Smart Home Automatic Alarm and Light Switch

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Abstrak

Proyek kami yakni Smart Home Automatic Alarm and Light Switch merupakan solusi inovatif yang kami rancang untuk meningkatkan rutinitas sehari-hari dan pola bangun tidur kita. Proyek ini menggunakan Light Dependent Resistor sebagai sensor cahaya eksternal. Sistem rangkaian ini hanya akan mengaktifkan LED dan alarm speaker sebagai respons terhadap cahaya eksternal yang terdeteksi dalam bentuk sinar matahari pagi. Sebuah operational amplifier berfungsi sebagai rangkaian komparator dan saklar yang membandingkan tegangan LDR dengan tegangan referensi. Sebuah Bipolar Junction Transistor berfungsi sebagai penguat yang memperkuat sinyal dari LDR ketika cahaya terdeteksi. Sinyal dari BJT kemudian akan memicu saklar Op amp yang akan menyalakan pencahayaan ruangan berupa LED dan alarm atau buzzer. Otomatisasi ini tidak hanya berfungsi sebagai saklar cahaya tetapi juga sebagai alarm pagi. Mengintegrasikan sistem ini ke dalam konsep "*smart city*" dapat mempromosikan konservasi energi dengan mengotomatisasi pencahayaan berdasarkan ketersediaan cahaya alami. Selain itu, rangkaian ini dapat membantu mahasiswa universitas untuk bangun tepat waktu dengan saklar cahaya dan alarm otomatis. Proyek ini merupakan solusi yang sederhana namun efektif terhadap aplikasi *smart city* yang dapat digunakan oleh hampir semua orang.

Kata kunci: Energi efisiensi, alarm otomatis, saklar lampu otomatis

Abstract

The Smart Home Automatic Alarm and Light Switch project serves as an innovative solution which we designed to enhance our everyday routine and waking up patterns. This project utilizes a Light Dependent Resistor as an external light sensor. This circuit system will activate an LED and a speaker alarm only in response to detected external light in the form of morning sunlight. An Operational Amplifier works as a comparator circuit and a switch which compares the LDR voltage with a reference voltage. A Bipolar Junction Transistor works as an amplifier which amplifies the signal from the LDR when light is detected. The signal from the BJT will then trigger the Op amp switch which will turn on both the room lighting in the form of an LED and the alarm or buzzer. This automation not only functions as a light switch but also as a morning alarm. Integrating this system into a "smart city" concept can promote energy conservation by automating lighting based on natural light availability. Moreover, this circuit can help university students to wake up on time with the automatic light switch and alarm. This project is a simple yet effective approach towards smart city applications that can be used for practically everybody.

Key words: Energy efficiency, automatic alarm, automatic light switch

A. Introduction

1. Background

   For many us university students, the initial problem of the day is simply getting out of bed in the morning. Among engineering students particularly, a common habit involves working our brain off to complete assignments and study at night, resulting in sleep deprivation. Often, after finishing their late night duties like finishing their homework, or *writing a 15 page long paper for their final project*, students forget to set an alarm for the following morning. Hence, there arises a necessity for a technological solution capable of waking us up by acting as an automatic alarm that is very loud and annoying to jolt people awake from deep sleep.

   This necessity has sparked the development of our innovative solution namely the Smart Home Automatic Alarm and Light Switch system. It addresses the challenge faced by students who struggle to wake up early. We used an external light sensor with a Light Dependent Resistor. This system triggers an alarm connected to an LED when detecting morning sunlight. The circuit utilizes an Operational Amplifier to compare the voltage from the LDR with a reference voltage, and a PNP type Bipolar Junction Transistor which amplifies the LDR signal upon light detection.

   The implementation of this system is not just a simple light switch, it also functions as a morning alarm helping those who find waking up a challenge. Integrating this concept within university settings or student dormitories can contribute to help to establish more regulated sleep patterns among students. Furthermore, its functions are applicable to smart city concepts, aiming to promote energy efficiency and offer a solution to morning wake up delays. Moreover, this solution not only caters to individual needs but can also be applicable to widespread use in university settings.

2. Problems Identification

   In today's world of academic hustle, university students, especially those in the engineering faculty confront a vital problem which is to wake up early and get on class

on time. This difficulty is due to the fact that university students often dedicate late hours to accomplish assignments and study related tasks. The need to complete extensive coursework and study into complex study materials often makes students into embracing a nocturnal routine, resulting in a perpetual state of sleep deprivation and longing exhaustion. The consequential effects of this habit are far reaching, destroying the students sleep and waking up pattern

Moreover, this cycle of nocturnal activities creates a vicious cycle where the student community have a habit of irregular sleep schedules to meet the pressing demands of their academic obligations. This sacrifice of sleep habit and a regulated sleep pattern poses detrimental effects on their overall well being, mental health, and physical health. Notably, the long periods of sleeplessness can cause a big impact on cognitive abilities, decreasing their learning capacities, concentration levels, and problem solving skills during their academic endeavors.

The absence of a structured sleep routine mixed by the oversight of setting morning alarms after study sessions further worsen the problem. Oversleeping, resulting from the oversight in setting morning alarms, will lead into the missing crucial morning classes, lectures, seminars, or even morning lab schedules. This recurrent challenge persists as a considerable problem, hindering not only their academic progress but also continuing a cycle of stress and inefficiency in their daily lives.

3. Research Purposes

The research dive deep to address the critical need for a reliable and effective wake-up mechanism for university students who encounter challenges in waking up early. The primary aim is to develop an innovative technological solution capable of autonomously waking individuals up from deep sleep. By integrating a system, using light sensors and alarm mechanisms, this research for the project seeks to design a Smart Home Automatic Alarm and Light Switch. This system aspires to be an automatic, energy efficient tool that detects morning sunlight and triggers a wake up alarm loud enough to wake us up from the deep sleep.

The main purpose is to create a solution that not only serves as an alarm but also aligns with the concept of smart city concepts. The goal is to facilitate improved sleep schedules among university students and mitigate the consequences of sleeping late at night. Additionally, by creating an energy efficient wake up mechanisms that uses natural light, the research aims to contribute to the broader concepts on sustainable living practices within a smart city. Ultimately, this research aims to offer a great solution that helps individual needs, catering to the broader community by promoting healthier wake up routines and energy conscious habits.

B. Theoretical Background

1. Diode

   Diode is an electronic component that has the function of allowing the flow of current in one direction while blocking it in the opposite direction. Diode is a type of semiconductor device with a p-n junction, p type semiconductor which has a lot of positively charged holes and an n type semiconductor which has a lot of negatively charged electrons. There are a lot of types for diodes and each with different uses or functionality such as LEDs or light emitting diodes which is a diode that emits light when forward-biased, Zener diode which is a diode that is designed to operate in the breakdown region, a Schottky diode which is a diode that have a significantly lower forward voltage drop compared to regular diodes, and many more. The operating point of a diode is a diode's operating condition when a voltage is applied across its terminals this is usually noted with Q or Q point. The parameters that are used determine the operating point of a diode are its forward voltage drop and forward current. In the load line graph the Q point is where the load line and the VI characteristic of the diode intersects.

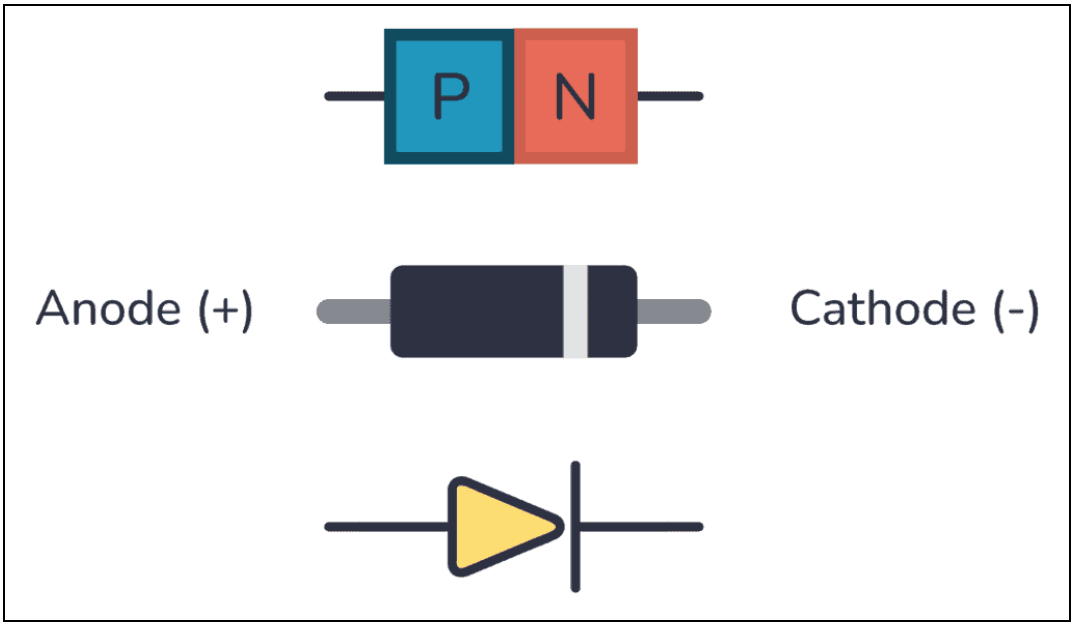

Figure 1. Diode

2. BJT

Bipolar Junction Transistor (BJT) is a semiconductor device with three terminals that has the ability to amplify signals due to its two p n junctions. It is known as “bipolar” Because this transistor uses both holes and electrons to function. The three terminals of BJT are base, collector, and emitter. BJT is a current controlled device which means that the amount of current flowing through it largely determines the operation. Current controlled devices are affected by the amount of current passing through them, as opposed to voltage-controlled devices, which react to applied voltage. There are two types of BJT which are NPN transistors and PNP transistors.

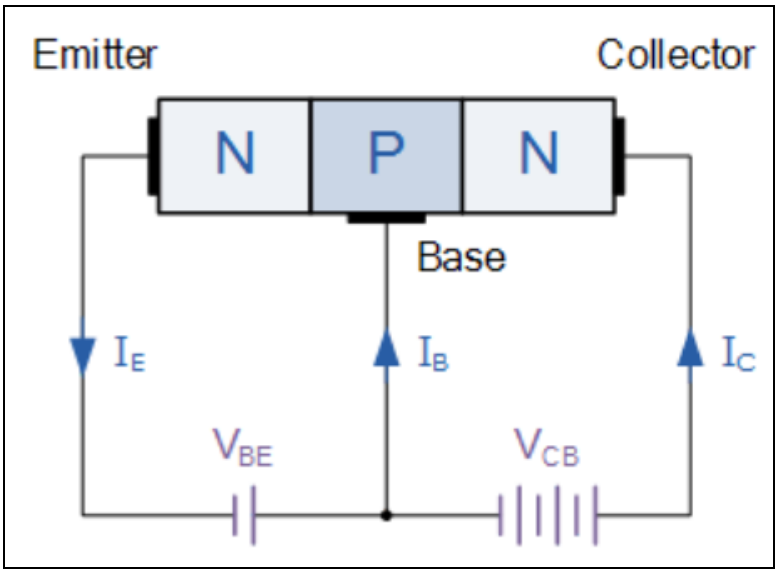

Figure 2. NPN BJT

The three layers of NPN semiconductor structure consist of: N type emitter, P type base, and N type collector. The majority charge carriers are electrons which can move from the emitter to the base of the transistor when the emitter-base junction is forward-biased. Major electron flow from the collector to the base is obstructed by the reverse biasing of the collector-base junction.

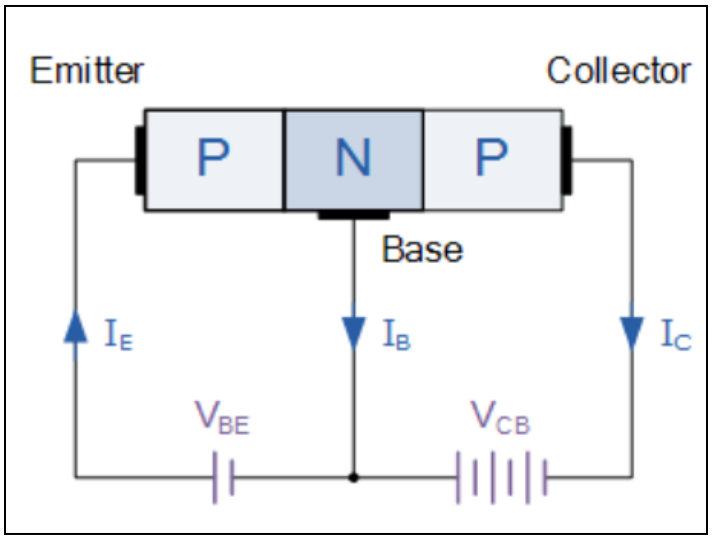

Figure 3. PNP BJT

The three layers of NPN semiconductor structure consist of: P type emitter, N type base, and P type collector. The majority charge carriers are holes which can move from the emitter to the base of the transistor when the emitter base junction is forward biased. Major holes flow from the collector to the base is obstructed by the reverse biasing of the collector-base junction.

3. BJT PNP CE Configuration

   In this circuit we used a PNP Common Emitter (CE) configuration. This particular configuration of a Bipolar Junction Transistor is used for signal amplification in a PNP common emitter configuration. With a P-type emitter, an N-type base, and a P-type collector, the PNP transistor functions in the opposite way as an NPN transistor. The base-emitter junction of the transistor is forward-biased, and the collector-base junction is reverse-biased. By establishing an appropriate operating point, this biasing makes sure the transistor functions in its active region. Consequently, corresponding variations are seen in the collector current, which is mainly determined by the base current. A voltage drop is produced as the collector current passes through the load resistor, amplifying and inverting the output signal across the collector resistor.

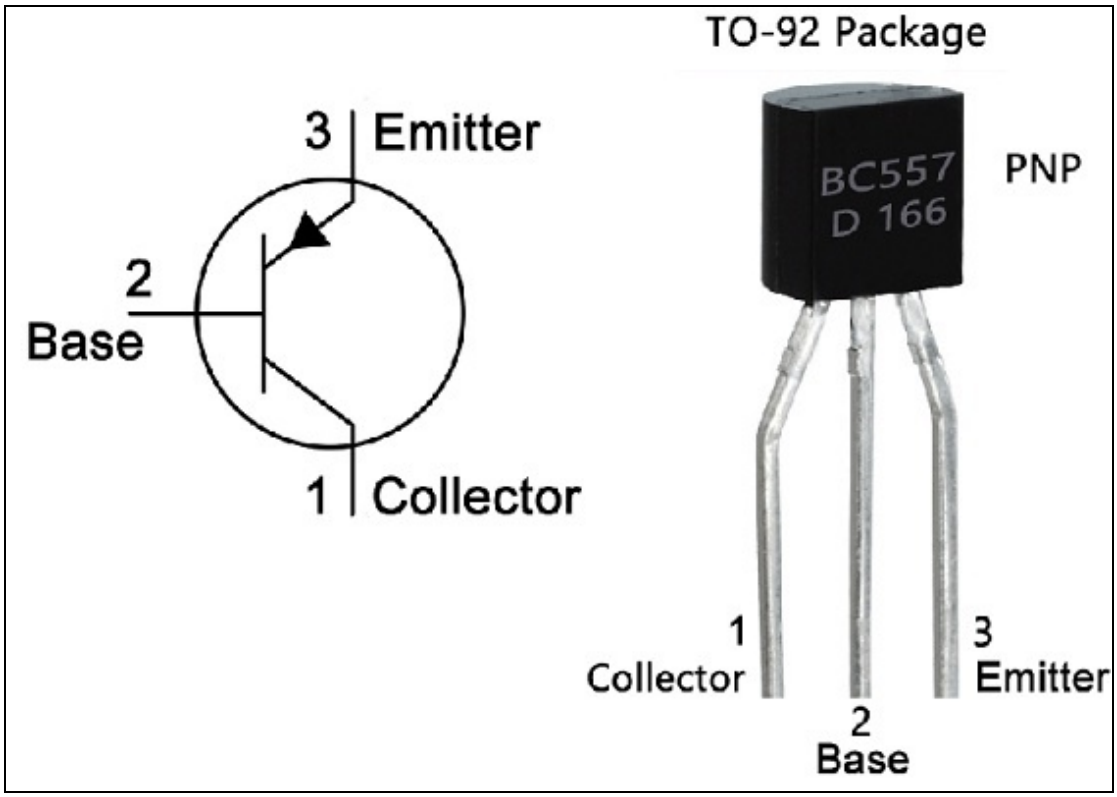

Figure 4. Common Emitter Configuration

4. Operational Amplifier

   An Operational Amplifier, known as an Op amp, is a critical component within electronics due to its ability to amplify voltage signals. Op amps are composed of numerous transistors, resistors, and other integral elements within a single device, the Op amp serves as a foundational tool for various electronic circuits. Its primary function involves amplifying voltage differences across its input terminals, offering high gain, high input impedance, low output impedance, and very good stability.

   Op amps has a lot of use as comparators within electronic circuits. When configured as a comparator, an Op Amp compares two different input voltages, designating one as the reference voltage and the other as the input voltage. It compares these voltages and produces an output based on the relationship between the two inputs. The output is a digital representation, typically at either the positive or negative saturation levels, upon which input voltage is higher. This setup is important in applications that necessitate

decision making based on voltage threshold levels, such as in sensing systems, oscillators, or signal conditioning circuits.

Op amps, when appropriately configured, can act as a switch-like behavior in an electronic circuit. By utilizing the Op-Amp as a comparator, us the creator of the circuit can create a switch that toggles its output based on predefined voltage thresholds. When one input voltage surpasses the other like when the input voltage exceeds the reference voltage, the Op amp's output transitions between its high and low states. This operation allows the Op amp to control other components or circuits by altering its output based on established voltage. The switch-like capability of Op-Amps can be used in diverse uses, including automation, sensor interfacing, and digital logic implementations.

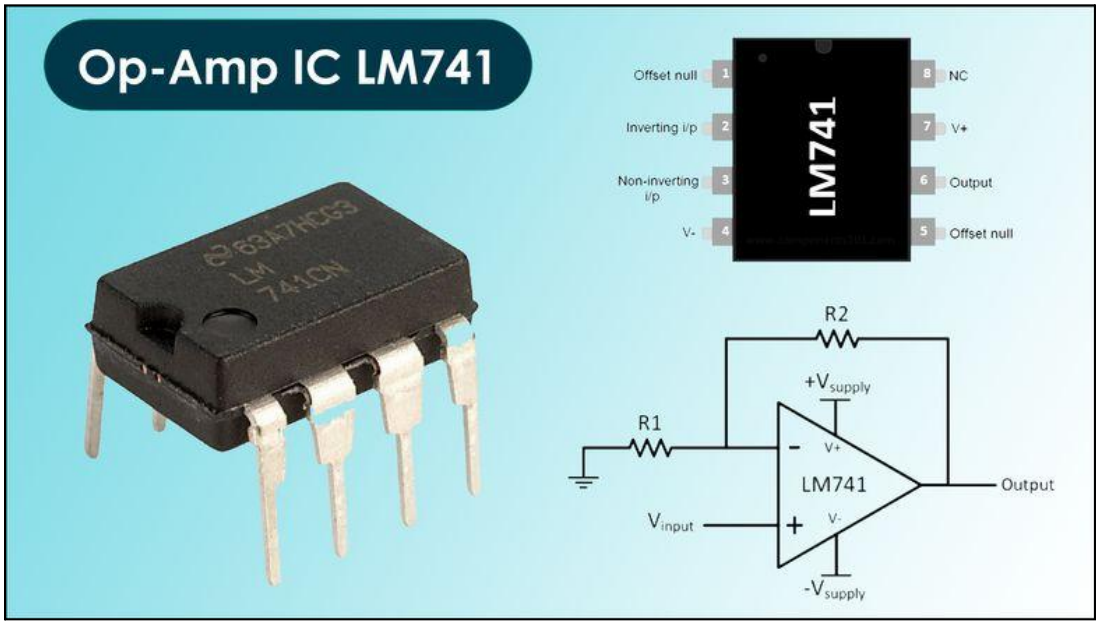

Figure 5. Operational Amplifier Configuration

5. Voltage Divider

A voltage divider is a fundamental electrical circuit arrangement used to produce an output voltage that is a fraction of the input voltage. It consists of two resistive elements most typically resistors connected in series across a voltage source. This arrangement

cuts a portion of the input voltage across one of the resistors which generates a reduced output voltage across the other resistor.

The output voltage across the second resistor is determined by the ratio of its resistance to the total resistance in the circuit, or sum of both resistors. According to Ohm's law, the voltage drop across a resistor is directly proportional to the current flowing through it. Therefore based on the voltage divider principle, the output voltage across the second resistor is proportional to the ratio of its resistance to the total resistance multiplied by the input voltage.

Voltage dividers have a lot of applications in electronics for various purposes, including providing reference voltages, biasing transistor circuits, setting levels for sensor interfaces, and scaling down voltage levels for different components in a circuit. They are simple yet effective which allows for the creating customized output voltages from a given input source, which can also be used to facilitate voltages for specific operational requirements within electronic circuits.

C. Research Methods

Our approach to this research project is by doing a combination of experimental and developmental research approaches, we do both because each of the two has a major impact on the direction and results of our project. The combination of these methodological techniques forms the foundation of our project which allows us to conduct a thorough inspection into optimizing our alarm in order to increase their effectiveness and their working concept.

Our method consists of testing and troubleshooting. These approaches act as a way to help us understand the working principle of each of the components that make up our alarm systems. We are very interested in both the internal workings of these systems like how each component works together and possible ways for improving the usefulness of our project, which will allow us to develop a greater understanding of how these systems might be optimized to make a big impact for our circuit users, if there's any.

While we test and troubleshoot the circuit, we also study the previous materials we got from class, lab, and other external sources like youtube videos to greater understand how each component works, which at the end of our study we successfully planned and carried out to examine the features of the alarms and LEDs created for our project. By conducting methodical examination we hope to understand their usefulness while also clarifying all aspects of their functioning and understanding the ways in which they contribute to our purpose of helping students to wake up on time.

Through the integration of these well thought out research methodologies, we explore a wide range of areas that we have not fully understood, and by studying it we go out and beyond to develop and experiment to not only optimize our alarm but also to create simple yet effective solutions that align with the goal of our project. This comprehensive approach highlights our dedication to the theoretical concepts as well as the application of our findings in real world scenarios.

D. Research Results

The result of our research efforts has resulted in a comprehensive understanding of each of the components used in our circuit. We are dedicated to dive in depth study of each of the elements, meticulously analyzing how they work and functional capabilities of the LED, operational amplifier , and bipolar junction transistor (BJT). Our study dissect the LED's light emitting properties, understanding its function as a room illuminator in response to the external light, specifically the morning sunlight detected by the Light Dependent Resistor.

Moreover, our research delved into the Op amp's vital role as a comparator circuit and switch. A lot of analyses understand its capacity to gauge the voltage difference between the LDR and a reference voltage, thereby creating a responsive trigger mechanism that activates both the LED and the alarm together at the same time. Additionally, our understanding into the BJT's amplification characteristics showed us its role in magnifying the signal from the LDR upon light detection, forming a pivotal link in the chain of operations leading to the circuit's activation.

The essence of our research lies in the comprehensive understanding of the individual components, and grasping their functionalities, and operational dynamics. This deep dive exploration culminated in our knowledge at skillfully combining these elements, fusing their individual functionalities into a harmonious circuit design. Our comprehension of each component's characteristics, gathered through rigorous study and experimentation, has resulted in the seamless integration of the LED, Op-Amp, and BJT, resulting in the successful creation of the Smart Home Automatic Alarm and Light Switch project.

E. Discussion

This circuit operates using a 9-volt battery as its power source, which provides all the necessary power to run its functionalities. When setting up this circuit we've divided it to place our components across two breadboards which ensures a neat and organized layout for effective functioning. On the first breadboard we placed the operational amplifier, LED, buzzer, and the essential resistors for both the LED and the voltage divider.

The power + pin of the operational amplifier connects directly to the positive output terminal of the battery, while the power - pin is linked to the negative terminal. The voltage divider, which is critical for our circuit, involves the use of two 100-ohm resistors linked to the inverting input of the operational amplifier. This arrangement makes the op-amp's voltage reference to a precise 4.5 volts, which is half of the battery voltage.

The LED and buzzer's positive pins are connected with the output of the op-amp, which serves as a switch, effectively controlling their activation. For the second breadboard we've placed the PNP type Bipolar Junction Transistor, the photoresistor or light dependent resistor, and their resistors. The wiring involves linking the photoresistors and its own resistors to the base pin of the BJT. The emitter pin of the BJT is connected to the positive output from the battery, ensuring a continuous power supply to keep things running.

The output from the collector pin of the BJT is connected to the non-inverting pin of the op-amp which continues the signal from the BJT to the op amp which will act as a switch. We've calculated the numbers, calculated the resistance of the LDR, and figured out the precise voltage requirements from the voltage divider to ensure that the circuit works. Upon detecting the morning sunlight through the photoresistor, this calculated circuit will prompt the LED to light up acting as room lighting while the alarm also turns on to wake up the user. We've also included a switch that allows us to toggle the entire circuit on or off. This switch will allow us the flexibility to turn off the whole circuit when it's not needed.

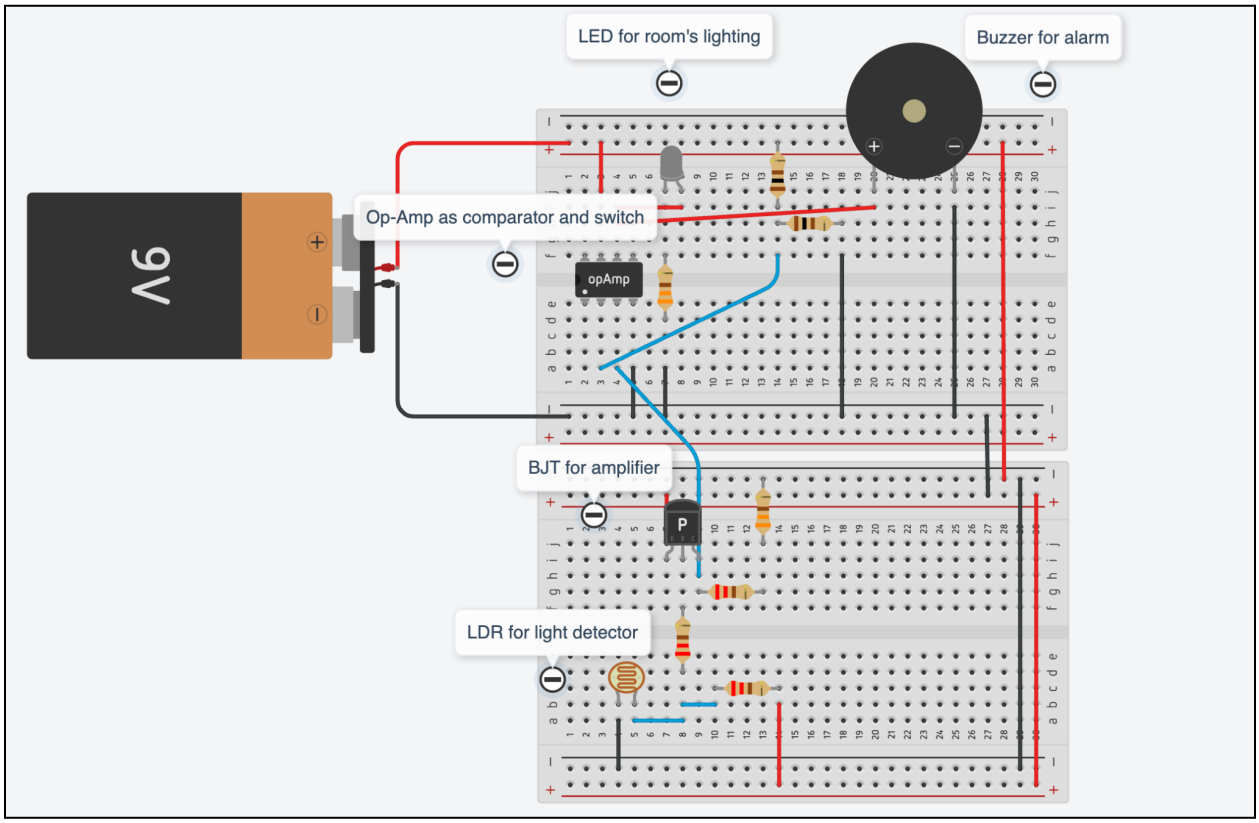

Figure 6. The Circuit in Tinkercad

F. Conclusion

The Smart Home Automatic Alarm and Light Switch project is an innovative response to enhance our daily routines and our daily waking up schedule. It usesa light dependent resistor as an external light sensor which triggers an LED and speaker alarm only in response to detected

external light or morning sunlight. The circuit configuration employs an operational amplifier as a comparator and switch, comparing LDR voltage with a reference voltage, while a bipolar junction transistor functions as an amplifier upon light detection. The BJT signal will trigger the op amp to switch, activating room lighting (LED) and an alarm (buzzer).

This circuit is not just a light switch, this automated system also serves as a morning alarm, which are in line with smart city concepts. Moreover, it helps university students by automating their wake up routines. This project is a straightforward yet impactful approach applicable to smart city concepts, not exclusively for university students but can be used for practically everybody.

This project rises from identifying the challenges of university students in waking up early. Sleep deprivation due to late night study sessions and forgetting to set morning alarms are a very widespread issues for engineering students. This project's development aims to create an efficient wake up alarm mechanism, aligning with smart city concepts.

The integration of various components, from diodes, BJTs, to Op amps and voltage dividers, shows a comprehensive approach towards designing a system at automating morning wake up routines. Our methods combined developmental and experimental research techniques, which resulted in a system that uses the reliable operation of LEDs and alarms.

More than just the functionality, our research opens opportunities for automation ideas and for energy conservation and sustainability. Its potential impact extends beyond mere verification, promising a future where energy efficiency and smart technologies are implemented seamlessly to create a more automated cities. This circuit's design, calculation, and user-friendliness has potential for widespread adoption in smart city applications.

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