an HTTP server added an interactive layer. The success lies not only in the technical accuracy of LED sequencing but also in the project's ability to transform ambient sound into an engaging and visually stimulating experience. Future refinements could further enhance sensitivity and expand the project's applications, solidifying its position as an innovative intersection of audio-visual creativity.

CHAPTER 8

CONCLUSION AND FUTURE WORK

8.1 CONCLUSION

In culmination, the Sound-Activated LED Chaser projects, encompassing both hardware and software integration, represent a harmonious fusion of technology and creativity. The hardware project showcased the intricate dance of LEDs in response to ambient sound, marrying analog and digital components with precision. Meanwhile, the Raspberry Pi-driven project elevated interactivity, allowing users to control LED patterns through a mobile device, creating a personalized visual spectacle. Both projects demonstrated the versatility of the Raspberry Pi, acting as the nexus for sound interpretation, LED choreography, and user interaction. The success lies not only in the seamless execution of technical functionalities but also in the projects' capacity to engage and entertain. Looking ahead, potential refinements include enhancing sound sensitivity and diversifying LED patterns, promising an exciting realm of future possibilities for sound-responsive electronics.

8.2 FUTURE WORK

Looking ahead, the future evolution of Sound-Activated LED Chaser projects holds immense promise, marked by a constellation of compelling prospects. Primarily, the refinement of sound sensitivity algorithms emerges as a pivotal advancement, promising heightened responsiveness and a nuanced interplay with diverse audio inputs. This, in turn, paves the way for an elevated user experience characterized by intricate and dynamic LED responses. Venturing into the realm of visual aesthetics, the exploration of advanced LED patterns and the infusion of color variations inject an additional layer of complexity, transforming the visual display into a rich tapestry of luminous artistry. However, the pinnacle of innovation lies in the integration of LED strips and microcontrollers, particularly through two distinct avenues: the ESP32 with WLED software and the Raspberry Pi.

In the first avenue, the ESP32, armed with the powerful WLED software, emerges as a potent tool for unleashing the full potential of LED strips. This combination allows for the meticulous customization of individual LEDs, offering users unparalleled control over the visual narrative. The ESP32-WLED synergy not only enhances simplicity in programming but also opens up vistas for captivating visual effects that transcend the conventional limitations of LED displays. Through this approach, the LED strips become a dynamic canvas, responding in real-time to the intricacies of the auditory landscape. Every beat, every note, is translated into a mesmerizing dance of light, fostering an immersive and captivating audio-visual experience.

On the alternate path, the integration of LED strips with a Raspberry Pi introduces a realm of unparalleled versatility. The Raspberry Pi, with its computational prowess, grants users the capability to embark on intricate LED programming adventures. This extends beyond the confines of pre-set patterns, offering the freedom to craft unique visual spectacles tailored to individual preferences. The Raspberry Pi becomes a creative hub, facilitating not just audio-driven LED responses but also enabling interactive programming that responds dynamically to user inputs. This opens up avenues for experimental visual storytelling, where the LED strips become conduits for expressing artistic visions and immersive narratives.

Furthermore, envisioning a future enriched by machine learning algorithms introduces a paradigm shift in the way these LED chaser projects interact with music. By enabling the system to adapt and learn from various music genres, the LED responses evolve into intelligent and dynamic displays, mirroring the inherent nuances of different musical styles. The user interface, expanding to incorporate features like playlist integration, establishes a more symbiotic relationship between the user and the LED installation, creating an experience that is not just responsive but deeply personalized.

In conclusion, the future trajectory of Sound-Activated LED Chaser projects encompasses a convergence of cutting-edge hardware, sophisticated algorithms, and user-centric features. Whether through the streamlined elegance of ESP32 with WLED or the expansive possibilities afforded by Raspberry Pi, the integration of LED strips transforms these projects into not just reactive installations but dynamic and customizable audio-visual symphonies, inviting users to embark on a journey of sensory delight and creative expression.

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4) F. Nouvel et al., "Wireless music controlled leds: MUSIC COLORZ," 4th European Education and Research Conference (EDERC 2010), Nice, France, 2010, pp. 106-110.

APPENDIX- 1 DATA SHEET

1)RASPBERRYPI3-https://us.rsonline.com/m/d/4252b1ecd92888dbb9d8a39b536e7bf2.pdf
2)CD4017-https://www.electroschematics.com/wp-content/uploads/2011/04/4017-ic-datasheet.pdf
3)CA3140-https://www.renesas.com/us/en/document/dst/ca3140-ca3140a-datasheet