ABSTRACT

In an era where security is crucial, the development of innovative and cost-effective alarm systems is essential. This project focuses on designing a shadow security alarm using a BPW34 photodiode and an operational amplifier (Op-Amp) CA3130, utilizing an inverting circuit configuration. The primary application scenario for this system is in security-sensitive areas where unauthorized access needs to be monitored, such as museums, warehouses, homes, or secure offices. The project utilizes the photodiode's sensitivity to changes in light intensity to detect the presence of a shadow, thereby indicating a potential intrusion.

The fundamental principle behind the shadow security alarm lies in the photodiode's ability to convert light into an electrical signal. When an object obstructs the light source, the resulting shadow causes the potential developed by the photodiode to decrease. This change is amplified by the CA3130 Op-Amp, configured in an inverting mode to produce a significant voltage shift, which triggers the alarm system. By integrating the ESP8266 device, the project incorporates Internet of Things (IoT) capabilities, enabling real-time notifications to be sent to a mobile device and emails detailing the shadow detection timeline. This connectivity ensures prompt alerts and comprehensive monitoring, enhancing the system's effectiveness.

The objectives of this project are comprehensive:

To design a reliable and responsive shadow detection circuit, to integrate IoT functionality for real-time communication, and to provide a cost-effective solution for enhancing security. By achieving these objectives, the project aims to contribute to the development of advanced security systems that are accessible and easy to implement. The combination of photodiode sensitivity, Op-Amp amplification, and IoT connectivity provides a robust platform for safeguarding premises against unauthorized access.

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CHAPTER 1

INTRODUCTION

Security systems are an integral component of modern infrastructure, ensuring the safety of assets, individuals, and information. In an age where technological advancements are rapidly transforming security solutions, the development of efficient, cost-effective, and reliable alarm systems is critical. This project presents a novel approach to security through the design and implementation of a shadow security alarm system. The primary components of this system include the BPW34 photodiode and the CA3130 operational amplifier, configured in an inverting circuit, complemented by IoT capabilities via the ESP8266 device.

The core functionality of the shadow security alarm system is based on the detection of changes in light intensity. The BPW34 photodiode is a semiconductor device that responds to light exposure by generating a voltage proportional to the intensity of the light. When an object obstructs the light source, creating a shadow, the photodiode's output voltage decreases. This decrease is detected and amplified by the CA3130 operational amplifier, configured in an inverting mode to enhance the voltage change, thereby triggering the alarm mechanism.

The integration of the ESP8266 IoT module extends the functionality of the shadow security alarm by enabling real-time notifications and alerts. When the system detects a shadow, the ESP8266 module sends a notification to a designated mobile device and an email with a timestamp of the detected shadow. This feature ensures that the security personnel or property owners are immediately informed of any potential intrusion, allowing for prompt and effective response.

This project explores the potential of photodiode-based security systems, emphasizing the simplicity and effectiveness of using light detection for security purposes. The BPW34 photodiode's sensitivity to light variations, combined with the amplification capabilities of the CA3130 operational amplifier and the connectivity of the ESP8266 module, provides a robust and innovative solution for modern security challenges. The development and successful implementation of this shadow security alarm system demonstrate the potential for integrating simple electronic components with advanced IoT technology to create practical and efficient security solutions.

CHAPTER 2

LITERATURE REVIEW

The invention of the photodiode is often credited to Julius Edgar Lilienfeld, a physicist and engineer known for his work in semiconductor devices. Lilienfeld, in the early 20th century, proposed and patented the concept of the "light-sensitive electric device," which laid the groundwork for the modern photodiode. His pioneering work in semiconductor physics and devices contributed significantly to the understanding and development of light-sensitive semiconductor components.

Security systems have evolved significantly over the years, with advancements in technology continually enhancing their effectiveness and scope. One area of particular interest is the development of shadow security systems, which utilize light detection principles to monitor and detect intrusions based on changes in ambient light conditions.

Historically, shadow detection has been employed in various security applications, dating back to early systems that used basic light sensors to trigger alarms when shadows were detected. These early systems laid the groundwork for more sophisticated approaches that emerged later, incorporating advancements in photodiode technology and operational amplifiers to improve sensitivity and reliability.

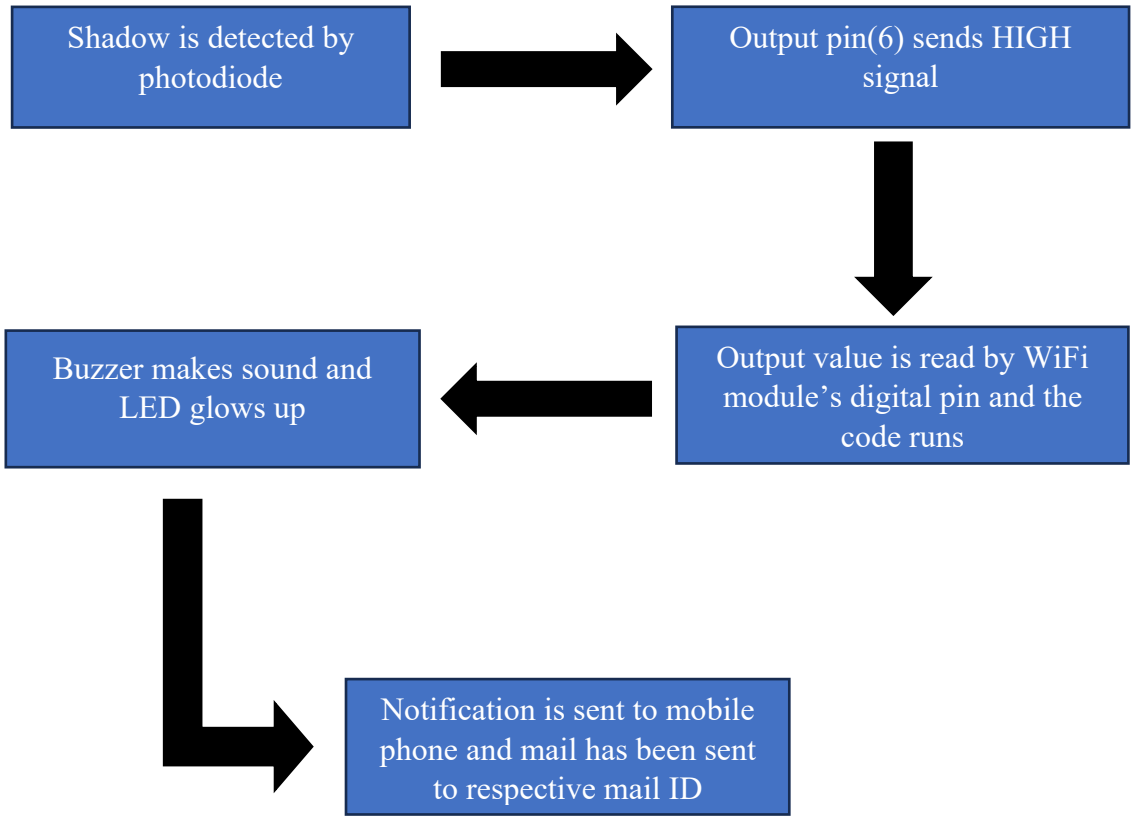
The concept of using shadows for security purposes gained traction as researchers and engineers explored ways to leverage light and shadow dynamics to detect motion and presence. Early applications included simple light-sensitive alarms that could detect changes in light levels caused by obstructing objects, indicative of potential intrusions.

In recent years, with the advent of IoT (Internet of Things) technology, shadow security systems have seen further enhancement. Integration with IoT platforms allows for real-time monitoring and remote notifications, enabling proactive security measures. Modern systems can send alerts to smartphones, tablets, or computers, providing instant updates on detected shadows and potential security breaches.

METHODOLOGY

Theory on the problem statement :

This project begins by choosing the necessary components like the BPW34 photodiode, CA3130 operational amplifier, and ESP8266 IoT module based on their specifications and how well they work together. We then create a circuit using the CA3130 to amplify signals from the photodiode, which detects changes in light that indicate a shadow. This circuit is built on a breadboard or PCB, making sure all the wires and parts are connected correctly for the circuit to work well and be stable. After building the circuit, we test and adjust it to make sure it detects shadows accurately and amplifies signals properly. We then integrate the ESP8266 module to enable the system to send real-time alerts to smartphones and emails when a shadow is detected. Finally, we evaluate the system by testing it in different lighting conditions to see how well it detects shadows and sends alerts, making any needed improvements for better performance.



Flow chart for operation of shadow alarm

Component description:

1.Photodiode:

The BPW34 is a silicon photodiode known for its high sensitivity to light and fast response times. It is capable of converting light into electrical signals, making it ideal for applications requiring precise light detection. With a spectral sensitivity range from 430 nm to 1100 nm, it efficiently detects visible and near-infrared light. The BPW34's small size and reliable performance make it a popular choice for use in light meters, optical communication devices, and security systems like shadow detection alarms.

2.CA3130(Op Amp):

The CA3130 is a high-performance operational amplifier that combines the advantages of both CMOS and bipolar transistors. It features high input impedance, low input current, and a wide bandwidth. The op-amp operates from a single or dual power supply and is known for its fast slew rate and excellent performance in low-power applications. It is widely used in signal processing, instrumentation, and medical electronics.

3.Potentiometer(10KΩ):

A potentiometer is a three-terminal variable resistor used to adjust voltage levels and control electrical devices. It consists of a resistive element and a sliding contact (wiper) that moves along the element to vary resistance. Potentiometers are commonly used for tuning and calibration in circuits, acting as voltage dividers to provide a variable output voltage. They are widely employed in applications like volume controls, position sensors, and adjusting parameters in electronic devices.

4.Piezo buzzer:

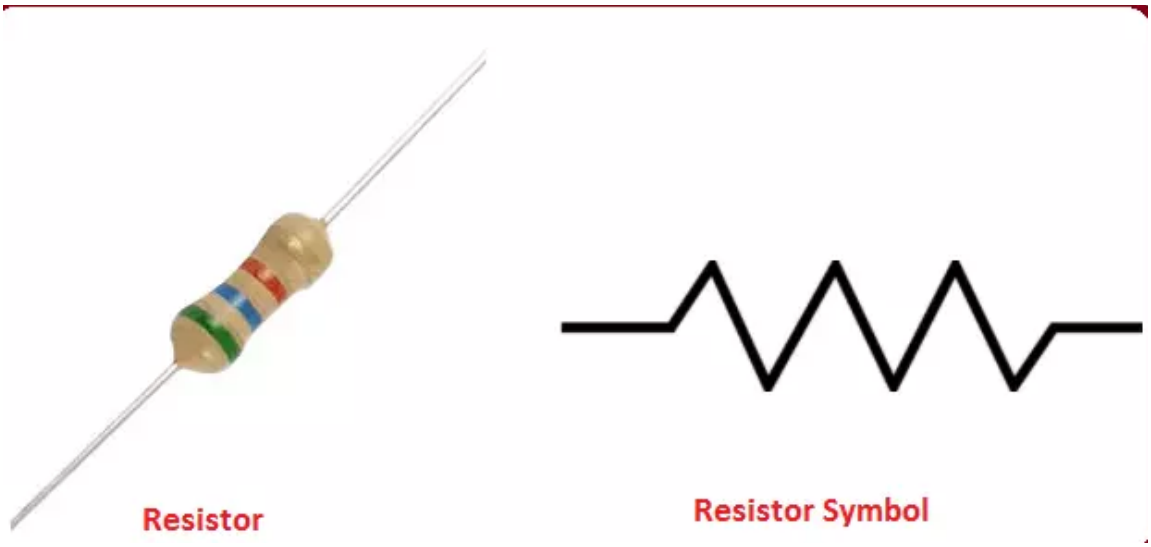
A piezo buzzer is an electronic device that produces sound when an electrical signal is applied to it. It consists of a piezoelectric ceramic disc that deforms when voltage is applied, creating sound waves. Piezo buzzers are known for their low power consumption, compact size, and high sound output. They are commonly used in alarms, timers, and various electronic devices to provide audio feedback or alerts.

5.Led:

A Light Emitting Diode (LED) is a semiconductor device that emits light when an electrical current passes through it. LEDs are known for their high efficiency, long lifespan, and low power consumption compared to traditional light sources. They come in various colors and sizes and are widely used in applications such as indicators, displays, and general lighting.

6.Resistors(100KΩ,100Ω):

Resistors are components that resist the flow of electric current, controlling current and voltage in circuits. They come in various types and values, crucial for protecting and regulating electronic components.

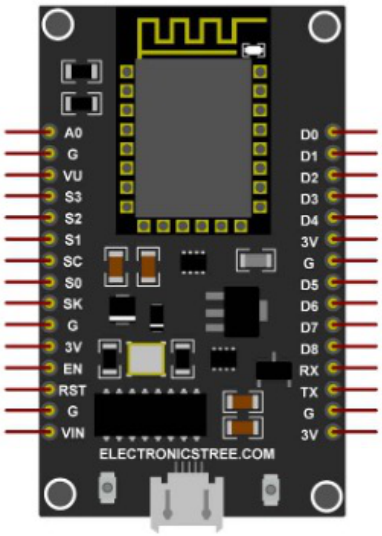


7.BJT(C945):

A Bipolar Junction Transistor (BJT) is a semiconductor device used for amplification and switching, consisting of three layers: emitter, base, and collector. It operates by using a small input current at the base to control a larger current flow between the collector and emitter.

8.Nodemcu ESP8266 WiFi module:

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability, widely used for IoT applications. It enables devices to connect to a Wi-Fi network and communicate with internet-based applications, featuring GPIO pins for interfacing with sensors and other peripherals.

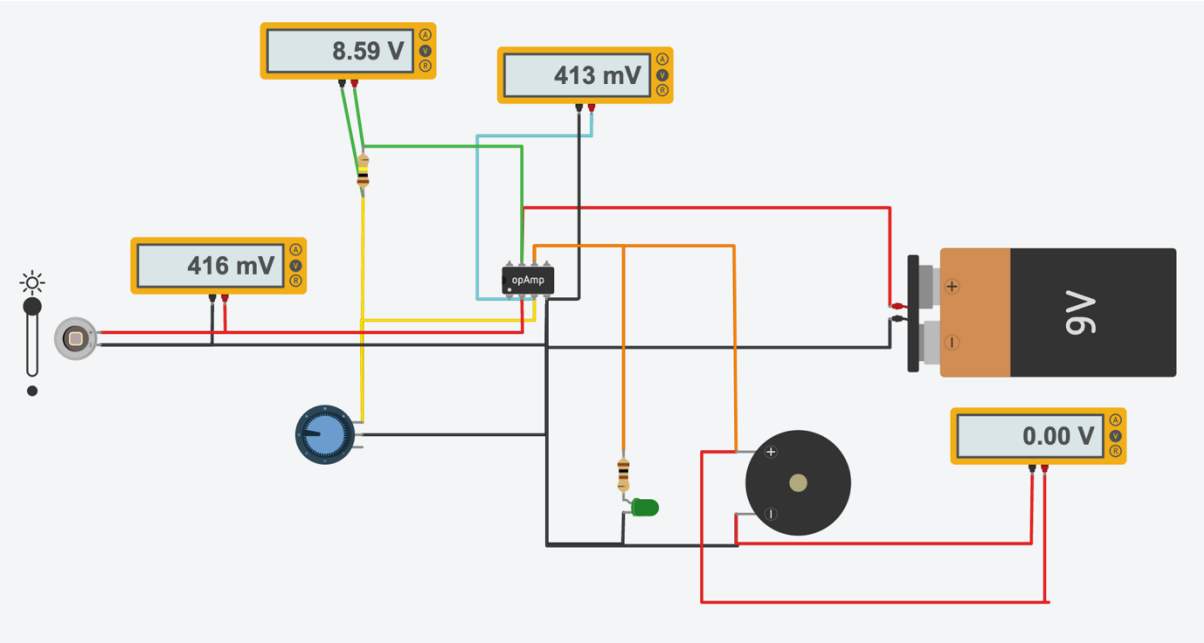


SOFTWARE IMPLEMENTATION/INTERIM RESULTS OF THE PROPOSED CIRCUIT

Software implementation of the proposed circuit:

In our project,we have used TinkerCad simulation software to simulate our proposed circuit

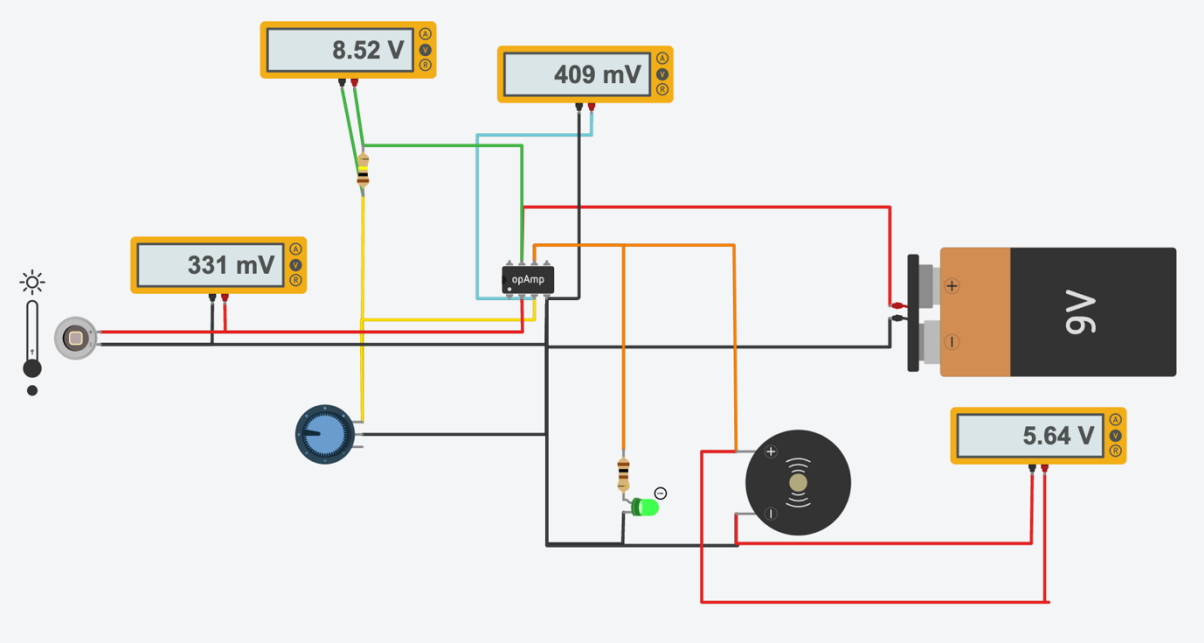
Simulation snapshot when there's no shadow falling over photodiode:



Simulation before falling of shadow

From the above snapshot we can clearly see that, the input voltage(from photodiode-416mV) across PIN2 is greater than reference voltage(413mV) across PIN3.Hence,the output state of Op Amp(CA3130) is LOW(say 0V).

Simulation snapshot when there's shadow falling over photodiode:



Simulation before falling of shadow

From the above snapshot we can clearly see that, the input voltage(from photodiode-331mV) across PIN2 becomes lower than reference voltage(409mV) across PIN3.Since ,we are using the Op Amp(CA3130) as INVERTING COMPARATOR,the output state of Op Amp(CA3130) is HIGH.

Simulation result:

TinkerCad has confirmed that our proposed circuit will work properly as expected.The Op Amp(CA3130) works as expected when the input value becomes lesser than reference value, the output state becomes HIGH.

Hardware implementation of the proposed ciruit :

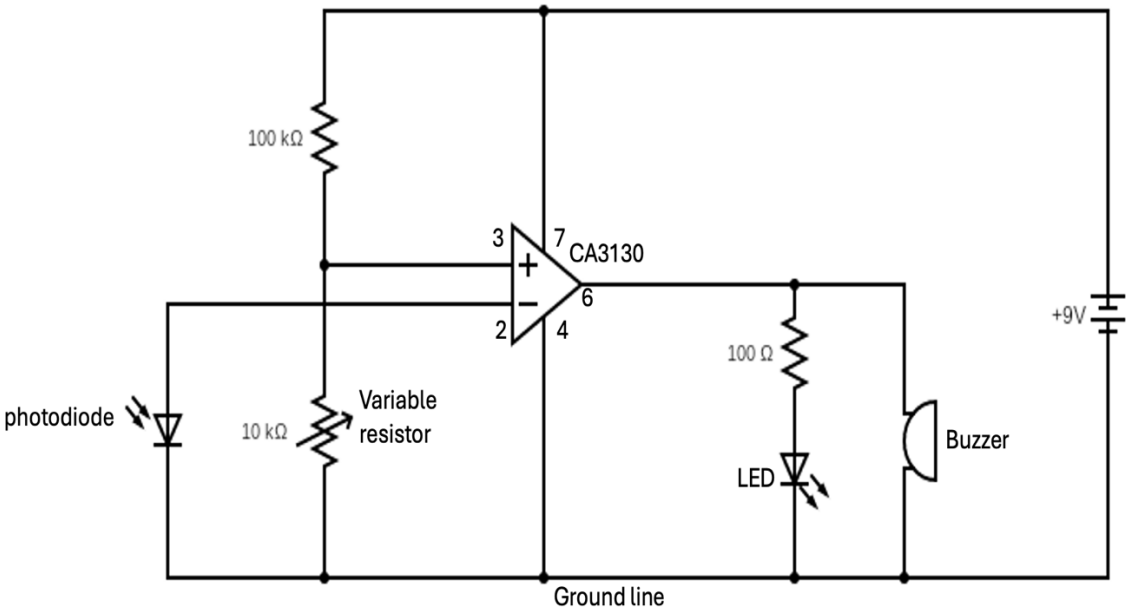
In this part,we are going to implement all the components in Universal PCB which is used to develop prototype of any project.

Step-1: Place all the components at respective place such that the space is consumed efficiently.

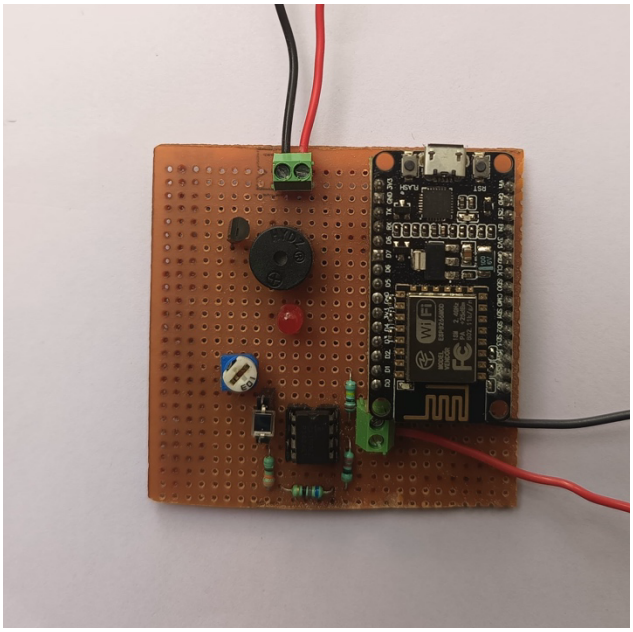
Step-2: Now,solder the terminals of each and every component at the backside of PCB.

Step-3: Connect the components as shown in the circuit diagram.

Circuit Diagram:



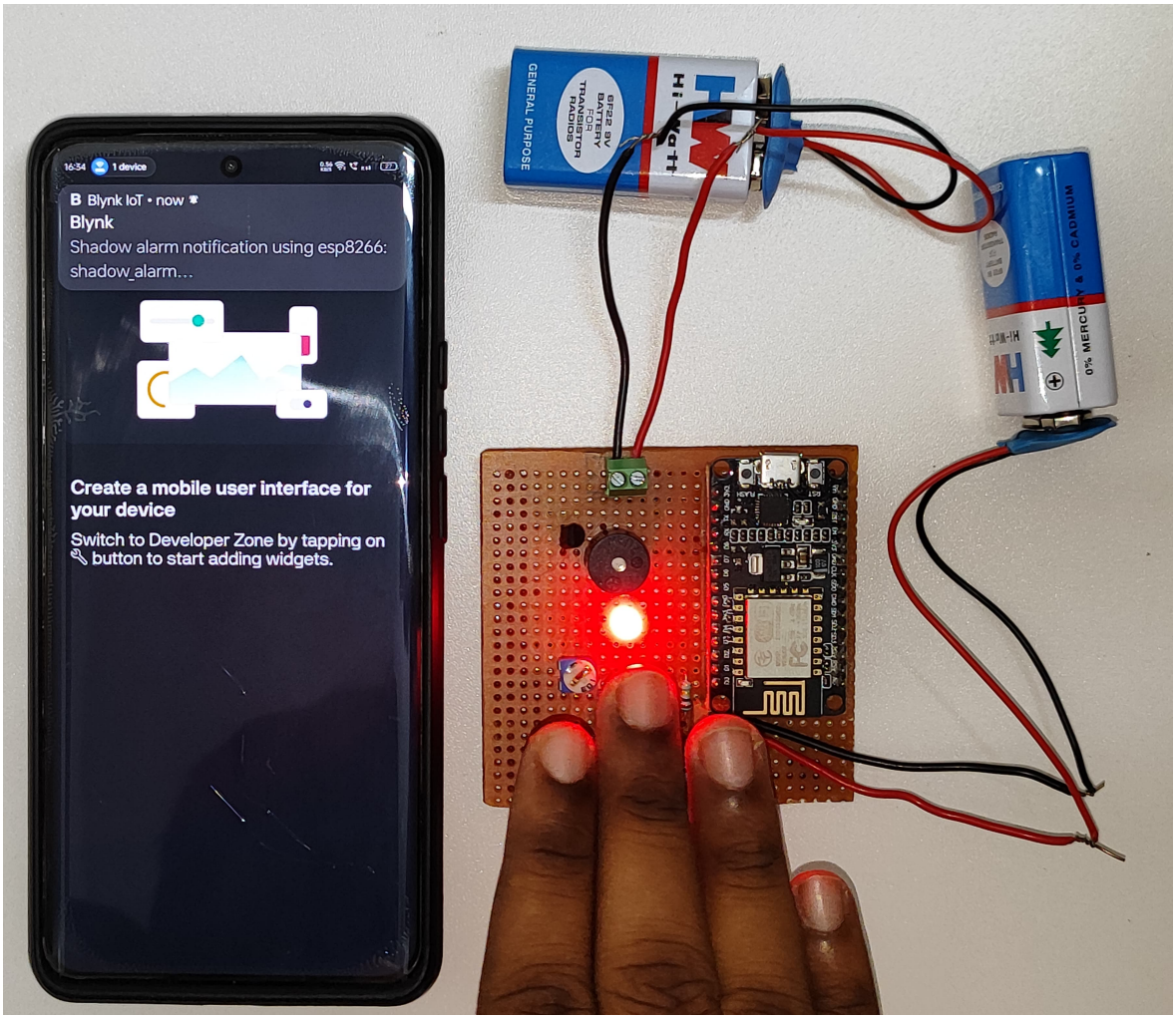
Circuit diagram of shadow detecting alarm



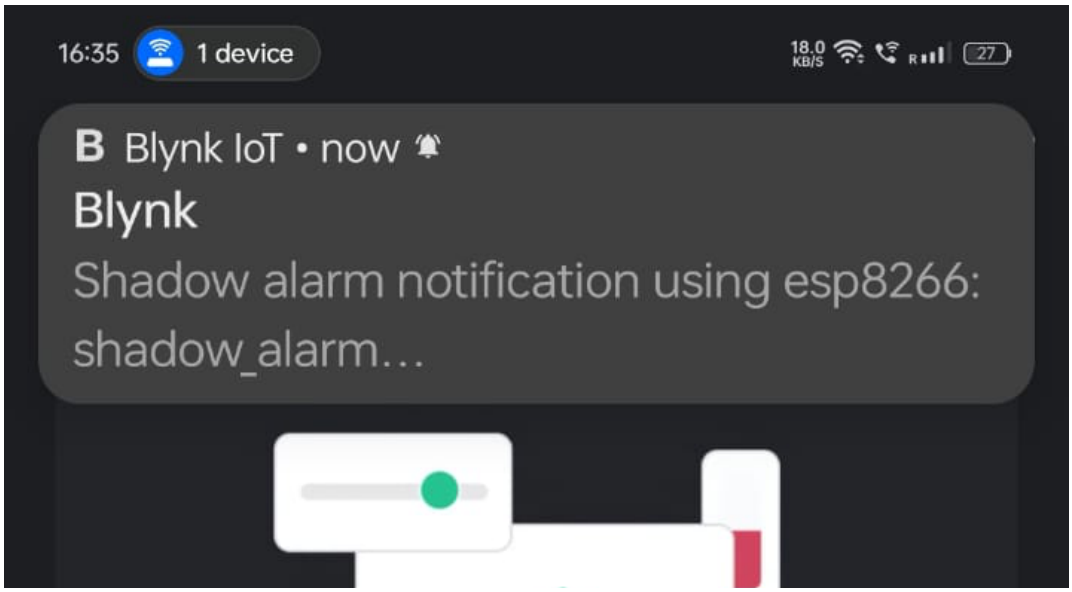
After implementation in Universal PCB

Result snapshots:

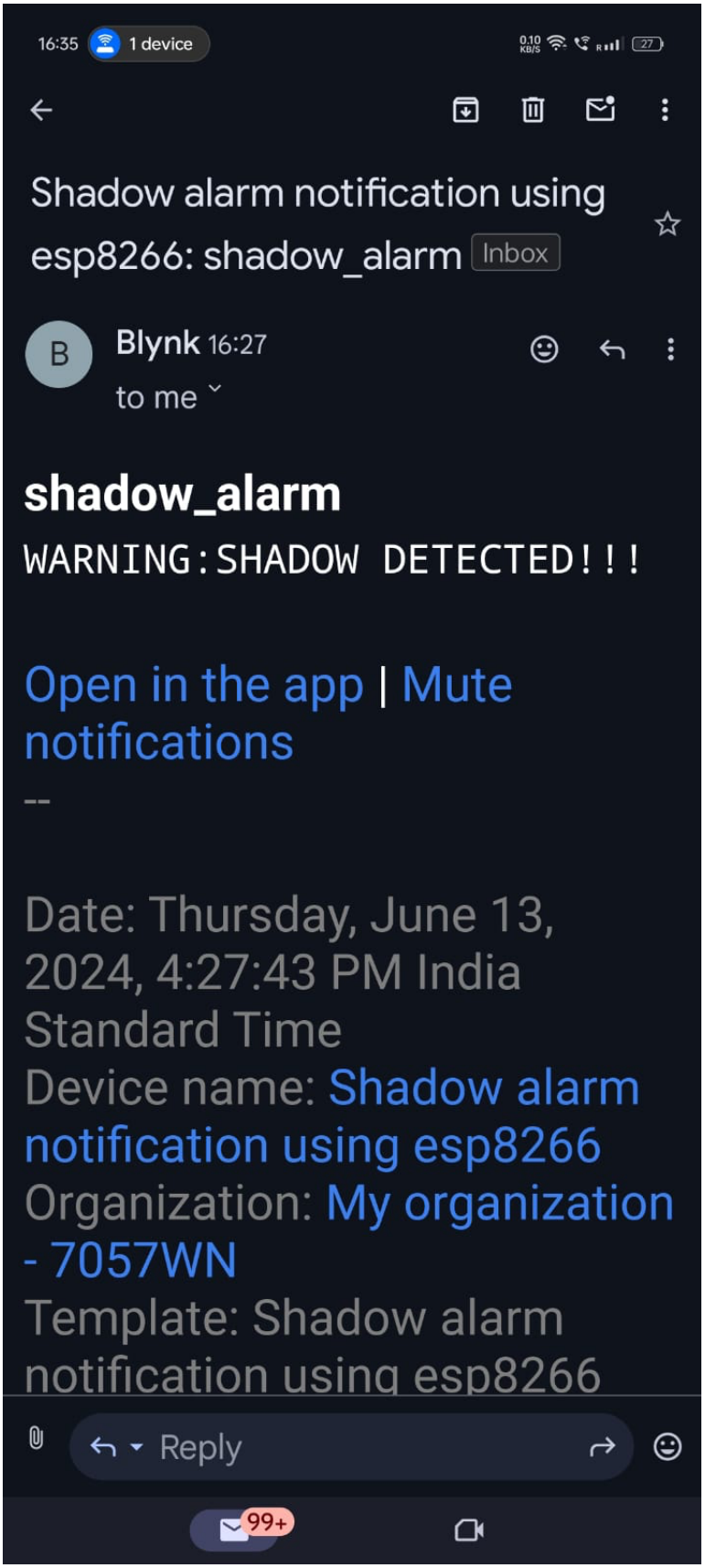
Before falling of shadow



After falling of shadow



After falling of shadow-Notification alert



After falling of shadow-Mail alert with timestamp

CONCLUSION:

The shadow security alarm system, utilizing the BPW34 photodiode, CA3130 operational amplifier, and ESP8266 IoT module, effectively detects shadows as potential intrusions. Its integration with IoT technology ensures real-time alerts, enhancing security across museums, warehouses, homes, and offices. The system's simplicity, affordability, and reliability make it a valuable addition to modern security solutions.

FUTURE WORK:

1. **Enhance Detection Accuracy:** Refine the photodiode sensitivity and amplifier settings to improve detection precision in different lighting conditions.
2. **Integrate Additional Sensors:** Incorporate motion detectors or infrared sensors to complement shadow detection for comprehensive security coverage.
3. **Implement Smartphone App:** Develop a user-friendly mobile application for remote monitoring, alert management, and system configuration.
4. **Explore Power Efficiency:** Optimize power consumption to extend battery life or reduce energy costs in operational settings.
5. **Expand IoT Capabilities:** Integrate with cloud services for data storage, analytics, and scalability, enhancing system functionality and management.
6. **Conduct Field Testing:** Perform extensive field trials to validate performance across diverse environments and scenarios, ensuring robustness and reliability.

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