International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 46 No. 2 September 2024, pp. 421-430

Development of Alarm System Using GSM Technology and RFID Integration

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Abstract – The eminent intent of this paper is to improve home security through a design concept that offers an inventive alarm system that integrates RFID (Radio Frequency Identification) technology with GSM (Global System for Mobile Communications) technology. The system aims to identify any unexpected movement within the allotted area of the owners' house while they are away and send them an SMS alert afterward. The primary features of the alarm system with GSM Technology and RFID Integration include using GSM technology to monitor and transmit warnings when unusual motion is detected. The RFID component enables the system to distinguish between permitted and illegal entry. The GSM module is essential to this pursuit, as it allows for remote homeowner alerts. The system's programming, which merges the GSM and RFID components, is critical to the project's operation. Finally, the SMS notification capability is required for distant alerts, making it an essential component of the alarm system. The Alarm System with GSM Technology and RFID Integration is a robust and adaptable security system with essential motion detection and alerting features. While it does have certain limitations, its reliability, benefits, and potential for enhancement make it a reassuring addition to any home security system.
Keywords – Alarm System, Global System for Mobile Communications (GSM), Radio Frequency Identification (RFID),

Introduction

In today's fast-paced world, the safety of one's home is paramount. With an increasing number of homeowners spending significant time away from their residences, there is a pressing need for reliable and effective alarm systems that can alert them to any unusual activity. This study, 'Alarm System Using GSM Technology and RFID Integration,' addresses this need and enhances security by providing a dependable solution that notifies homeowners of any detected motion within their houses while they are away.

The suggested alarm system uses modern GSM technology and RFID integration to track and report anomalous motion. To initiate the system, the homeowner must touch an RFID tag on a scanner before leaving the house. When the system is turned on, it uses motion sensors that detect Passive Infrared (PIR). This technology detects heat and movement to identify any illicit movement or access into the residence. When the system detects motion, it sounds an audible alarm via a buzzer at the entrance,

alerting anybody to the incursion. Simultaneously, the GSM module gives the homeowner an immediate notice by phone call or SMS notifying them of the observed motion.

Easy to use, dependable, and providing real-time notifications are just a few benefits of this innovative alarm system. RFID technology assures the system that authorized users can only trigger or deactivate it, reducing false alarms. The use of GSM technology ensures that alerts are sent quickly, even without internet access. This capstone project improves home security and provides a practical and effective way for homeowners to stay informed about their house activities, resulting in a safer living environment. The system uses RFID technology to activate and deactivate the alarm system, guaranteeing that authorized users can only manage it. Once triggered, the system uses Passive Infrared (PIR) motion sensors to detect illicit entrance or movement. Upon detection, the system sounds an audible alarm via a buzzer and immediately warns the homeowner by phone or SMS utilizing GSM technology.

This alarm system's primary features include RFID technology for secure activation, PIR motion sensors to detect movement, and GSM modules for real-time remote alerts. The RFID component guarantees that only authorized users may manage the system, reducing false alarms and increasing security. The PIR sensors detect motion accurately, and the GSM module notifies homeowners of any suspicious behavior immediately, regardless of their location.

As mentioned, the study aims to prevent and identify unauthorized entrance while notifying relevant parties in real-time using RFID and GSM technology. The RFID security system provides initial protection by linking RFID cards to an authorized RFID sensor. The GSM module in the system delivers SMS notifications to pre-registered phone numbers, such as those of the homeowner, a security service, or local authorities. The system is always armed, allowing only authorized individuals with valid RFID cards to enter, and any illegal access attempts cause the GSM module to transmit SMS messages. The two-factor authentication technique improves security.

Objectives

The objective of combining GSM technology and RFID technology for detection is to create a layered security system that offers several benefits:

Early Identification and Dissuasion: Unauthorized access attempts can be detected early, thanks to the system. As soon as an unauthorized entrance is attempted, an RFID card placed on valuables or access points will immediately sound an alarm. This early alert makes Faster reactions possible, possibly deterring the intruder from entering the property further.

Remote Alert: The security system uses GSM technology to notify specific phone numbers via SMS. Even when they are not physically present on-site, this function ensures that property owners or security professionals are notified of any unexpected behavior in real time. The system's efficacy is increased, and the capability to receive remote notifications guarantees prompt reactions to any dangers.

Better Monitoring: The ability to track the movement of tagged things within a specific range is determined by the capabilities of the RFID technology. This data may be sent over GSM, giving authorities important information in the case of loss. Better tracking and monitoring of pilfered goods is possible by combining RFID and GSM technology.

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Strengthened Confirmation: RFID cards are an even more secure verification method than conventional keys or codes. Because of this, it is far more difficult for unauthorized people to get around the security system. To improve overall security, the RFID cards ensure that only people with the proper authority may turn on or off the alarm system.

Strengths Altogether: The technology integrates GSM's long-range communication capabilities with RFID's long-range precision. The technology integrates GSM's long-range communication capabilities with RFID's short-range precision. GSM ensures that notifications are transmitted over extended distances, while RFID enables accurate identification of approved things or people. Combining these two produces a strong and dependable security system that can be used to identify and handle illegal intrusions.

The overall goal of this system is to provide a more dependable security solution by enabling earlier alerts, improved notification and communication using GSM technology, the ability to monitor using RFID, and more robust access control protocols. These characteristics work together to improve the alarm system's monitoring and security functions, making it a valuable tool for securing homes.

Literature Review

The RFID Technology

Originally invented by Mario W. Cardullo in 1973 and used to track aircraft during World War II, RFID (Radio Frequency Identification) has since become integral in various fields by incorporating Automatic Identification and Data Capture (AIDC) technology. It is a prominent example that is widely used to identify objects, automatically collect data, and update computer systems without human intervention, thus highlighting convenience, according to Potdar, Wu, and Chang (2010). On the other hand, Liu and Chen (2009) and Roberts (2006) state that RFID stands out for its use of wireless radio waves to transmit, identify, track, organize, and verify different items efficiently, having the key components: tag and the reader, which facilitate communication between objects and the system.

The evolution of RFID technology and its expanding use in multiple sectors highlight its transformative potential. The high efficiency and security of RFID make it valuable and trusted in industries like retail, logistics, and library systems, where it boosts inventory management and reduces cases of theft. Another notable application is automated toll systems, where cars equipped with RFID tags allow for seamless and contactless toll payment for motorists without stopping, reducing congestion and streamlining the travel experience (Namdas & Naik, 2023). This plays a vital role in modernizing toll collection systems in the Philippines, particularly on major highways and expressways.

Compared to barcodes, RFID outperforms these traditional systems as it has more significant advantages – such as having higher data capacity, two-way communication, and enhanced resistance to environmental factors like heat, humidity, and magnetic interference (Bi et al., 2011). The authors added that RFID systems also have a more extended transmission range and offer better security through encryption. Roberts (2006) emphasized that additional benefits include more efficient read/write functionality, reusability, and adaptability, making RFID superior to other AIDC technologies, such as cameras or magnetic cards. Overall, as it enables the automatic identification and tracking of objects through radio waves, it enhances accuracy, speed, and convenience in different operations.

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Global System for Mobile Communication (GSM)

Mobile communication has drastically changed interpersonal interactions by enabling instant voice and data transmission across long distances without physical connections (Macwan, 2017). With this, GSM (Global System for Mobile Communications), which was developed in the 1980s and officially launched in 1991, provides a robust foundation for global mobile communication, as it converts voice into electrical signals, which are then transmitted to the nearest base station and received by the destination device, allowing real-time communication (Stuber, 1996).

As Kandel (2019) points out, GSM is widely used due to its ability to allocate radio channels to multiple users via Time Division Multiple Access (TDMA). This standardized protocol allows for seamless operation across GSM-compatible devices, making it easy for users to switch SIM cards between phones. GSM evolved over the years with the introduction of other wireless technologies that emerged to enhance data transfer, like WAP (Wireless Application Protocol), UMTS (Universal Mobile Telecommunications System), GPRS (General Packet Radio Service), which allowed packet-switched data services, and EDGE (Enhanced Data Rates for GSM Evolution), which increased data transfer speeds. GSM is still used widely today, particularly in regions where newer technologies like 4G and 5G are not yet fully deployed, and it remains a foundational technology for mobile communication globally.

In the capstone project, GSM technology is combined with RFID for a Robber Detection System to enhance security. RFID is the first level of protection against unauthorized access, allowing only verified users to control the system. On the other hand, GSM provides reliable communication, enabling real-time alerts and warnings, which improve the system's ability to prevent unauthorized access and respond quickly to potential security threats. The project creates a dependable and effective home security solution by integrating RFID's strengths with GSM's real-time alert capabilities.

Methodology

The approach for this capstone project is to use an Arduino Uno board to integrate and implement a complete security system that includes an RFID scanner, GSM module, PIR sensor, active buzzer, and LED light. The first step is to install the RFID scanner, which is connected to the Arduino board using jumper wires and requires the 3.3V pin and several digital pins (13, 12, 11, 10) to function properly.

The system registers the RFID card's distinct ID to facilitate the alarm's activation and deactivation. The GSM module is then inserted, linked to pins 2 (TX) and 3 (RX), and powered by the 5V pin. Call and SMS alerts are then enabled via a registered SIM card. In order to enable the PIR sensor to detect illegal movements, it is then configured to detect motion and linked to pin 6, pin 5V, and the ground. When an incursion is detected, additional features like an LED light and an active buzzer are included to offer visible and audible notifications.

The RFID card operates the alarm; once engaged, any motion detected by the PIR sensor causes the GSM module to initiate a phone call to the owner, alerting anybody in the vicinity with a buzzer and an LED light. To ensure safe and regulated access to the system, deactivate the alert by touching the RFID card again. By utilizing the capabilities of the Arduino Uno and other connected components to provide real-time warnings and strong protection, this technique guarantees a dependable and efficient security solution for both residential and commercial premises.

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HARDWARE REQUIRED:

ARDUINO UNO:

Arduino is an open-source hardware and software program software company, initiative, and customer community that designs and manufactures single-board microcontrollers and microcontroller toys to create digital devices and interactive objects that can be used and used in physical and digital world objects. Its merchandise is licensed under the GNU Laser General Public License (GNU General Public License), which enables the Arduino board and software program software to be transported to anyone. Arduino boards have historically been together as pre-assembled constructions or personalized toys. Arduino board layout uses a range of microprocessors and controllers to change. Boards comprise digital and analog enter/output (I / O) pin gadgets that can be interfaced with an additional range of increment boards or routibars and separate circuits. Boards have serial communication interfaces, which include Universal Serial Bus (USB) in some models, which are also used to load packages from non-public computers. Microcontrollers are usually programmed to use a dialect of aspects from programming language C and language C ++. In addition to using regular compiler system chains, Arduino Enterprises provides a built-in Improvement Environment (IDE) primarily based on processing language projects. The Ordino project started in 2002 as a software program for students at the University of Interjection Design Institute. Ivory in Ivory, Italy, aims to create devices that are worried about using sensors and activators in their environment to refresh, cost the authorities, and decrease the way to reach them. Common examples of such gadgets supposed for beginner hobbyists are made less complicated.

PIR SENSOR:

The PASSIVE INFRARED (PIR) sensor detects human presence within a range of approximately 10 meters. This standard range can vary between 5 and 12 meters, depending on the specific model and settings. PIR sensors detect changes in infrared radiation levels, typically emitted by warm objects like humans.

These sensors are highly regarded for their compact design, cost-effectiveness, and ease of use. They come with lenses to suit different detection patterns and have a straightforward interface. Most PIR sensors feature a 3-pin connection—typically ground, signal, and power—with the power usually up to 5V. Some advanced modules may not provide a direct output but control a relay for switching purposes.

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Interfacing PIR sensors with microcontrollers is straightforward. They typically act as digital outputs, indicating high or low states based on detected motion. When motion is detected, the output remains high for a period and then returns low after a few seconds unless the motion continues. This cyclic behavior helps in detecting movement effectively.

It is important to note that PIR sensors require a brief warm-up period upon initialization to stabilize and calibrate properly for accurate motion detection within their designated field of view.

Pin	Name	Function
-	GND(Ground)	Connects to Ground (VSS)
+	Vcc	3.3V to 5V ~100uA
OUT	Output	I/O set INPUT mode

PIEZO BUZZER:

The piezo, also known as the buzzer, is a component for generating sound. It is a digital component that can be connected to digital outputs and emits a tone when the output is HIGH. Alternatively, it can be connected to an analog pulse-width modulation output to generate various tones and effects. The **Grove Buzzer** operates at 3.3V and 5V with a sound output of 85 decibels. This module can provide sound feedback to your application, just like the clicking sound of a button on a digital watch.

SIM800L V2 5V Wireless GSM GPRS Module:

SIM800L V2 5V Wireless GSM GPRS MODULE Quad-Band with Antenna power supply for 5 v, computer debug USB to TTL serial port. Power to the output current of 800 ma, TTL serial interface is compatible with 3.3 V and 5 V micro-controller, can be directly after purchase and single-chip computer connection.

The IPX antenna interface can arbitrarily switch PCB glue stick antenna and suction cups. SIM800L 4 frequency communications, data available in the world. Foreign trade and foreign trade projects are preferred.

SIM800L V2.0 GSM/GPRS Module is a QUAD-BAND GSM/GPRS module compatible with Arduino. The module works by adding both GSM features (voice call or SMS) and GPRS features. The advantages of these modules are the VCC and TTL serial levels with 5V voltage, so you can directly connect it to Arduino or another minimum system with a 5V voltage level.

So many GPRS/GSM modules on the market must add a 5V regulator and level converter circuit. In contrast, the SIM800L V.2 GSM/GPRS module already has a built-in regulator circuit and TTL level converter on the board.

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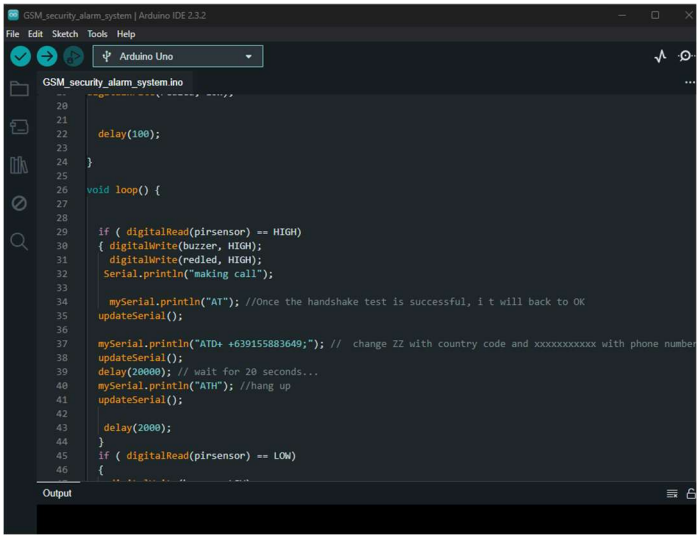
SOFTWARE REQUIREMENT:



Design of Systems, Product, and/or Processes and Description of the Prototype

The main control unit of the alarm system, built with GSM technology and RFID integration, is the Arduino Uno microcontroller. This solution efficiently integrates several parts to guarantee robust security monitoring and alerting capabilities.

The Arduino Uno Board is an excellent tool for prototyping because of its ease of use and simplicity in system construction. Using digital pins, the researchers incorporated an RFID reader that scans RFID cards for user verification. When a move is detected, an SMS warning is sent to specific numbers using a GSM module attached to the Arduino's TX and RX ports. In addition, a PIR motion sensor attached to an Arduino digital pin detects movements within the building. An active buzzer is incorporated to give auditory notifications in the event of an invasion, and LED indicators show the state of the system, such as when an alarm is triggered and offer a visual indication.

Integration and implementation included attaching the RFID reader to the Arduino, assigning it to certain pins, and powering it with 3.3V. In order to guarantee that the PIR motion sensor received a 5V supply, it was fastened to a pin and grounded. After plugging up a registered SIM card to enable SMS capabilities, the GSM module was powered by the Arduino's 5V pin and linked to the proper ports. We created Arduino code that continually reads data from the GSM module, PIR sensor, and RFID reader. In order to prevent false alarms from small variations in sensor readings, the code was set up to trigger the buzzer and light the LEDs upon motion detection.

The alarm activation procedure is simple: when the system senses motion, it activates the buzzer and LEDs. In order to provide prompt notifications, the GSM module is incorporated to send SMS alerts to specified recipients. Power management strategies were used to increase battery life, particularly for standalone systems, by implementing sleep modes for the Arduino. This allowed the device to sense activity and wake up, allowing it to continue monitoring.

Testing and calibration involved several tries to guarantee that all components worked properly. The sensitivity of the sensor was adjusted to reduce false alerts and improve accuracy. Tests were conducted on the GSM module to ensure dependable

alert delivery. In order to properly monitor the property, the system was placed in key areas, and routine maintenance was planned to guarantee that it would remain responsive and functioning.

Additional considerations include conforming to appropriate safety guidelines and regulations in the system design process. A system setup and monitoring interface was created with ease of use in mind. In order to enable remote monitoring and control, we also looked into the feasibility of combining the alarm system with currently installed smart home systems. Ultimately, the implementation of data logging features allowed for the future study and troubleshooting of sensor readings and alarm occurrences.

This thorough design guarantees that the alarm system is strong, dependable, and able to efficiently protect the property by sending out timely signals.

Development & Testing

The alarm system was developed utilizing GSM technology and RFID integration to provide a dependable security solution. GSM technology and RFID integration with an Arduino Uno board were used in the development of the alarm system. The system has a motion-detecting PIR sensor, an RFID scanner to read key cards, a GSM module for delivering notifications, an LED light and buzzer for alerts, and an active buzzer. The Arduino was equipped with an RFID scanner and a GSM module, which facilitated the system's activation upon tapping an RFID card. The GSM module receives signals from the PIR sensor when it senses motion, setting off the alarm.

During testing, the researchers examined that the RFID scanner read key card IDs correctly and that the PIR sensor detected motion properly. In order to verify timely notice transmission, the GSM module was tested. They also confirmed that the LED light and buzzer were working properly to provide clear notifications. The efficacy of the system in identifying illegal entry and transmitting real-time alerts was demonstrated using simulated intrusion scenarios. In order to reduce false alarms and guarantee the dependability of the system for both residential and commercial premises, calibration was carried out.

Results

The research objective was to create and install a security alarm system that would notify property owners of unwanted intrusion by utilizing RFID integration and GSM technology. The system, which is controlled by an Arduino Uno board, was created to provide all-around security by integrating a PIR motion detection sensor, GSM connectivity, and RFID access control.

Connecting the RFID scanner to the Arduino board and making sure it could read RFID cards to turn on and off the system were the setup steps during the early testing. After that, the GSM module was installed and set up to notify users by SMS or call in the situation that an intrusion was discovered. The PIR sensor's calibration allowed it to precisely detect motion without setting off false alerts. To offer both visible and auditory notifications when the device was activated, an active buzzer and red LED light were also included.

During the initial test, the RFID cards were successfully read by the system and registered. The alarm system was successfully turned on and off using the RFID reader. The PIR sensor promptly sensed motion when the system was turned on, triggering the GSM module to send an SMS alert to the specified phone number. At the same time, there was a buzzer and a red LED light flash to signal the intrusion.

Further testing verified the system's dependability. Notifications were transmitted by the GSM module immediately upon request, and the PIR sensor remained accurate under all circumstances. By adjusting the sensor's sensitivity, false alarms were reduced, and the system was only activated by actual invasions.

Overall, the project's goals were effectively met. The security system performed admirably in terms of identifying unwanted access, issuing alarms in real time, and delivering prompt visual and audio warnings. The objective of the project was to create a dependable and effective alarm system, and it was successfully achieved through the integration of RFID, GSM, and PIR technologies into a cohesive system.

Discussion

The development of technology has greatly improved our awareness of security, making it a necessary component of contemporary life. Modern technology has supplemented traditional security methods, such as simple alarm systems and manual locks, to offer more effective and resilient property protection options. The integration of GSM technology and RFID systems into alarm security systems is a significant step forward in protecting homes and businesses. These systems are essential in today's hectic environment because they provide real-time notifications, adaptability, and convenience of use.

Constant protection is one of the main advantages of an alarm system with RFID integration and GSM technology. These systems work 24/7, guaranteeing that any unwanted access is quickly identified and dealt with, in contrast to previous approaches that can depend on security personnel or physical presence. Access points are secured by the RFID scanner, and property owners receive real-time notifications via the GSM module, enabling prompt action. The security of both residential and commercial premises is greatly improved by this degree of automation and response.

Furthermore, the simplicity with which these systems may be relocated increases their desirability. The ability to detach and reinstall wired and wireless alarm systems at multiple places gives consumers flexibility in case they need to relocate their security configuration. Because of their flexibility, the security measures can change to meet the property's and its owners' evolving demands.

However, there are particular limitations to consider. The strength and dependability of the GSM signal have a major impact on the system's efficacy. The system's alert-sending capability can be compromised in places with weak cellphone connectivity. Additionally, when unauthorized persons are near the sensors on an RFID system, false alarms may occasionally be set off. With proper placement and extra safety precautions, these false alarms can be avoided.

Despite these difficulties, the combination of RFID and GSM technologies in alarm systems offers a clever and effective way to secure property. These systems provide improved safety, flexibility, and usability by utilizing contemporary technology, which makes them an invaluable complement to any security plan. The project's successful completion highlights the possibility of fusing software and hardware to produce creative and useful security solutions.

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