Intrusion Detection System

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Abstract:

“Civilization is the progress toward a society of privacy. The savage's whole existence is public, ruled by the laws of his tribe. Civilization is the process of setting man free from men.” – Ayn Rand

In a world where information doubles itself every few years, technology that outgrows itself every minute, it is essential that we should be able to negate the ill effects of the very same technology we created. Security and privacy have been severely hit by the developments in technology and have now become some of the major concerns of our modern lifestyles. Hundreds and thousands of rupees is spent on securing our homes, offices, banks, hospitals, schools etc.

Throughout this project, we would like to enunciate the designing, modeling, construction and working of an Intrusion Detection System. The entire system can be constructed using basic engineering applications and can find wide variety of applications in domestic and low level to medium level commercial applications. The underlying principle behind the project is the usage of an infrared transmitter and an infrared receiver. Using several ICs and relays as a part of the circuit, we can successfully design the system.

Key words: infrared receiver, infrared transmitter, IC 7805, IC 7809, 555 timer, relays, resistances and capacitances, camera, light, 9 V battery supply, 12 V adaptor, infrared modules for detection.

INTRODUCTION

The entire Intrusion Detection System can be broken down to three major components

1. The Transmitter Circuit: As shown in the circuit diagram, this circuit uses the operation of the 555 timer and another 7805 IC along with resistors and capacitors in corresponding circuit to produce an infrared beam through an IR lead. The IR lead is powered using a 9 V battery.

2. The Receiver Circuit: This consists of an IR detection module, which in turn is made up of an IR receiver powered using a 12 V adaptor. The IC nos are 7805 and 7809.

3. The Triggering Circuit: This circuit gets initiated when the infrared beam is cut. It consists of 4 relays, two of which are in series with the timers. The remaining two relays are connected to the camera and the light respectively. It is preferred that we use the web cam here because it can be easily powered using a computer or a laptop. Among the two Timer ICs, one is connected to the Alarm and the other is connected to the Mobile phone.

To understand the working of the system on the whole, we have to understand the workings of individual components and individual circuits.

Working of the Intrusion Detector: When the intrusion detector is under normal circumstances, the receiver is receiving the IR rays. Please refer to the circuit diagram where the receiver V_in and Ground are connected using a 100 microfarad capacitor thereby completing the circuit. The moment the circuit is broken by a foreign intrusion, the alarm, mobile phone, light and camera are triggered. Once these components are switched on, they can’t be switched off till reset.

Therefore, we have successfully designed an Intrusion Detection System using simple engineering applications and tools.
Circuit Diagram indicating
1. The transmitter circuit,
2. Receiver circuit
3. Triggering circuit.

Pin diagrams of
1. TSOP1738
2. GP1UW
3. IC7805

Suggested Arrangement for Proximity Detector:
1. The Transmitter Circuit:

The chief operating component of the transmitter circuit is the 555 timer. To understand the working of the transmitter circuit, we need to have a thorough understanding of the 555 timer.

Pin Diagram of the 555 timer:

The 555 timer can be used in three modes

a) Astable Mode: This is the free running mode where the timer operates as an oscillator. It is used in LEDs, Pulse Generation, Logic Clocks etc.

b) Monostable Mode: This is the 'one shot' mode of the timer. It is involved in applications like the timers, missing pulse detection, touch switches, frequency divider etc.

c) Bistable or Schmitt Trigger: In this mode, the timer can be used as a flip-flop.

Use of 555 timer in the detection system:

Referring to the above diagram and to the main circuit diagram we extrapolate the working of the 555 timer. To make the 555 work, a trigger pulse at pin 2 initially sets the 555's internal flip-flop 'on'. It does so by comparing the input pulse to 1/3 of the supply power to a second comparator. This turns off the transistor across the timing capacitor and allows the timing capacitor to start the charge cycle. The 555 stays 'on' until this timing cycle turns it 'off' again by resetting the control flip-flop.

The timing cycle can be made to start over again by applying a pulse to pin 4 (reset). This turns on the transistor that discharges the timing capacitor, and so delaying the charge from reaching 2/3 \( V_{cc} \).

In some applications, the reset (pin 4) is connected to the trigger input (pin 2) so that each new input trigger signal restarts the timing cycle.

When the threshold at pin 2 drops, at the end of a timing cycle, that voltage drop can be used to start a new timing cycle right away by connecting pin 6 (threshold) to pin 2, the trigger input. This type of system is called an "astable free running oscillator" and is the most common one. If you look at a variety of diagrams where a 555 is used you notice that in most cases pins 2 and 6 are connected.

The 555’s output circuit includes two high current transistors, each capable of handling at least 200mA. One transistor is connected between the output pin 3 and \( V_{cc} \), and the other between pin 3 and ground. This way you can use the output pin 3 to either supply \( V_{cc} \) to your load (source) or provide a ground for your load (sink). If you have heard mentioning about 'sink' or 'source' this is exactly what it means. This tester will flash the LED's alternately with good 555 under test, because both LED's are driven from the single output pin 3 because of the way the 555 is designed. What an awesome chip!

Reasons for using 555 timer:

555 timer was preferred because it is easily available and is very cheap. It has been in use for several decades and the literature for its understanding and usage is abundantly available.

Resistors:

Resistors, like diodes and relays, are another of the electronic parts that should have a section in the installer's parts bin. They have become a necessity for the mobile electronics installer, whether it be for door locks, parking lights, timing circuits, remote starts, LED's, or just to discharge a stiffening capacitor.

Resistors "resist" the flow of electrical current. The higher the value of resistance (measured in ohms) the lower the current will be.

Several resistors are required throughout the experiment. These resistors are identified using the color-coding techniques, which are explained hereunder:
To read the color code of a common 4-band 1K-ohm resistor with a 5% tolerance, start at the opposite side of the GOLD tolerance band and read from left to right. Write down the corresponding number from the color chart below for the 1st color band (BROWN). To the right of that number, write the corresponding number for the 2nd band (BLACK). Now multiply that number (you should have 10) by the corresponding multiplier number of the 3rd band (RED) (100). Your answer will be 1000 or 1K.

If a resistor has 5 color bands, write the corresponding number of the 3rd band to the right of the 2nd before you multiply by the corresponding multiplier number of the multiplier band. If you only have 4 color bands that include a tolerance band, ignore this column and go straight to the multiplier.

The tolerance band is usually gold or silver, but some may have none. Because resistors are not the exact value as indicated by the color bands, manufacturers have included a tolerance color band to indicate the accuracy of the resistor. Gold band indicates the resistor is within 5% of what is indicated. Silver = 10% and None = 20%. Others are shown in the chart below. The 1K-ohm resistor in the example (left) may have an actual measurement anywhere from 950 ohms to 1050 ohms.

If a resistor does not have a tolerance band, start from the band closest to a lead. This will be the 1st band. If you are unable to read the color bands, then the multimeter is used.

Capacitors:

Usage of Capacitors in alternating current:

The capacitor's function is to store electricity, or electrical energy. The capacitor also functions as a filter, passing alternating current (AC), and blocking direct current (DC). This symbol —[ ]— is used to indicate a capacitor in a circuit diagram.

The capacitor is constructed with two electrode
plates facing each other, but separated by an insulator.

When DC voltage is applied to the capacitor, an electric charge is stored on each electrode. While the capacitor is charging up, current flows. The current will stop flowing when the capacitor has fully charged.

When a circuit tester, such as an analog meter set to measure resistance, is connected to a 10 microfarad (µF) electrolytic capacitor, a current will flow, but only for a moment. You can confirm that the meter's needle moves off of zero, but returns to zero right away. When you connect the meter's probes to the capacitor in reverse, you will note that current once again flows for a moment. Once again when the capacitor has fully charged, the, current stops flowing. So the capacitor can be used as a filter that blocks DC current. However, in the case of alternating current, the current will be allowed to pass. Alternating current is similar to repeatedly switching the test meter's probes back and forth on the capacitor. The value of a capacitor (the capacitance) is designated in units called the Farad (F). The capacitance of a capacitor is generally very small, so units such as the microfarad (10⁻⁶ F), Nano-farad (10⁻⁹ F), and Pico-farad (10⁻¹² F) are used.

Recently, a new capacitor with very high capacitance has been developed. The Electric Double Layer capacitor has capacitance designated in Farad units. These are known as "Super Capacitors."

Sometimes, a three-digit code is used to indicate the value of a capacitor. There are two ways in which the capacitance can be written. One uses letters and numbers, the other uses only numbers. In either case, there are only three characters used. [10n] and [103] denote the same value of capacitance. The method used differs depending on the capacitor supplier. In the case that the value is displayed with the three-digit code, the 1st and 2nd digits from the left show the 1st figure and the 2nd figure, and the 3rd digit is a multiplier which determines how many zeros are to be added to the capacitance. Pico farad ( pF ) units are written this way.

For example, when the code is [103], it indicates 10 x 10³, or 10,000pF = 10 nano farad ( nF ) = 0.01 microfarad ( µF ).

If the code happened to be [224], it would be 22 x 10⁴ = or 220,000pF = 220nF = 0.22µF. Values under 100pF are displayed with 2 digits only. For example, 47 would be 47pF.

The capacitor has an insulator( the dielectric ) between 2 sheets of electrodes. Different kinds of capacitors use different materials for the dielectric.

Breakdown voltage: When using a capacitor, you must pay attention to the maximum voltage, which can be used. This is the "breakdown voltage." The breakdown voltage depends on the kind of capacitor being used. You must be especially careful with electrolytic capacitors because the breakdown voltage is comparatively low. The breakdown voltage of electrolytic capacitors is displayed as Working Voltage.

The breakdown voltage is the voltage that when exceeded will cause the dielectric (insulator) inside the capacitor to break down and conduct. When this happens, the failure can be catastrophic.

Aluminum is used for the electrodes by using a thin oxidation membrane. Large values of capacitance can be obtained in comparison with the size of the capacitor, because the dielectric used is very thin. The most important characteristic of electrolytic capacitors is that they have polarity. They have a positive and a negative electrode.[Polarized] This means that it is very important which way round they are connected. If the capacitor is subjected to voltage exceeding its working voltage, or if it is connected with incorrect polarity, it may burst. It is extremely dangerous, because it can quite literally explode. Make absolutely no mistakes. Generally, in the circuit diagram, the positive side is indicated by a "+" (plus) symbol. Electrolytic capacitors range in value from about 1µF to thousands of µF. Mainly this type of capacitor is used as a ripple filter in a power supply circuit, or as a filter to bypass low frequency signals, etc. Because this type of capacitor is comparatively similar to the nature of a coil in construction, it isn't possible to use for high-frequency circuits. (It is said that the frequency characteristic is bad.)
The photograph is an example of the different values of electrolytic capacitors in which the capacitance and voltage differ. From left to right:

- 1µF (50V) [diameter 5 mm, high 12 mm]
- 47µF (16V) [diameter 6 mm, high 5 mm]
- 100µF (25V) [diameter 5 mm, high 11 mm]
- 220µF (25V) [diameter 8 mm, high 12 mm]
- 1000µF (50V) [diameter 18 mm, high 40 mm]

The size of the capacitor sometimes depends on the manufacturer. So the sizes shown here on this page are just examples.

Receiver and Alarm Triggering Circuits:

Apart from the 555 timers and the detection modules for infrared, relays form an integral part of the project. Therefore, we devote some space to their study and their usage in our experiment hereunder:

Relays:

A relay is an **electrically operated switch**. Current flowing through the coil of the relay creates a magnetic field, which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are **double throw (changeover)** switches.

Purpose of using a relay:

Relays allow one circuit to switch a second circuit, which can be completely separate from the first.

For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a **transistor** is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. For further information about switch contacts and the terms used to describe them please see the page on switches.

Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay.

The supplier's catalogue should show you the relay's connections. The coil will be obvious and it may be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage you must connect a **protection diode** across the relay coil.

The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

**Relays and transistors compared**

Like relays, transistors can be used as an electrically operated switch. For switching small DC currents (< 1A) at low voltage they are usually a better choice than a relay. However transistors cannot switch AC or high voltages (such as mains electricity) and they are not usually a good choice for switching large currents (> 5A). In these cases a relay will be needed, but note that a low power transistor may still be needed to switch the current.
for the relay’s coil! The main advantages and disadvantages of relays are listed below:

**Advantages of relays:**

- Relays can switch **AC and DC**, transistors can only switch DC.
- Relays can switch **high voltages**, transistors cannot.
- Relays are a better choice for switching **large currents** (> 5A).
- Relays can switch **many contacts** at once.

**Disadvantages of relays:**

- Relays are **bulkier** than transistors for switching small currents.
- Relays **cannot switch rapidly** (except reed relays), transistors can switch many times per second.
- Relays **use more power** due to the current flowing through their coil.
- Relays **require more current than many ICs can provide**, so a low power transistor may be needed to switch the current for the relay's coil.

Usage in the experiment:

The four relays are used as follows:

1. Relay No 1 is in series with a 555 timer.
2. Relay No 2 is also in series with another 555 timer.
3. Relay No 3 is connected to the camera.
4. Relay No 4 is connected to the lights.

Receiving Circuit ICs:

One of the ICs is connected to the alarm and the other might be connected to call up a mobile program using a simple application.

Conclusion:

Thus, we have proposed a working model of an intrusion alarm. We have improvised in several ways from the regular burglar alarm.

Applications:

Burglar (or intrusion), fire and safety alarms are all electronic today. Sensors are connected to a control unit via a low-voltage hardwire or narrowband RF signal which is used to interact with a response device. The most common security sensors indicate the opening of a door or window or detect motion via passive infrared (PIR). New construction systems are predominately hardwired for economy. Retrofit installations often use wireless systems for a more economical and quicker install. Some systems serve a single purpose of burglary or fire protection. Combination systems provide both fire and intrusion protection. Sophistication ranges from small, self-contained noisemakers, to complicated, multi-zoned systems with color-coded computer monitor outputs. Many of these concepts also apply to portable alarms for protecting cars, trucks or other vehicles.