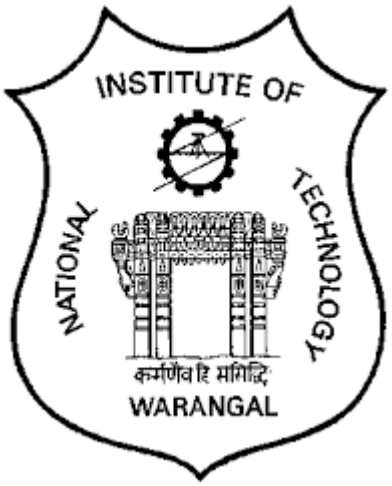
IR Based Security Alarm Using 555 Timer



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Introduction:

Security alarms are essential in today's world as they provide an effective way to protect our homes, businesses, and properties from theft, burglary, and other types of intrusions. A security alarm system typically consists of sensors, control panels, and alarm sirens that work together to detect and alert the presence of an intruder.

An IR based security alarm using 555 timer is a simple and cost-effective device and it detects any sort of unauthorised access to any area. The IR LED emits a beam of light and when this gets interrupted then an alarm is triggered. The 555 timer is used to generate timing signals and can be used for a numerous number of applications.

The 555 timer is known to be a very versatile IC (integrated circuit), it can be used as an oscillator, timer, or flip-flop. In this project the 555 timer IC is used as an astable multivibrator to generate a square wave output at a fixed frequency. The frequency of the square wave is determined by the values of resistors and capacitors connected to the timer IC.

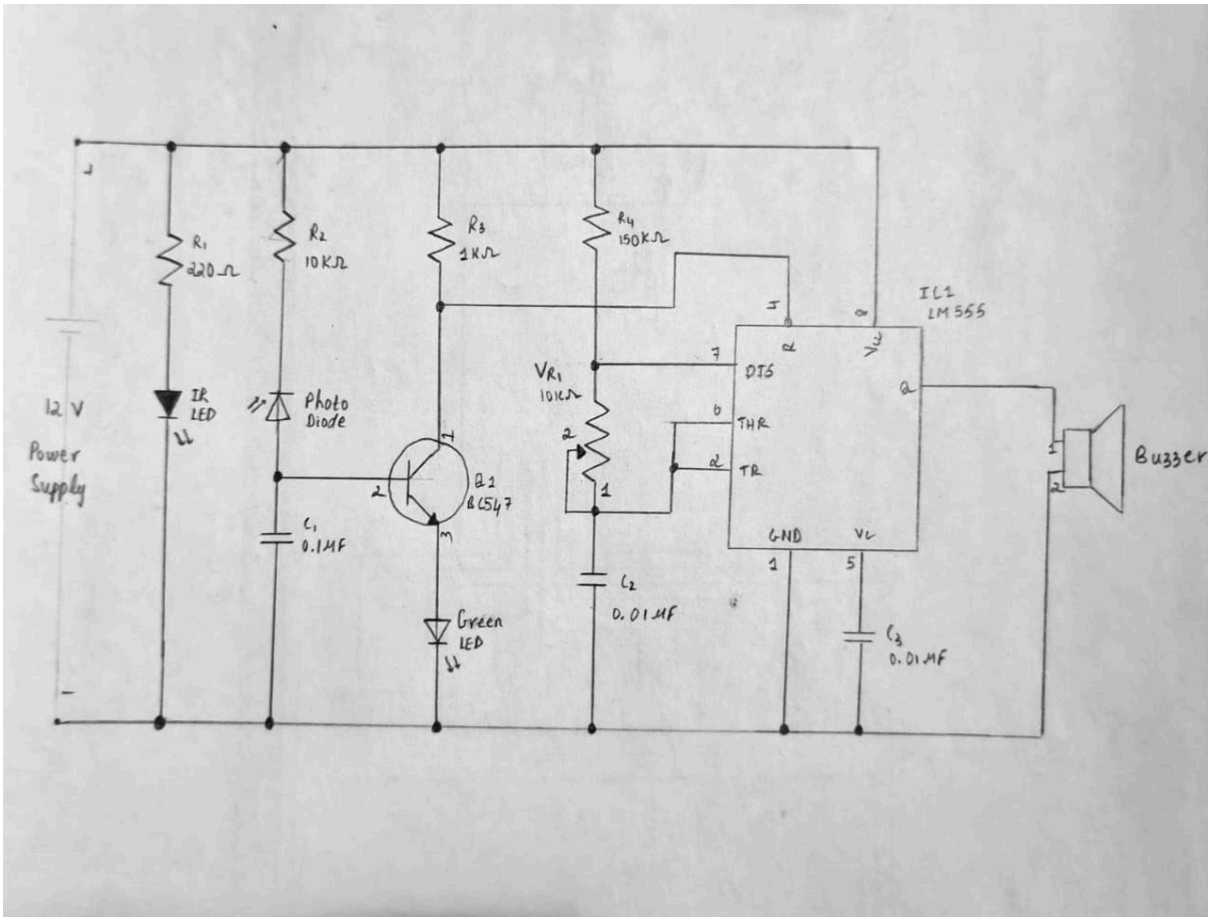
In the security alarm circuit, the square wave output of the 555 timer IC is connected to the buzzer and the LED, which gives us the output audio and emits light from the LED. When the output of the 555 timer IC is high, the buzzer and the LED turns on, giving out a loud noise emitting bright light. When the output is low, the output volume of the buzzer and the intensity of light from the LED reduces.

Overall, the importance of security alarms cannot be overstated, as they are a vital component of any comprehensive security strategy.

Components Required:

1. Resistors - 220 ohm,10k ohm,1k ohm,150k ohm
2. Capacitor - 0.1mu F, 0.01mu F - 2
3. 12V Battery
4. IR LED, LED - Green
5. Photo diode
6. Transistor - BC547
7. Connecting wires
8. 8 Ohms Speaker
9. Potentiometer - 10K ohm
10. IC555

Circuit Diagram:



Here in this circuit diagram,

The photodiode continuously monitors the surrounding environment for any changes in the IR signal, indicating object movement.

When the photodiode detects the presence of an object, it sends a signal to the trigger pin (Pin 2) of the IC555, triggering the IC555.

The IC555 starts the timing cycle, and its output pin (Pin 3) goes high, activating the base of transistor BC547.

Transistor BC547 acts as a switch and allows current flow from the positive terminal of the power supply to the buzzer, generating an audible alarm sound.

The duration of the alarm sound is determined by the timing components (resistor and capacitor) connected to the IC555.

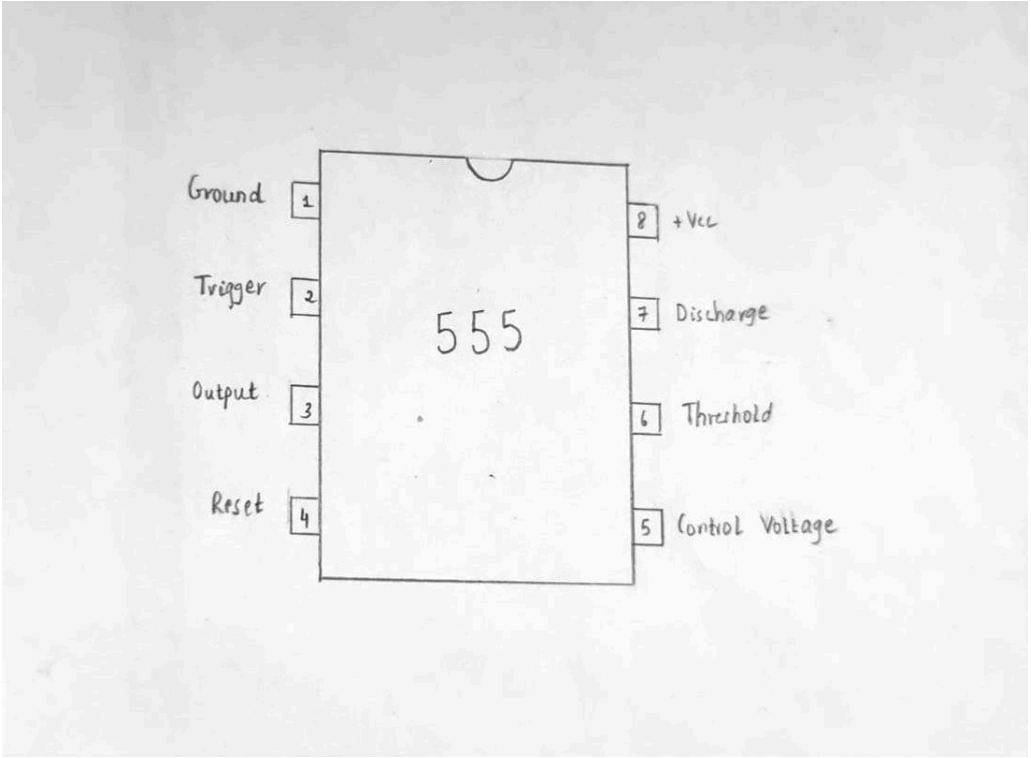
After the timing cycle completes, the output pin (Pin 3) of the IC555 goes low, turning off the base current of transistor BC547 and subsequently stopping the alarm sound.

The IC555 remains in standby mode until the photodiode detects another object and triggers the IC555 again

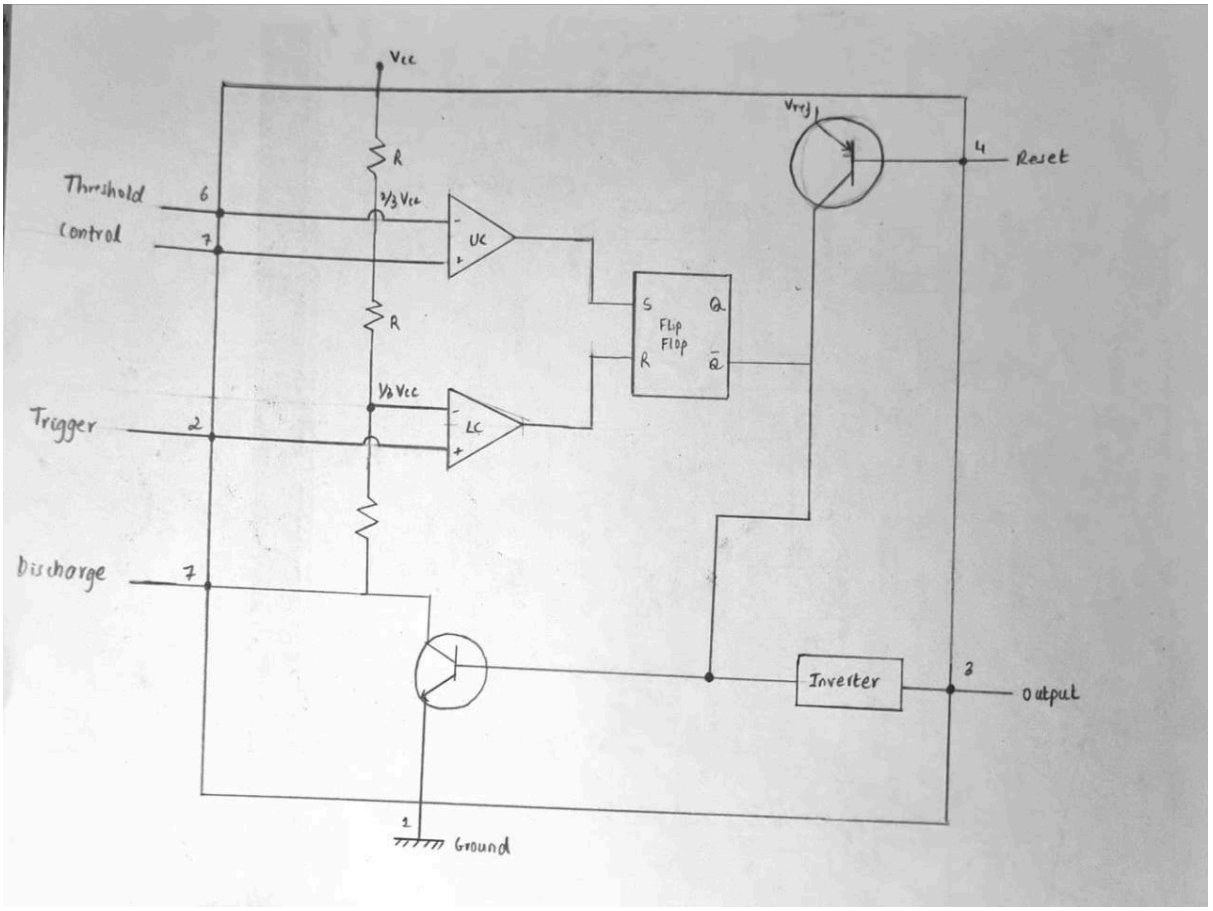
Explanation of the modules:

- IC 555 timer:

  The IC555, is a widely used integrated circuit used in various electronic circuits as a timer, oscillator, and pulse-width modulation (PWM) generator.It serves as a very important component in the making of many electronic projects. The working principle is a combination of both the analog and digital circuitry.



- Inner circuit of 555 timer:



Pin 1:GND - reference voltage connected to ground (0v).

Pin 2:Trigger input - the output of the ic depends completely on this trigger input amplitude we give.the output is high as long as the trigger input is low.

Pin 3:output - it gives the output according to the input we give which drives approximately 1.7v below +vcc or to gnd.

Pin 4:Reset - resets the whole device when we give 1v.

Pin 5:control - this pin provides control access to the internal voltage divider.

Pin 6:Threshold voltage - it controls the timing interval,when this voltage is higher than control input the timing interval ends.

Pin 7:Discharge - it is in phase with output. will discharge a capacitor between intervals.

Pin 8:Vcc - positive supply voltage.

- ## Working of IC 555 in IR Based Security Alarm:

  In the IR based security alarm circuit, the 555 timer IC is used as an astable multivibrator to generate a square wave output at a fixed frequency. The frequency of the square wave is determined by the values of resistors and capacitors connected to the timer IC.

  The 555 timer IC consists of two comparators, a flip-flop, and an output stage. The comparators compare the voltage at the threshold and trigger inputs to the voltage at the control input. When the voltage at the trigger input is less than 1/3 of the control voltage, the flip-flop is set, and the output of the IC goes high. When the voltage at the threshold input is greater than 2/3 of the control voltage, the flip-flop is reset, and the output of the IC goes low.

  In the astable multivibrator configuration, the control voltage is connected to the timer IC through a resistor and a capacitor. The resistor and capacitor form a timing circuit, which determines the frequency of the output square wave. When the voltage at the control input is between 1/3 and 2/3 of the supply voltage, the output of the timer IC oscillates between high and low states, producing a square wave output.

  In the security alarm circuit, the square wave output of the 555 timer IC is connected to the buzzer and the LED, which gives us the output audio and emits light from the LED. When the output of the 555 timer IC is high, the buzzer and the LED turns on, giving out a loud noise emitting bright light. When the output is low, the output volume of the buzzer and the intensity of light from the LED reduces.

  The 10k variable resistor is used to adjust the frequency of the square wave output of the 555 timer IC, which in turn controls the output volume of the buzzer and the intensity of light emitted. When the IR rays are exposed to the photodiode it sends a signal to the 555 timer IC, which generates a high-frequency square wave output, turning on the buzzer and LED. As the rays get blocked by any interference, it sends a signal to the 555 timer IC, which generates a low-frequency square wave output, reducing the intensity of light in the LED and reducing the output volume from the buzzer.

- ## Photodiode:

  A photodiode is a semiconductor device that converts light into an electrical current. It is a type of photodetector that is specifically designed to detect and measure light intensity.

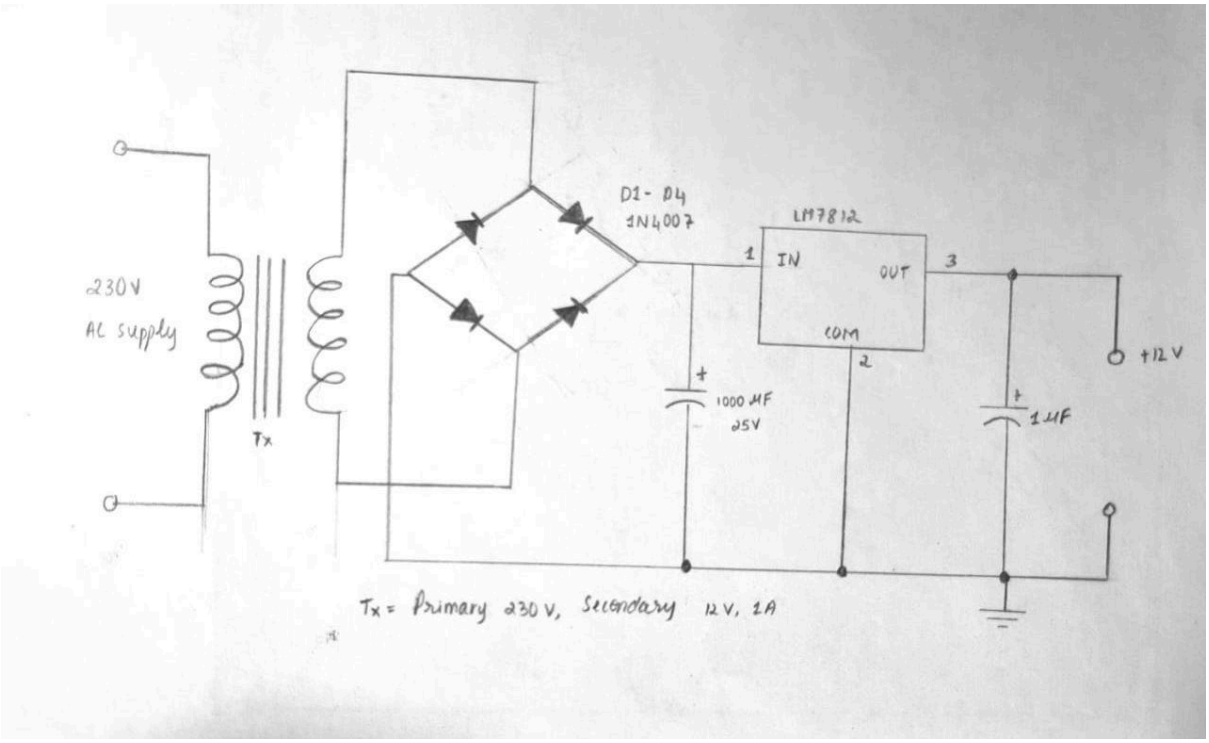
- ## IR LED:

  It is a type of LED that emits infrared light. Infrared light has a longer wavelength than visible light and is invisible to the human eye.

- Transistor - BC547

  The basic operation of a transistor involves three layers of semiconductor material: the gate, drain and source for FETs. It regulates or controls current or voltage flow and also amplifies and generates the electrical signals and act as a switch/gate for them.

POWER SUPPLY CIRCUIT



Working of Power Supply Circuit:

The circuit you are referring to is a power supply circuit that uses a 9V transformer and a 7812-voltage regulator IC to provide a stable 12V DC output. The circuit works by first stepping down the AC voltage from the transformer to a lower AC voltage, which is then rectified and filtered to produce a stable DC voltage. The voltage regulator IC then regulates this DC voltage to the desired output voltage.

The 9V transformer used in the circuit is a step-down transformer that reduces the input AC voltage to a lower voltage suitable for use in the circuit. The transformer has two primary windings and two secondary windings, each with a centre tap. The two primary windings are connected in parallel to the input AC voltage, while the two secondary windings are connected in series to produce a 12V AC output.

The 12V AC output from the transformer is then fed into a bridge rectifier circuit, which consists of four diodes that are arranged in a bridge configuration. The rectifier circuit converts the AC voltage into a pulsating DC voltage, which contains both positive and negative voltage swings. The pulsating DC voltage is then filtered using a capacitor connected across the output of the rectifier circuit. The capacitor smoothes out the voltage fluctuations and produces a more stable DC voltage.

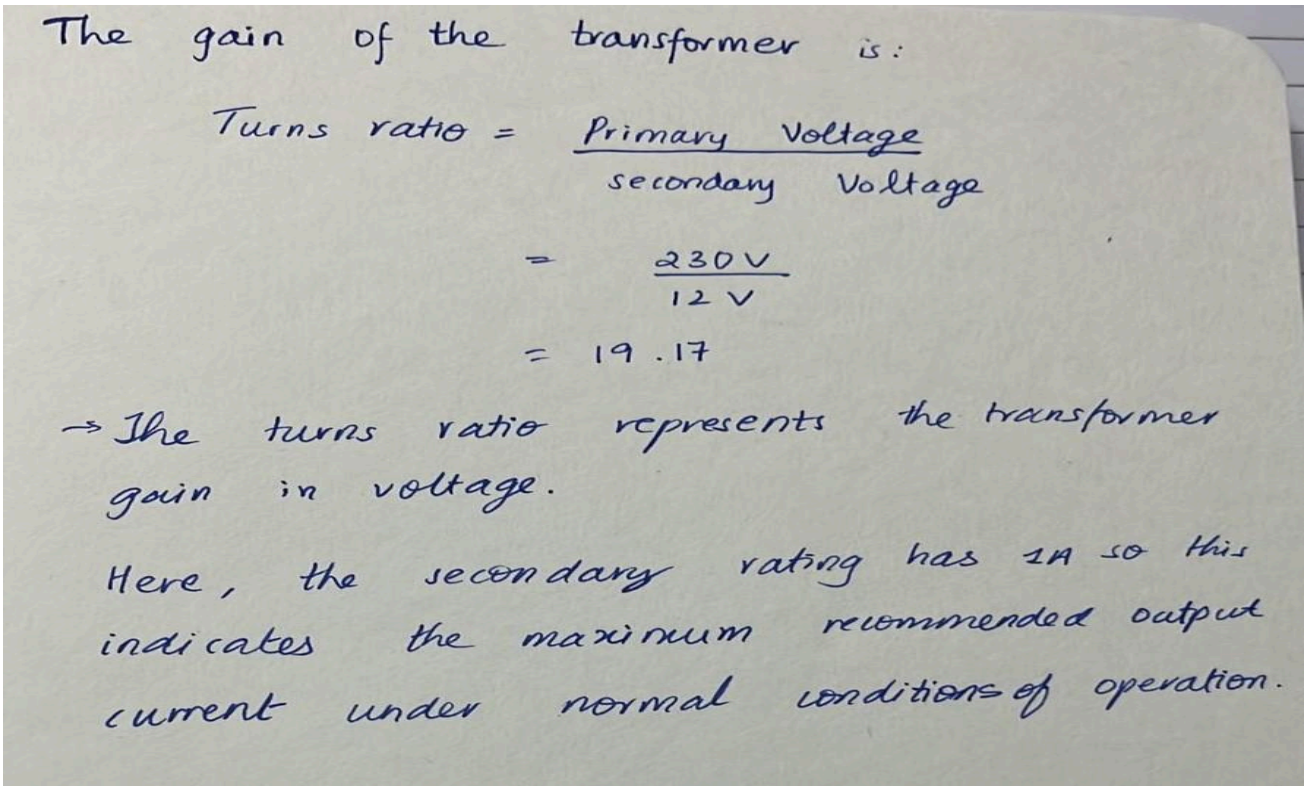
The filtered DC voltage is then fed into the input of the 7812-voltage regulator IC. The 7812 IC is a three-terminal voltage regulator that regulates the input voltage to a stable 12V DC output. The IC contains a voltage reference, an error amplifier, and a power transistor, which work together to regulate the output voltage. The voltage reference sets the desired output voltage, while the error amplifier compares the actual output voltage to the reference voltage and adjusts the power transistor accordingly to maintain a constant output voltage.

- Potentiometer:

  A potentiometer is a three terminal variable resistor that is commonly used to control electrical voltage in electronic circuits.It has a manual adjustment of resistance that leads to controlling the flow of electric current.

  It has three terminals which are input or wiper ,output and the reference or ground.It consists of a resistive element, which is a long, continuous strip of resistive material and a wiper that moves along the resistive element .

- 9V Transformer:



- IC 7812CV Voltage Regulator:

  The IC 7812CV is a voltage regulator chip used to regulate DC voltage in electronic circuits. It takes an input voltage between 14 to 35 volts DC. The IC 7812CV regulates the input voltage to a constant output voltage of 12 volts DC. It achieves this using a fixed reference voltage of 1.25 volts, which is compared to a fraction of the output voltage using an internal voltage divider circuit.

Working of the Project:

The IR based security alarm project has a photo diode that is sensitive to IR light and when IR light falls on the photodiode , it generates a small current that can be amplified and used as a trigger signal for the 555 timer.

So the circuit is built in such a way that the photodiode is facing an IR LED that keeps emitting IR rays continuously onto the photodiode in a straight line.

When the IR rays are blocked then the circuit will be connected to positive supply and produce an alert sound through the buzzer and the LED will light up .

By varying the resistances and capacitance values, we get different levels of audible sound from the buzzer.

The circuit has two stages , firstly being an IR emitter and IR receiver stage

Secondly being astable multi vibrator timer circuit , Here the timer circuit reset pin is accessed by the IR stage and hence the multivibrator oscillates when the IR rays are blocked.

When the IR sensor detects radiation, it triggers the 555 timer , which in turn activates a buzzer and an LED to signal the presence of an intruder.

The circuit can be easily built using a breadboard or a PCB (printed circuit board) and the circuit is powered using a 12V DC supply.

For the power supply circuit, we use a 9V transformer and a 7812-voltage regulator IC that works by first stepping down the AC voltage from the transformer, rectifying and filtering the voltage to produce a stable DC voltage, and then regulating the DC voltage to the desired output voltage using the 7812 IC. The circuit provides a stable and reliable 12V DC output that can be used to power a variety of electronic devices.

Applications:

- These IR based security alarms can be installed in homes to protect against burglary and unauthorised access.These systems use infrared motion sensors to detect any movement within the protected area.When an intruder is detected, the alarm is triggered, alerting the occupants and potentially deterring the intruder.

- Businesses and commercial establishments can benefit from IR based security alarms to safeguard their premises.

- IR based security alarms can be used along the perimeter of properties to create a security barrier.

- These alarms can be used to secure outdoor areas, such as gardens, driveways and parking lots.outdoor motion sensors equipped with infrared technology can detect any movement within their range and trigger alarms to deter trespassers or potential threats.

- These can be installed in warehouses and industrial facilities to protect valuable assets and monitor restricted areas.

- It can be used in temporary or mobile setups, such as construction sites, outdoor events or temporary storage areas.

- This can also be employed to protect vehicles from theft or unauthorised entry.

FUTURE SCOPE:

The IR based security alarm project has significant future scope, as it can be improved and expanded in several ways. Some of the possible future developments are:

- **Enhanced Detection Capabilities**: Future IR- based security alarms may incorporate advanced sensors and algorithms to improve detection accuracy. which involves the development of multi-spectrum sensors that can detect a wider range of IR wavelengths.
- **Integration with IoT and home automation**: IR based security alarms could be integrated into smart home automation systems using the internet of things. This integration would allow users to monitor and control the security system remotely using their smartphone.
- **Advanced analytics and predictive capabilities**: By analysing historical data and patterns, the system could develop predictive capabilities, such as identifying potential threats or suspicious behaviour before an actual intrusion occurs.
- **Integration with other sensors**: These security alarms can be integrated with other types of sensors to provide comprehensive security coverage. For example, combining IR sensors with video surveillance cameras could offer both motion detection and visual evidence of the event.
- **Energy efficiency and sustainability**: This could involve the development of low power sensors and systems that consume less energy while maintaining reliable performance.
- **Smart AI Assisted features**: Future IR based security alarms may incorporate smart features such as facial recognition or behaviour analysis.

It is important to note that these future scopes are speculative and based on current technology trends. The actual development of IR based security alarms will depend on various factors, including market demands, technological breakthroughs and regulatory considerations.

Cost (in rupees):

IR Based Security Circuit

NAME OF COMPONENT	QUANTITY	PRICE
Timer IC NE555	1	8.5/-
10k Ohm Potentiometer	1	35/-
Transistor BC547	1	2/-
Green LED	1	10/-
Photo Diode	1	10/-
IR LED	1	15/-
Resistors ● 150k Ohm ● 1k Ohm ● 220 Ohm ● 10k Ohm	 1 1 1 1	 4/- 2/- 2/- 2/-
Capacitors ● 0.01µF ● 0.1µF	 2 1	 10/- 5/-

Power Supply Circuit

NAME OF COMPONENT	QUANTITY	PRICE
L7812CV Voltage Regulator	1	10/-
Transformer 0 to 9V	1	129/-
IN4007 Diode	4	4/-
Capacitors ● 1000µF ● 1µF	 1 1	 15/- 5/-

Limitations and issues faced:

As with any project, there are always limitations and issues that arise during the process. Here are some limitations and issues that may be faced while doing the IR based security alarm project.

- **Component availability**: this is one of the main limitations of this project which is availability of components. Some components, such as 555 timer IC , may not be readily available in certain regions. This can make it difficult to source the necessary parts for the project.
- **Power supply**: The project requires a stable DC power supply, which can be obtained in certain regions. This may require additional components for making our own power supply.
- **False alarms**: primary challenge is minimising false alarms triggered by environmental factors like sunlight, changes in temperature. or movement of objects like curtains. Calibrating the system to differentiate between genuine threats and false triggers can be complex and require careful adjustments.
- **Range and coverage**: IR sensors have a limited range and field of view, which can pose challenges in achieving sufficient coverage for large areas. Ensuring adequate detection range and minimising blind spots may require strategic placement of sensors.
- **Environment factors**: environmental conditions, such as extreme temperatures, humidity,dust or moisture can impact the performance and durability of IR sensors.
- **Cost constraints**: Budget limitations can also present challenges during the development of an IR based security alarm project.
- **system reliability**: building a robust and reliable IR based security alarm system involves careful component selection, quality assurance, and thorough testing.
- **Integration and compatibility**: if planning to integrate the IR based security alarm with other systems or devices, compatibility issues may arise.
- **Interference**: interference from other IR sources such as other security systems, lighting systems or electronic devices can affect the accuracy and reliability of IR based security alarms.

Despite these limitations and issues, the IR based security alarm project can be a rewarding and educational project for those interested in electronics and communication. With careful planning and attention to detail, it is possible to overcome these limitations.

Alternatives:

- **IC 556:**

  The IC 556 is a dual 555 timer IC that contains two 555 timers that are separate but in a single packageIt is usually used when we want multiple timing functions for the IR based security alarm.

- **IC 4093:**

  The IC 4093 is a quad 2-input NAND Schmitt trigger IC, hence it has four separate NAND gates with Schmitt trigger inputs.

Why IC 555 is preferred over the other alternatives:

- **IC 556:**

  Simplicity: The IC 555 is a single timer IC, but the IC 556 is a dual timer IC. When a single timer is needed, IC 555 serves as a better option as it simplifies the circuit design and reduces components needed as the unused timers will be eliminated .

  Availability and Cost: IC 555 can be found anywhere because it is so commonly used. IC 555 is also much cheaper than IC 565.

  Flexibility: The IC 555 can be easily used in different operating modes such as monostable or astable so that it provides you with the desired timing characteristics that the alarm needs.

  While the IC 556 is pretty useful where multiple timing functions are required, for most IR based security alarm applications, the simplicity, availability, cost, and flexibility makes it more of a preferred choice.

- **IC 4093:**

  Output Capability: IC 555 provides a higher output current compared to IC 4093. The reason why this is desired is so when we need to drive external devices such as relays or sirens, they could potentially need more current to operate efficiently. We can have a direct interface instead of using an additional circuitry such as a buffer.

  Wide Operating Voltage Range: The IC 555 typically operates over a wide voltage range, usually around 4.5V-16V. Hence we can work with many different power supply configurations according to the different circuit requirements. In contrast, the IC 4093 has more of a limited voltage range.

  Timing Functionality: The IC 555 can be easily used as a monostable or astable multivibrator. So there is a very precise timing control and you can set the duration and frequency of the alarm signal.

  The IC 4093 has its own advantages, such as the Schmitt trigger inputs being included for a better noise immunity, the IC 555's timing functionality, output capability, and wide operating voltage range makes it a preferred choice for the IR based security alarms.

Conclusion:

The IR-based security alarm using IC555 provides a cost-effective solution for detecting the presence of objects and generating an alarm. The 555 timer chip acts as an oscillator to generate a continuous tone or beep sound. An LED is also used to provide a visual indicator of the alarm activation.

The combination of a buzzer and an LED provides a dual warning system, which can help to ensure that the alarm is noticed even if occupants are in a different room or cannot hear the alarm sound. The system is relatively easy to construct and can be designed to be battery-powered or AC-powered, depending on the requirements of the application.

While the effectiveness of the system depends on the quality of the sensors and the design of the circuit, a properly designed security alarm system using a 555 timer chip can provide an effective early warning system, deter burglars, and reduce the risk of theft and property damage.

Overall, a security alarm system using a 555 timer chip is a valuable addition to any comprehensive security strategy. The simplicity of the circuit design, along with the versatility of the IC555, makes this project suitable for hobbyists, students, and electronics enthusiasts.

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