Intruder Alert System Using Motion Sensors and GSM Module

A REPORT

on

B. Tech 4th semester Mini Project-I (EE2291)

By

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DECLARATION BY THE CANDIDATES

We certify that to the best of my knowledge
i) The work contained in the report has been done by ourselves.

ii) We have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.

iii) Whenever we have used materials (data, theoretical analysis and text) from other sources, we have given due credit to them by citing them in the text of the report and giving their details in the references.

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We would like to express our sincere gratitude to the following individuals and entities for their invaluable contributions to the successful completion of our mini-project, " Intruder Alert System Using Motion Sensors and GSM Module”

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We would also like to acknowledge the vast online community of Arduino enthusiasts. Their tutorials, forums, and code libraries proved to be invaluable resources during the development process. We learned a great deal from their experiences and contributions, and we are grateful for their willingness to share their knowledge with others.

Finally, we would like to thank the creators and contributors of the various online resources that we consulted throughout this project. These resources provided us with the necessary knowledge and understanding of the components and concepts involved, which enabled us to design and build the night light successfully.

Abstract of the report

This report explores the design and implementation of a cost-effective and user-friendly intruder alert system for residential or commercial security applications. The system hinges on the combined functionalities of passive infrared (PIR) sensors and a GSM module to provide real-time notification of potential security breaches. PIR sensors, adept at detecting changes in infrared radiation emitted by objects with varying temperatures, effectively identify unauthorized movement within a designated area. Upon detecting motion in an armed state, the system transitions into action.

A microcontroller unit (MCU) serves as the system's central processing unit. It continuously monitors sensor data from the PIR sensors and executes pre-programmed functionalities based on the system's armed/disarmed state. If motion is detected during armed mode, the MCU initiates a two-pronged response. First, it triggers an audible alarm, typically a buzzer or siren, to deter intruders and alert occupants on the premises. Simultaneously, the MCU establishes communication with the GSM module.

The GSM module, equipped with a SIM card, acts as a cellular modem, enabling the system to transmit alerts beyond the physical location. The MCU transmits pre-programmed instructions via AT commands, instructing the GSM module to send SMS notifications to designated phone numbers. These SMS alerts typically convey a message indicating a potential intrusion and may even specify the sensor that triggered the alarm, providing valuable location context.

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SL NO.	Product	Cost
1.	Arduino	260
2.	Bread Board	50
3.	PIR sensor	50
4.	Relay	30
5.	Jumper wire	30
6.	Battery	20
7.	LED Bulb	15
8.	Buzzer	10
9.	GSM Modulo	180

Total Cost: Rs.625

Introduction

The prevalence of property crimes necessitates robust security measures for homes, offices, and other sensitive locations. Intruder alert systems play a crucial role in deterring unauthorized entry and alerting occupants of potential threats. This report presents a cost-effective and user-friendly intruder alert system employing motion sensors and a GSM module.

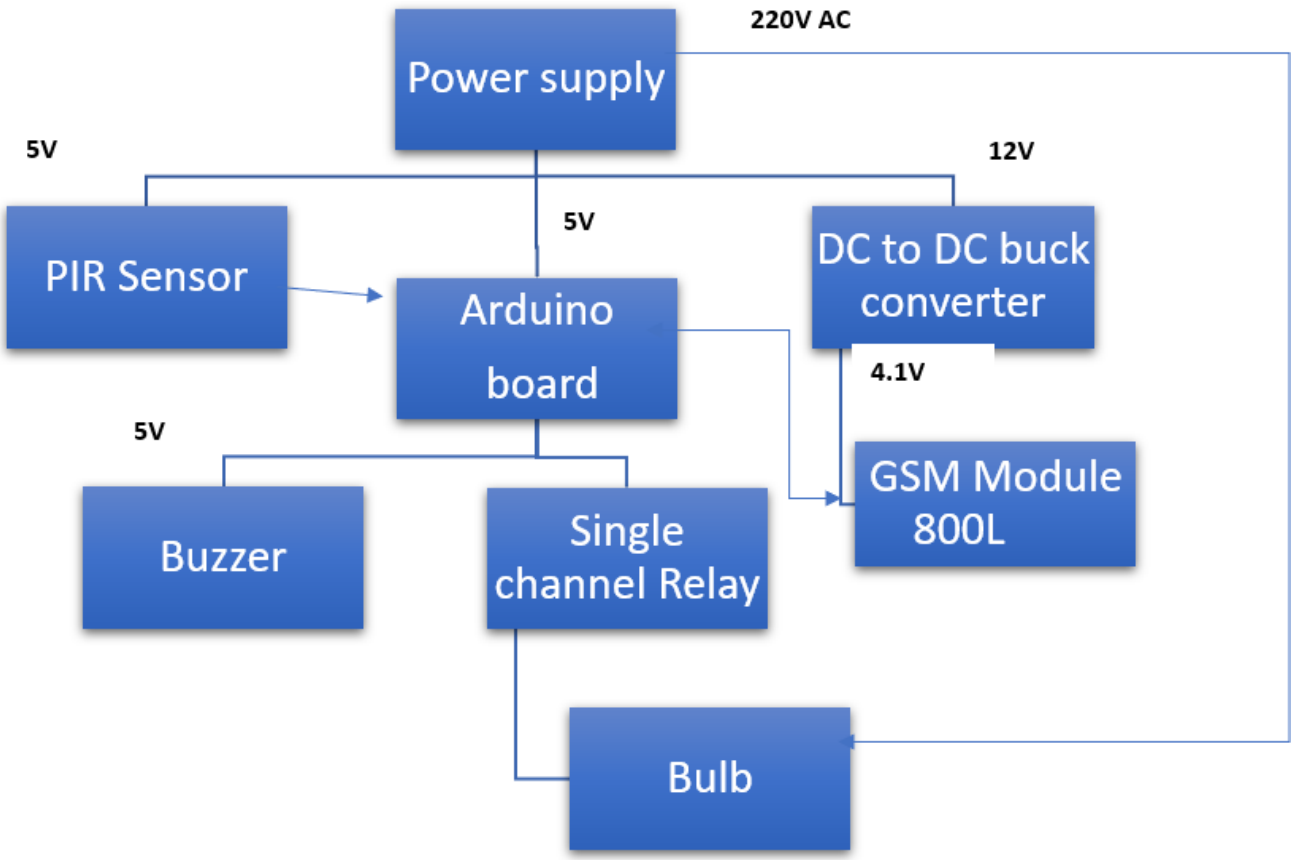
The system operates by deploying passive infrared (PIR) sensors, which detect changes in infrared radiation emitted by objects with varying temperatures, including humans. Upon detecting motion within its designated range, the PIR sensor transmits a signal to the microcontroller unit (MCU). The MCU, acting as the system's brain, processes the sensor data. If motion is detected during an armed state, the MCU triggers an alarm (local buzzer or siren) and initiates communication with the GSM module.

The GSM module, equipped with a SIM card, functions as a cellular modem. The MCU transmits pre-programmed instructions via AT commands, instructing the GSM module to send SMS alerts to pre-defined phone numbers. These SMS notifications typically include a message indicating a potential intrusion and may even specify the sensor that triggered the alarm.

List Of Apparatus

- Microcontroller Unit (MCU): Arduino Uno
- Passive Infrared (PIR) Sensor: Detects changes in infrared radiation, triggering an alert upon detecting motion.
- GSM Module: (SIM800L) - Cellular modem that transmits SMS alerts via a SIM card.
- Breadboard: Temporary platform for prototyping and circuit construction.
- Jumper Wires: Electrical wires for connecting components on the breadboard.
- Resistors: Electrical components that regulate current flow.
- Buzzer/Siren: Audible alarm to deter intruders and alert occupants.
- LED: Light-emitting diode for visual indication of system status.
- Power Supply: Provides regulated voltage to power the system components.
- SIM Card: Enables cellular communication through the GSM module.

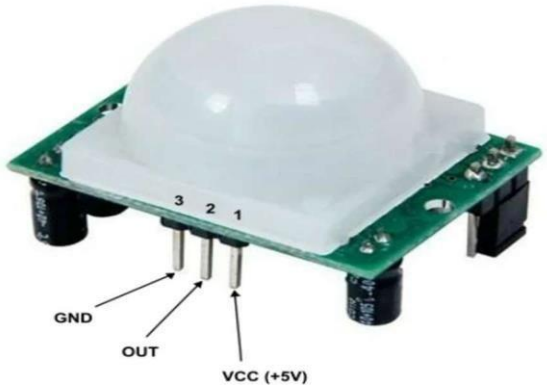
Block Schematic Diagram



Passive Infrared Sensor

What is a PIR Sensor?

A passive infrared sensor is an electronic sensor that measures infrared light radiating from objects. PIR sensors mostly used in PIR-based motion detectors. Also, it used in security alarms and automatic lighting applications. The below image shows a typical pin configuration of the PIR sensor, which is quite simple to understand the pinouts. The PIR sensor consists of 3 pins.



(fig-1 PIR sensor)

- Pin1 corresponds to the drain terminal of the device, which connected to the positive supply 5V DC.
- Pin2 corresponds to the source terminal of the device, which connects to the ground terminal via a 100K or 47K resistor. The Pin2 is the output pin of the sensor. The pin 2 of the sensor carries the detected IR signal to an amplifier from the
- Pin3 of the sensor connected to the ground

PIR Sensor Working Principle:

The passive infrared sensor does not radiate energy to space. It receives the infrared radiation from the human body to make an alarm. Any object with temperature is constantly radiating infrared rays to the outside world. The surface temperature of the human body is between 36° C - 27 ° C and most of its radiant energy concentrated in the wavelength range of 8 um-12 um.

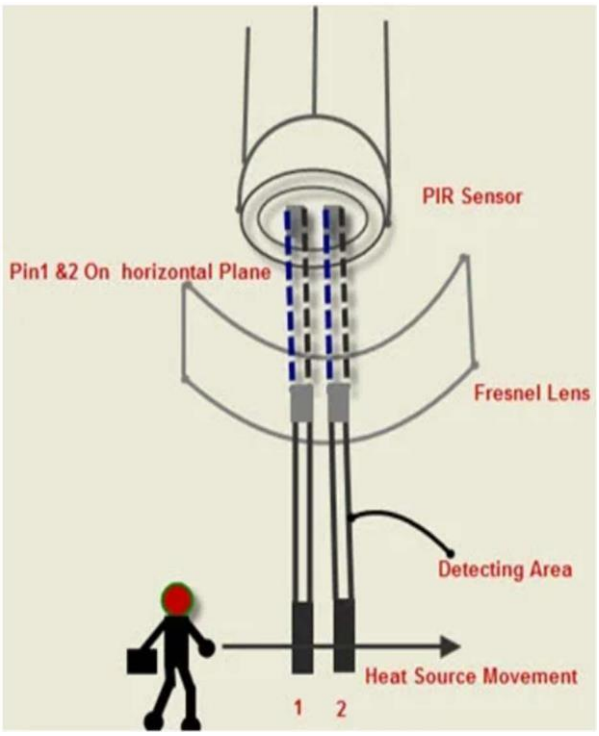


Fig-2: Working procedure of PIR

Passive infrared alarms classified into **infrared detectors** (infrared probes) and alarm control sections. The most widely used infrared detector is a pyroelectric detector. It uses as a sensor for converting human infrared radiation into electricity. If the human infrared radiation is directly irradiated on the detector, it will, of course, cause a temperature change to output a signal. But in doing all this, the detection distance will not be more. In order to lengthen the detection distance of the detector, an optical system must be added to collect the infrared radiation. Usually, plastic optical reflection

system or plastic **Fresnel lens** used as a focusing system for infrared radiation

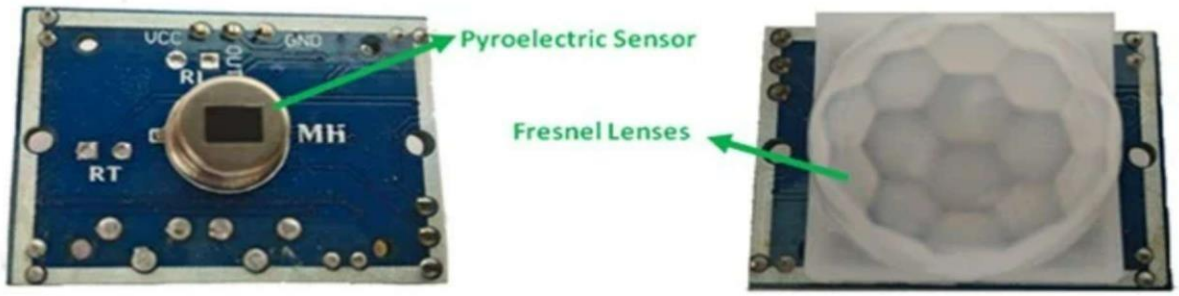


Fig-3: pyroelectric sensor and Fresnel Lenses

In the detection area, the lens of the detector receives the infrared radiation energy of the humanbody through the clothing and focused on the pyroelectric sensor. When the human body moves in this surveillance mode, it enters a certain field of view in sequence and then walks out of the field of view. The **pyroelectric sensor** sees the moving human body for a while and then does not see it, so the infrared radiation of human body constantly changes the temperature of the pyroelectric material. So that it outputs a corresponding signal, which is the alarm signal.

What is the Range of PIR Sensor?

- Indoor passive infrared: Detection distances range from 25 cm to20

m.

- Indoor curtain type: The detection distance ranges from 25 cm to20 m.
- Outdoor passive infrared: The detection distance ranges from 10 meters to 150 meters.
- Outdoor passive infrared curtain detector: distance from 10 meters to 150 meters

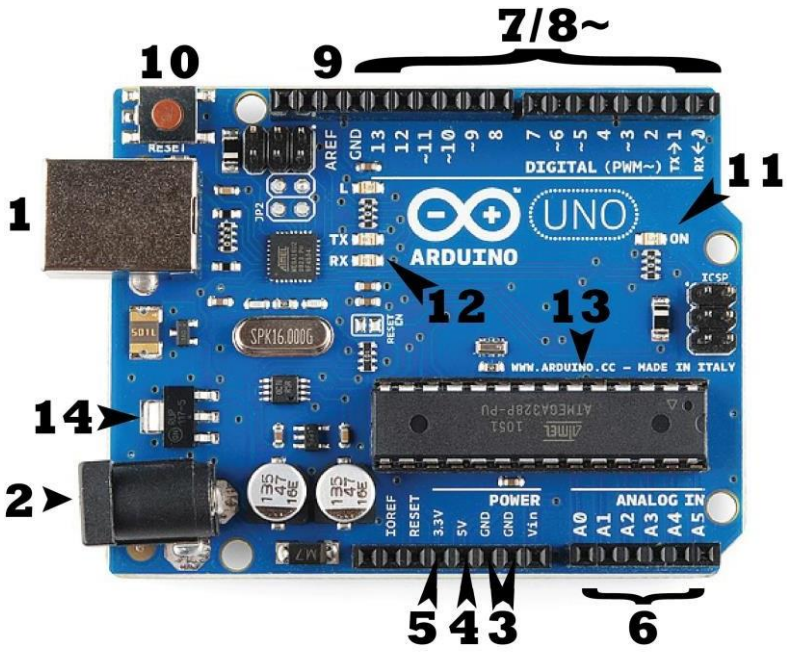
Arduino

An Arduino is a microcontroller-based kit which can be either used directly by purchasing from the vendor or can be made at home using the components, owing to its open-source hardware feature. It is basically used in communications and in controlling or operating many devices. It was founded by Massimo Banzi and DavidCuartielles in 2005.

Fig-4 Arduino UNO

What is on the board?

There are many varieties of Arduino boards that can be used for different purposes.Some boards look a bit different from the one below, but most Arduinos have the majority of these components in common:



(fig-5: Components of Arduino)

Power (USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply that is terminated in a barrel jack. In the picture above the USB connection is labeled **(1)** and the barrel jack is labeled **(2)**.

The USB connection is also how we will load code onto our Arduino board.

NOTE: Do NOT use a power supply greater than 20 Volts as you will overpower (and thereby destroy) your Arduino. The recommended voltage for most Arduino models is between 6 and 12 Volts.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are the places where you connect wires to construct a circuit (probably in conjunction with a breadboard and some wire. They usually have black plastic ‘headers’ that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.

- **GND (3)**: Short for ‘Ground’. There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- **5V (4) & 3.3V (5)**: As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.
- **Analog (6)**: The area of pins under the ‘Analog In’ label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.
- **Digital (7)**: Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).
- **PWM (8)**: You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM).
- **AREF (9)**: Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Reset Button

Arduino has a reset button **(10)**. Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if your code doesn’t repeat, but you want to test it multiple times.

Power LED Indicator

Just beneath and to the right of the word “UNO” on your circuit board, there’s a tiny LED next to the word ‘ON’ **(11)**. This LED should light up whenever you plug your Arduino into a power source. If this light doesn’t turn on, there’s a good chance something is wrong.

TX RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs **(12)**. These LEDs will give us some nice visual indications whenever our Arduino

is receiving or transmitting data (like when we're loading a new program onto the board).

Main IC

The black thing with all the metal legs is an IC, or Integrated Circuit **(13)**. Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the ATmega line of IC's from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the top side of the IC.

Voltage Regulator

The voltage regulator **(14)** is not actually something you can (or should) interact with on the Arduino. The voltage regulator controls the amount of voltage that is let into the Arduino board. It will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so do not hook up your Arduino to anything greater than 20 volts.

Working Principle of Arduino:

The Arduino platform provides a simple and accessible way for anyone to create electronic projects and interact with the physical world. At its heart is a small programmable computer called a microcontroller. This microcontroller is the brains of the Arduino and is responsible for executing the instructions you provide.

Here is a breakdown of the working principle:

1. Hardware:

- Microcontroller: The central processing unit (CPU) of the Arduino. It's responsible for fetching, decoding, and executing instructions. Models like ATmega328P, ATmega16U2, and ATmega2560 are commonly used.
- Memory: Stores instructions and data used by the microcontroller. Two types: Flash memory for storing programs, and RAM for temporary data storage.

- Input and Output (I/O) Pins: These pins allow the Arduino to interact with the outside world.
    - Digital I/O Pins: Used for digital signals, like HIGH (5V) or LOW (0V) for turning on/off LEDs or reading button presses.
    - Analog I/O Pins: Used for analog signals like voltage levels from sensors or potentiometers.
- Power Supply: Provides the necessary voltage to power the microcontroller and other components.
- Additional Components: Depending on the model, some Arduinos may have additional features like built-in LEDs, buttons, USB ports, etc.

2. Software:

- Arduino IDE (Integrated Development Environment): A software program that allows you to write code for your Arduino board. It's based on Processing and uses a simplified version of C++.
- Sketch: The code you write for your Arduino. It contains instructions for the microcontroller to follow, defining how it should process inputs and generate outputs.
- Libraries: Pre-written code that provides additional functionality to your sketch. They include libraries for working with sensors, motors, communication protocols, etc.

PIEZO SPEAKER

A piezo buzzer is a sound producing device.

The main working principle is based on the theory that, whenever an electric potential is applied across a piezoelectric material, a pressure variation is generated. A piezo buzzer consists of piezo crystals in between two conductors.

When a potential difference is applied across these crystals, they push one conductor and pull the other conductor by their internal property. The continuouspull and push action generates a sharp sound wave.

Piezo buzzers generate a loud & sharp sound. So, they are typically used as a alarm circuits. Also, they are used to make an alert of an event, signal or sensor input. A special characteristic of piezo buzzer is, the sound pitch or level is not depended on the voltage level that is, it works only in a specific voltage range.

Typically, a piezo buzzer produce can generate a sound in the range of 2 to 4 kHz

Piezo Buzzer

Schematic Symbol

(Fig-5 Piezo Buzzer and Schematic Symbol)

Working Principle of Piezo Speaker:

A piezo speaker is a type of speaker that uses the piezoelectric effect to convert electrical energy into sound. The piezoelectric effect is a property of certain materials that causes them to generate an electric charge when they are subjected to mechanicalstress (pressure or force). Conversely, when an electric field is applied to a piezoelectricmaterial, it will deform or vibrate. This is the reverse piezoelectric effect, and it is the principle that piezo speakers rely on to produce sound.

A piezo speaker typically consists of a piezoelectric disc or plate sandwiched between two metal electrodes. When an alternating voltage is applied to the electrodes, the electric field in the piezoelectric material causes it to vibrate back and forth. The frequency of the vibration is determined by the frequency of the alternating voltage. Thevibrating piezoelectric disc then couples its vibrations to the surrounding air, creating sound waves.

The efficiency of a piezo speaker depends on the material used for the piezoelectric disc. Some common materials used for piezo speakers include lead zirconate titanate(PZT), barium titanate ($BaTiO_3$), and polyvinylidene fluoride (PVDF). The size and shape of the disc also affect the sound quality. Smaller discs typically produce higher-frequency sounds, while larger discs produce lower-frequency sounds.

Piezo speakers have several advantages over other types of speakers. They are very compact and lightweight, making them ideal for portable devices. They are also very rugged and durable, and they can operate in a wide range of temperatures and humidityconditions. Additionally, piezo speakers are very efficient, and they require very little power to operate.

However, piezo speakers also have some disadvantages. They typically have a

limitedfrequency range, and they are not as loud as some other types of speakers. Additionally, the sound quality of piezo speakers can be somewhat harsh and tinny.

Overall, piezo speakers are a versatile and reliable type of speaker that is well-suited fora variety of applications. They are commonly used in electronic devices such as computers, phones, and toys. They are also used in industrial applications such as alarms, sirens, and ultrasonic transducers.

LED

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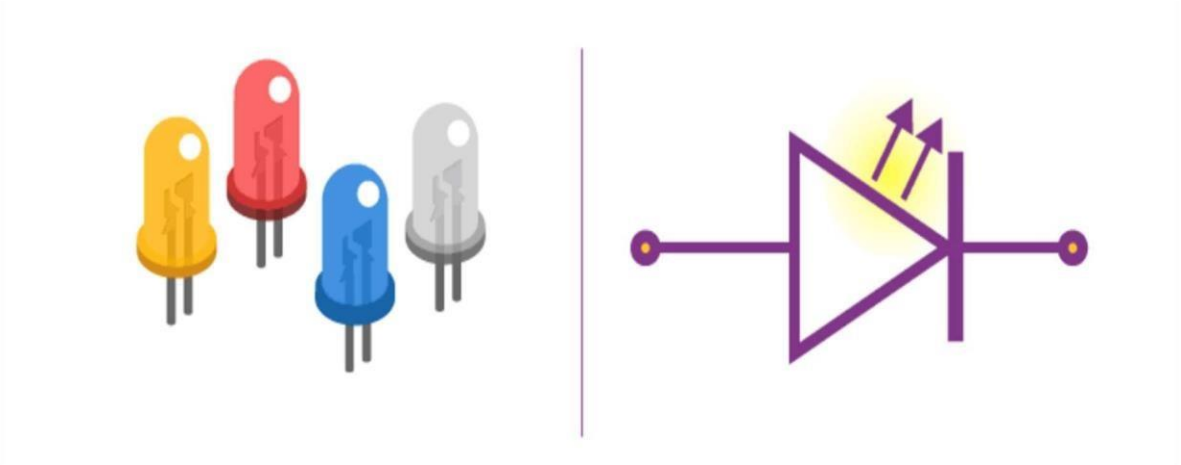
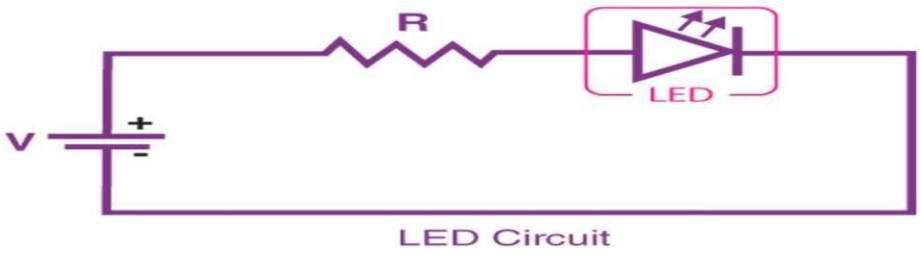
What is LED?

Light-emitting diode (LED) is a widely used standard source of light in electrical equipment. It has a wide range of applications ranging from your mobile phone to large advertising billboards. They mostly find applications in devices that show the time and display different types of data. Light-emitting diodes are heavily doped p-n junctions. Based on the semiconductor material used and the amount of doping, an LED will emit colored light at a particular spectral wavelength when forward biased. As shown in the figure, an LED is encapsulated with a transparent cover so that emitted light can come out.



(FIG-5 LED)

(**Fig-6 Led circuit)**

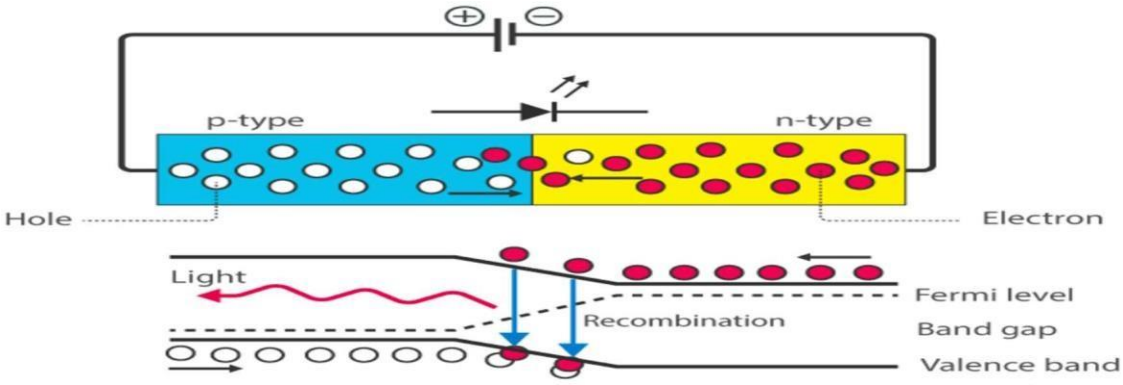


Symbol is the standard symbol for a diode, with the addition of two small arrows denoting the emission of light.

How does an LED work?

When the diode is forward biased, the minority electrons are sent from p → n while the minority holes are sent from n → p. At the junction boundary, the concentration of minority carriers increases. The excess minority carriers at the junction recombine with the majority charges carriers

The energy is released in the form of photons on recombination. In standard diodes,the energy is released in the form of heat. But in light-emitting diodes, the energy is



released in the form of photons. We call this phenomenon electroluminescence. Electroluminescence is an optical phenomenon, and electrical phenomenon where amaterial emits light in response to an electric current passed through it.

GSM Module

A GSM module, also known as a GSM modem, is a compact device that allows electronic devices to communicate over a GSM (Global System for Mobile Communications) network. The SIM800L GSM module, manufactured by SIMCom, stands as a cornerstone of cellular connectivity integration within the realm of embedded systems. This technical document delves into the intricate details of the SIM800L, empowering developers to harness its capabilities and unlock a world of possibilities for their projects.

Core Functionalities:

- **Quad-band GSM/GPRS:** The SIM800L boasts operation across four cellular network frequency bands, encompassing GSM 850/900 MHz and DCS 1800/1900 MHz. This expansive range guarantees seamless compatibility with a multitude of GSM networks around the globe.
- **Voice Calling:** Establish and receive voice calls using a repertoire of AT commands. This functionality unlocks applications such as remote communication systems and automated alert mechanisms.
- **SMS (Text Messaging):** Bidirectional communication becomes a reality with the ability to send and receive SMS messages. Leverage this feature for notifications, data logging, and basic control operations within your project.
- **GPRS (Optional):** Specific variants of the SIM800L come equipped with GPRS support, enabling your project to connect to the vast expanse of the internet. This opens doors for remote data transfer, control over long distances, and cloud-based integration.

Technical Specifications:

- **Network Type:** GSM/GPRS (quad-band)
- **Frequency Bands:** GSM850/EGSM900, DCS1800, PCS1900 MHz
- **GPRS Class:** Multi-slot class 12 (maximum throughput of 85.6 kbps)
- **SIM Card Type:** Micro SIM
- **Power Supply:** 3.4V to 4.4V DC
- **Power Consumption:** Exceptionally low, reaching as low as 1mA in sleep mode
- **Interface:** UART (TTL serial)
- **Control Mechanism:** AT Commands (adhering to 3GPP TS 27.007, 27.005 standards, along with SIMCom-enhanced commands)

- **Physical Dimensions:** Typically 17.8 x 15.8 x 2.4 mm (consult the datasheet for precise dimensions specific to your model)

Hardware Considerations:

- **Power Supply:** Deliver a regulated 3.7V power supply using a reliable Li-Po battery or a DC-DC buck converter.
- **Serial Communication:** Establish a serial communication channel between your microcontroller (e.g., Arduino) and the SIM800L, utilizing the designated TX and RX pins. Refer to the SIM800L datasheet for the exact pin assignments.
- **Antenna:** While the SIM800L typically comes with an antenna, consider employing a higher-gain antenna for enhanced signal reception in areas with weak cellular coverage.

Software Interaction (AT Commands):

The SIM800L doesn't possess its own programming language. Instead, interaction occurs through a standardized set of instructions known as AT commands. These commands are transmitted from your microcontroller to the SIM800L via the established serial communication interface. Here's a breakdown of the typical process:

1. **Initialization:** Establish serial communication between the microcontroller and the SIM800L at the appropriate baud rate (e.g., 9600 baud).
2. **Module Status Check:** Utilize AT commands to verify the operational state of the SIM800L, including its registration with the cellular network (e.g., AT+CPPS).
3. **Configuration:** Tailor settings like the SMS center number (AT+CMSC), call forwarding preferences (AT+CF), or GPRS connection parameters (AT+SAPBR) to align with your project's specific requirements.
4. **Functionality Execution:** Leverage AT commands to execute the desired actions:
    - **Making Calls:** Initiate a voice call using the ATD<phone number>; command.
    - **Sending SMS:** Transmit an SMS message with the AT+CMGS=<phone number>; command, followed by the message content.
    - **Receiving SMS:** Upon receiving an SMS, the SIM800L may notify the microcontroller using a specific AT command response (refer to the datasheet for details). You can then use AT commands to retrieve the message details.
    - **GPRS Connection (if supported):** Establish a GPRS connection for internet access using AT commands as outlined in the SIM800L datasheet.

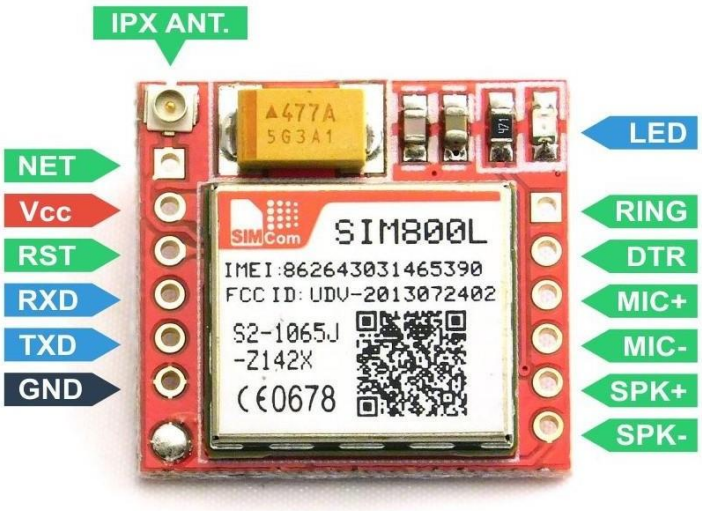


Fig 7-GSM Modulo

Working of SIM800L GSM module with Arduino:

Hardware Connection:

1. **Power Supply:** The SIM800L typically requires a regulated 3.7V power supply, often provided by a Li-Po battery with a capacity sufficient for your application's needs. You can also use a DC-DC buck converter to regulate voltage from a higher source.
2. **Ground Connection:** Connect the GND pin of the SIM800L to the GND pin of your Arduino.
3. **Serial Communication:** Establish serial communication between the SIM800L and the Arduino using TX and RX pins. The specific pins used may vary depending on your Arduino board and the SIM800L's configuration. Consult the module's datasheet for precise pin assignments.

Software Communication (AT Commands):

The SIM800L does not have its own programming language. Instead, it is controlled using a set of standardized instructions called AT commands. These commands are sent from the Arduino to the SIM800L via the serial communication interface. Here is a general flow:

1. **Initialization:** Upon startup, the Arduino code typically initializes the serial communication with the SIM800L at a specific baud rate (e.g., 9600 baud).

2. **Module Status Check:** The code might send AT commands to check the SIM800L's status, such as its registration with the cellular network (e.g., AT+CPPS).
3. **Configuration:** Based on your project's requirements, you might send AT commands to configure settings like SMS center number (AT+CMSC), call forwarding (AT+CF), or GPRS connection parameters (AT+SAPBR).
4. **Functionality:** Once configured, you can send AT commands to perform the desired actions:
    - **Making Calls:** Initiate a voice call with ATD<phone number>;.
    - **Sending SMS:** Send an SMS with AT+CMGS=<phone number>; followed by the message content.
    - **Receiving SMS:** The SIM800L might notify the Arduino upon receiving an SMS using a specific AT command response. We can then use AT commands to read the message details.

Advantages of SIM800L GSM module:

The SIM800L GSM module, manufactured by SIMCom, has become a ubiquitous choice for integrating cellular connectivity into a wide range of embedded system applications. Its combination of robust features, compact form factor, and cost-effectiveness makes it a compelling solution for developers seeking to add real-time communication capabilities to their projects. Let's delve into the key advantages that set the SIM800L apart:

1. Unmatched Versatility: A Communication Powerhouse

The SIM800L empowers your project with a comprehensive suite of communication functionalities:

- **Global Reach:** With quad-band GSM/GPRS support (GSM850/EGSM900, DCS1800, PCS1900 MHz), the SIM800L seamlessly operates on cellular networks across the globe. This ensures reliable connectivity regardless of your project's location.
- **Voice Calling:** Establish and receive voice calls using a set of AT commands. This feature opens doors for remote communication systems, automated alert mechanisms, and hands-free interaction.
- **SMS (Text Messaging):** Enable two-way communication by sending and receiving SMS messages. Utilize this capability for notifications, data logging, and basic control operations within your project.
- **GPRS Connectivity (Optional):** Specific variants of the SIM800L boast GPRS support, allowing your project to connect to the internet. This unlocks possibilities for remote data transfer, long-distance control, and cloud-based integration.

2. Compact Design and Cost-Effectiveness:

The SIM800L's small footprint makes it ideal for projects with limited space constraints. Its integration seamlessly blends into the overall design without sacrificing functionality. Additionally, the SIM800L is a remarkably cost-effective solution, making cellular connectivity accessible for a broader range of projects and budgets.

3. Straightforward Integration and Control:

The SIM800L employs a user-friendly serial communication interface (UART) for easy connection to your microcontroller. The module is controlled using a standardized set of instructions known as AT commands. This approach simplifies the integration process and minimizes the learning curve for developers.

4. Energy Efficiency:

The SIM800L excels in power efficiency. Its low power consumption extends battery life, making it suitable for battery-powered projects and applications in remote locations with limited access to power

Disadvantages of SIM800L GSM module:

While the SIM800L GSM module offers a plethora of advantages, it's essential to acknowledge its limitations to make informed decisions for your project. Here's a breakdown of the key drawbacks to consider:

1. Limited Data Speeds (GPRS):

- The SIM800L utilizes GPRS technology, known for its relatively slow data transfer rates compared to modern cellular standards like 3G or 4G. This might pose a challenge for applications requiring real-time high-bandwidth data transmission.
- GPRS typically reaches maximum speeds of around 85.6 kbps, which may be insufficient for large data transfers or streaming applications.

2. Phasing Out of 2G Networks:

- GSM, the core technology of the SIM800L, is gradually being phased out by cellular network operators in favor of more advanced technologies. This trend may lead to reduced network coverage and potential connectivity issues in the future.

- While the timeframe for complete 2G network shutdown varies by region, it's crucial to stay updated on developments in your area and consider alternative modules if long-term support is critical.

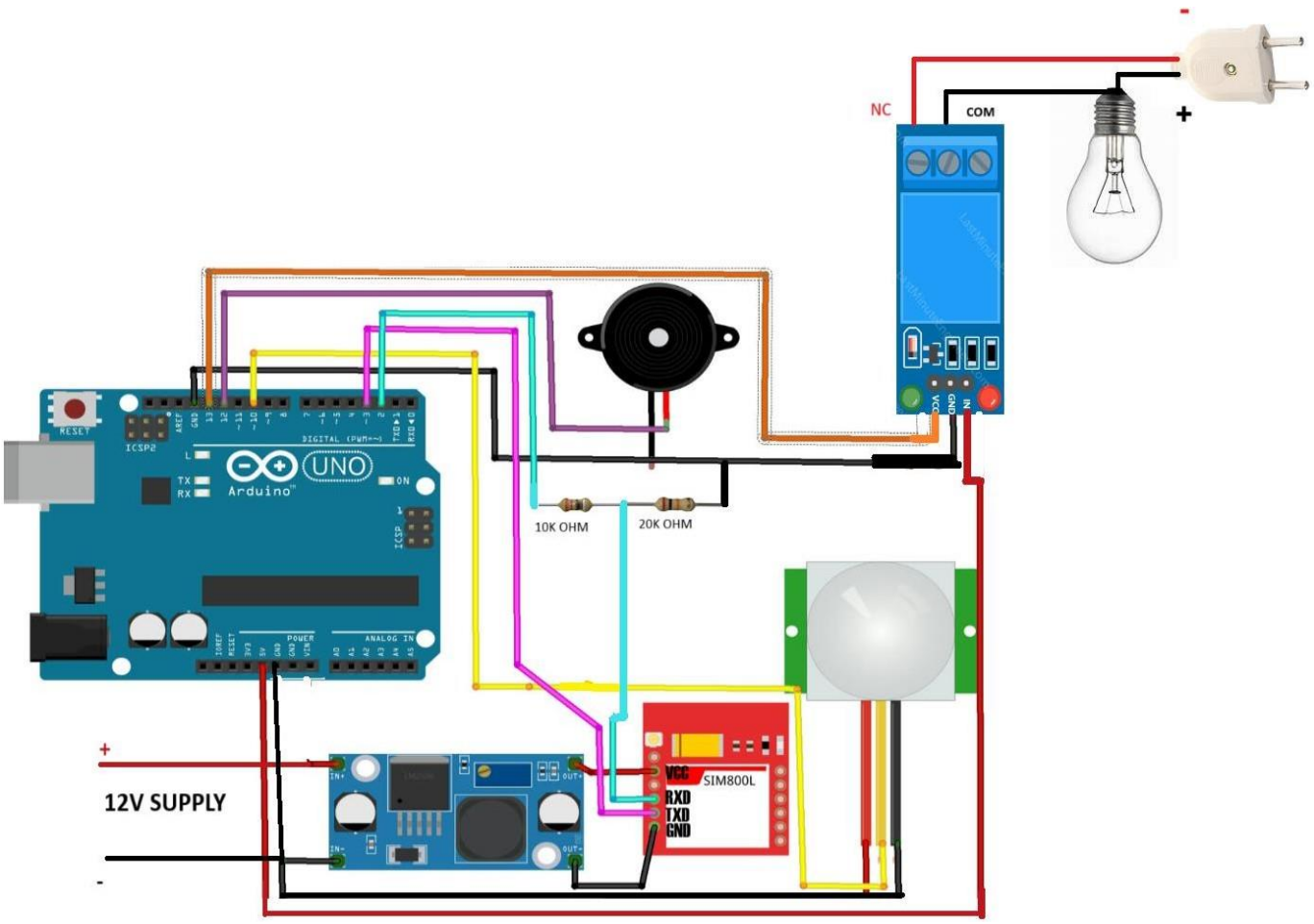
3. Limited Processing Power and Onboard Memory:

- The SIM800L is primarily designed for communication and doesn't possess extensive processing power or significant onboard memory. This can be a constraint for complex applications that require intensive data manipulation or storage capabilities.
- If your project demands advanced processing or data storage, consider modules with integrated microcontrollers or explore solutions involving separate microcontrollers for handling complex tasks.

4. Security Considerations:

- While the SIM800L offers basic security features like password protection, it's essential to implement additional security measures in your application for sensitive data transmission.
- Consider encryption techniques and secure communication protocols to safeguard your data from potential interception.

Circuit Diagram of the Project



Working Methodology

This intruder alert system operates in a series of coordinated steps, acting as an electronic watchdog that triggers alerts upon detecting unauthorized entry. Here is the breakdown of its functionality:

1. System Setup:

- **Hardware Integration:** The core components of the system include a microcontroller unit (MCU) like Arduino Uno, a passive infrared (PIR) sensor, a GSM module (SIM800C), and a power supply. These components are interconnected on a breadboard using jumper wires. Additionally, resistors are often employed to regulate current flow within the circuit. Optionally, an LED can be integrated for visual indication of system status, and a buzzer or siren can be added to sound an alarm locally.
- **Software Programming:** The MCU is programmed with specific code using an Integrated Development Environment (IDE) like Arduino IDE. This code defines the system's logic and functionalities. Key aspects of the code include:
    - Continuously reading data from the PIR sensor, which detects changes in infrared radiation caused by movement within its designated range.
    - Monitoring the system's armed/disarmed state, typically controlled by a push button switch or keypad in this basic version (future enhancements can involve mobile app integration).
    - Triggering the alarm sequence upon motion detection in armed state. This sequence might involve:
        - Activating the buzzer/siren to deter intruders and alert occupants on the premises.
        - Initiating communication with the GSM module.
    - Sending SMS alerts to pre-programmed phone numbers via the GSM module using AT commands (commands used to control the GSM module). These SMS messages typically notify the user(s) of a potential intrusion and may even specify the sensor that triggered the alarm, providing valuable location context.

2. System Operation:

- **Arming and Disarming:** The system can be switched between armed and disarmed states through a designated method. In armed mode, the MCU continuously monitors the PIR sensor for any motion detection. If the system is disarmed, the MCU ceases actively monitoring the sensor, and the alarm and notification functionalities are disabled.
- **Motion Detection and Alert Triggering:** When motion is detected by the PIR sensor while the system is armed, the pre-programmed code within the MCU initiates the alarm sequence. The

buzzer/siren sounds, potentially deterring the intruder and alerting those present within the location. Simultaneously, the MCU establishes communication with the GSM module.

- **GSM Module and SMS Notification:** The GSM module, equipped with a SIM card containing a cellular service plan, acts as a cellular modem. The MCU transmits instructions via AT commands, directing the GSM module to send SMS alerts to designated phone numbers. These SMS messages convey a critical message indicating a potential intrusion and may even specify the triggered sensor's location.

Arduino Code

```
#include <SoftwareSerial.h>

SoftwareSerial mySerial(3, 2);

int pirsensor = 10;

int buzzer = 12;

int redled = 13;

void setup() {

randomSeed(analogRead(0));

Serial.begin(9600);

mySerial.begin(9600);

Serial.println(" logging time completed!");

pinMode(pirsensor, INPUT);

pinMode(buzzer, OUTPUT);

pinMode(redled, OUTPUT);

digitalWrite(buzzer, LOW);

digitalWrite(redled, LOW);

delay(100);

}

void loop() {

if ( digitalRead(pirsensor) == HIGH)

{

digitalWrite(buzzer,  HIGH);

digitalWrite(redled,   HIGH);

Serial.println("making call");
```

```
mySerial.println("AT"); //Once the handshake test is successful, it will back to OK

updateSerial();

mySerial.println("AT+CSQ");

updateSerial();

mySerial.println("ATD+ +917393811881;");

updateSerial();

delay(20000); // wait for 20 seconds...

mySerial.println("ATH"); //hang up

updateSerial();


delay(2000);

}

if ( digitalRead(pirsensor) == LOW)

{

digitalWrite(buzzer, LOW);

digitalWrite(redled, LOW);

delay(1000);

}

}

void updateSerial()

{

delay(500);

while (Serial.available())

{
```

```
mySerial.write(Serial.read());//Forward what Serial received to Software Serial Port

}

while(mySerial.available())

{

Serial.write(mySerial.read());//Forward what Software Serial received to Serial Port

}

}
```

Scope for Future Work

The development of the Intruder Alert System using motion sensors and a GSM module has laid the groundworkfor a robust security solution. To further enhance its effectiveness and adaptability, the following detailed scopeoutlines potential areas of research and development:

1. **Enhanced Detection Mechanisms:**
    - **Multi-Sensor Integration:** Combining different types of sensors, such as infrared, ultrasonic, andvibration sensors, to improve detection accuracy and reduce false alarms.
    - **Sensor Fusion Techniques:** Employing advanced algorithms to analyze data from multiple sensorssimultaneously, providing a more comprehensive understanding of the environment.
2. **Communication Upgrades:**
    - **Multiple Communication Protocols:** Incorporating Wi-Fi, Bluetooth, and Zigbee alongside GSM forredundancy and to ensure system functionality even if one communication channel fails.
    - **Real-Time Notifications:** Developing an app or web-based platform for instant notifications and livevideo feed access when an intrusion is detected.
3. **Power Management:**
    - **Energy-Efficient Design:** Researching low-power sensor networks that can operate on battery powerfor extended periods, making the system more sustainable.
    - **Solar Power Integration:** Exploring the use of solar panels to power the system, particularly inoutdoor settings, to reduce reliance on the electrical grid.
4. **System Interoperability:**

- **Smart Home Integration:** Ensuring the system can seamlessly connect with existing smart homedevices and platforms for a unified home security ecosystem.
- **Standardization of Protocols:** Working towards the standardization of communication protocols tofacilitate compatibility with a wide range of devices.

5. **User Interface and Experience:**
   - **Customizable Alerts:** Allowing users to set preferences for different types of alerts, such as SMS,email, or app notifications, based on the level of threat.
   - **User-Friendly Dashboard:** Designing an intuitive dashboard that provides a quick overview of the
     system's status and easy access to historical data.

Conclusion

This report has explored the design and implementation of a cost-effective intruder alert system utilizing motion sensors and a GSM module. This system offers a practical solution for residential or commercial security applications, effectively detecting unauthorized entry attempts and triggering real-time notification via SMS alerts. The report has detailed the system's components, functionalities, and limitations, while acknowledging its potential for further development.

The core system presented serves as a robust foundation for future advancements. By integrating additional sensors, a mobile application, and cloud connectivity, the functionalities can be significantly expanded. These enhancements, such as remote system control, real-time notifications with sensor location details, and historical data analysis, can contribute to a more comprehensive and user-friendly security solution.

Furthermore, exploring alternative power management solutions and potential camera integration would further strengthen the system's reliability and effectiveness. In conclusion, this intruder alert system offers a valuable tool for deterring potential intrusions and promoting a sense of security for property owners. It presents a strong foundation for further development, paving the way for a more comprehensive and user-centric approach to residential and commercial security.

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