E-ISSN 2581 – 7957
P-ISSN 2277 – 3916

CVR Journal of Science and Technology, Volume 26, June 2024
DOI: 10.32377/cvrjst2606

GSM-Enabled Home Automation and Security System: A Comprehensive Investigation and Implementation

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Abstract: **This research project focused on integrating home control and security through advanced Home Automation Systems. A thorough analysis and practical implementation of home automation technology were conducted, utilizing Global System for Mobile Communication (GSM) modems to manage various home appliances, including fans, air conditioning systems, and security systems. The system relied on Short Message Service (SMS) text messages for control and monitoring. Key features included an entrance security mechanism to promptly notify homeowners of unauthorized access, bolstering overall security. Additionally, an anti-theft reporting system employed alarms and SMS notifications to inform owners of security breaches. The system also integrated safety protocols for fire or gas leakage, dispatching SMS notifications and activating alarms to alert homeowners. The use of GSM technology provided wireless access to control connected devices, enhancing system efficiency and convenience. This research contributed to the smart home technologies field by presenting an advanced system that harmonized automation, security, and safety, with potential applications across diverse residential settings. While numerous home automation systems were available in the market, the significance of the proposed home automation system lay in its advanced features and comprehensive approach to integrating control and security functions. Unlike many existing systems, which may have offered basic automation capabilities, the proposed system went beyond simple automation by seamlessly integrating security measures using GSM technology. This allowed homeowners to effectively manage a wide range of home appliances, including fans, air conditioning systems, and security systems, all through the convenience of SMS text messages. Key features of the proposed system, such as the entrance security mechanism and anti-theft reporting system, addressed critical security concerns and provided homeowners with real-time notifications of unauthorized access or security breaches. Additionally, the integration of safety protocols for fire or gas leakage further enhanced the system's utility and value by prioritizing homeowner safety. Moreover, the utilization of GSM technology offered wireless access to control connected devices, significantly enhancing system efficiency and convenience compared to traditional wired systems. This wireless connectivity ensured that homeowners could remotely monitor and control their home environment from anywhere, at any time, providing them with peace of mind and control over their living space. Overall, the proposed home automation system represented a significant advancement in the field of smart home technologies by offering a comprehensive solution that harmonized automation, security, and safety. Its potential applications across diverse residential settings underscored its importance and relevance in meeting the evolving needs of modern homeowners.**

Index Terms: **Short Message Service (SMS), GSM modems, Safety protocols, Gas leakage detection.**

I. Introduction

The escalating prevalence of wireless communication has spurred the utilization of mobile phones for remote household appliance control and security feedback. This paper outlines a system for remotely controlling various household appliances and monitoring home safety and security through SMS notifications. The controller proves particularly advantageous in scenarios where wired connections are impractical, allowing for the seamless ON and OFF switching of devices from any location worldwide. The microcontroller plays a pivotal role in receiving SMS commands and subsequently controlling home appliances accordingly. It provides feedback in case of a security breach, gas leakage, or fire incident. This proposed solution is characterized by its user-friendly interface, simplicity, security, and robustness. Additionally, it provides the convenience of management via dedicated Android mobile applications. The system outlined in this paper presents a simple yet efficient method for remote control of home appliances, as well as enhancing security and safety through GSM SMS.

A. Objective

This home automation project aims to enable remote control of household appliances using a basic GSM-based phone. It eliminates the need for a smartphone, allowing users to operate and manage home electronic devices effortlessly with a standard GSM phone. The project centers around a dedicated Controller responsible for overseeing the entire process. GSM wireless communication is the key technology employed for the remote control of home appliances. By sending specific commands via SMS from the GSM phone, users can seamlessly switch ON or OFF various household electronic devices. The Controller receives these commands through the GSM module and subsequently sends signals to relays with the assistance of a relay driver, facilitating the efficient control of home appliances based on user instructions.

B. Motivation

This research involves an in-depth examination of existing literature and case studies to create a comprehensive overview of GSM-based home automation and security systems. By synthesizing this information, our goal is to present a thorough and insightful analysis. The integration of

Received on 05-03-2024, Revised on 04-04-2024, Accepted on 04-05-2024.

CVR Journal of Science and Technology, Volume 26, June 2024
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a GSM module into the system is a key aspect, enabling communication with mobile networks. Various sensors have been incorporated into the system for both security and automation purposes. These sensors are connected and configured to the microcontroller to provide real-time data. By linking the GSM module to the microcontroller, the system facilitates the control and monitoring of home appliances, allowing users to check their status.To implement the necessary logic for controlling and monitoring devices based on sensor inputs and user commands, code can be developed using KIEL software. Additionally, security features have been implemented in the logic, including the capability to send SMS alerts or make phone calls in the event of security breaches. The overall design ensures a robust and integrated GSM-based home automation and security system.

II. Literature Review

Safial Islam Ayon et al. [1] stress security's pivotal role in home automation, introducing a fully automated smart security box to promptly alert authorized users of unauthorized breaches. This device, praised for its advanced security, affordability, and user-friendly design, utilizes Arduino and GSM technology for robust detection and notification. Despite its advantages, challenges such as susceptibility to GSM network outages and integration limitations with existing setups should be acknowledged. Additionally, a comparative analysis with solutions like the GSM-Enabled Home Automation and Security System: A Comprehensive Investigation and Implementation could offer valuable insights into its efficacy and suitability within the broader smart security landscape.

In their recent study, Ahmed Faraz Husain et al. [2] explored wireless sensor networks (WSNs) potential applications, particularly in security systems for businesses like banks, jewellery, and electronic stores. They propose a novel security system utilizing Zigbee technology to enhance security at these establishments. The system provides three levels of security: at the main door locker, upon entry, and when accessing the cash locker. It comprises Zigbee modules, a microcontroller, a voltage regulator, and sensors to detect abnormal activities, especially at night. Alerts are sent via Zigbee to a GSM module, which notifies the owner or designated recipient. The authors justify Zigbee's choice due to its reliability, low power consumption, simplicity, and flexibility. This system highlights wireless technologies' ability to replace complex wired systems, offering extensive coverage, reliability, remote control, real-time service, and user-friendliness. Comparing this system with the GSM-Enabled Home Automation and Security System: A Comprehensive Investigation and Implementation, drawbacks and limitations should be considered. For instance, Zigbee's potential drawbacks may include range limitations and interference from other devices. A comparative analysis could reveal whether Zigbee outperforms GSM in reliability, scalability, and integration. Moreover, differences in addressing security concerns, such as intrusion detection and emergency notifications, could be highlighted. Such analysis would aid stakeholders in making informed decisions regarding security system implementations.

Neha R. Ghate et al. [3] proposed a smart home security monitoring system. This system uses Radio Frequency (RF) technology to monitor the status and security of the electrical system, and it also contributes to energy conservation. The technology used in this research includes the Global System for Mobile Communications (GSM), Frequency Hopping Method, and PIC18F452 Microcontroller. The system employs a Time Password (OTP) concept to provide a reliable, efficient, and safe environment for occupants. The OTP serves as a communication tool between the hardware and the software. A Graphical User Interface (GUI) is developed and configured to facilitate the OTP service. The auto-generated OTP is sent to the homeowners, and if there is an attempt to breach security, the OTP session will expire. Frequency Hopping is defined as a communication scheme between a transmitter and a receiver, where the system changes the frequency during transmission at regular intervals. This allows the RF channel used for signaling channel (SDCCH) time slot or traffic channel (TCH) time slots, to change frequency every TDMA frame (4.615 ms). The frequency is changed on a per-burst basis, meaning all the bits in a burst are transmitted at the same frequency.

Vishaka D. Vaidya et al. [4] emphasize the growing significance of home automation and security systems in modern lifestyles, highlighting their capacity to streamline tasks and provide peace of mind. They commend wireless smart home systems for their versatility, portability, and cost-effectiveness, enabling remote appliance control and enhancing security measures. While automation primarily focuses on managing lights, fan speed, and other devices, security features include gas leakage detection and intrusion prevention, catering especially well to the needs of the elderly, handicapped, and busy individuals by providing real-time alerts through mobile technology. Although the study conducts a comparative analysis of smart home systems utilizing various technologies like GSM, Bluetooth, IoT, and PIC Microcontroller with ZigBee modulation, it does not explicitly address the drawbacks of the proposed system or compare it with existing literature. A comparison with "GSM-Enabled Home Automation and Security System: A Comprehensive Investigation and Implementation" could reveal differences in methodology, technology integration, and system performance, offering a comprehensive understanding of their strengths and weaknesses and aiding in selecting the most suitable approach for home automation and security needs.

Ebrahim Abidi et al. [5] presented a remote development of a voice-controlled home security system for smart home automation. This system uses an Arduino Mega, GSM SIM900A, Bluetooth module, and HC-SR04 ultrasonic sensor. A microcontroller is programmed to control up to four home appliances via Bluetooth technology and transmit the received signal from the sensor to the user’s smart phone. The authors note that while there have been many commercial and research projects on smart homes, most of these products use remote controls with touch screen buttons. They propose a wireless remote control for home devices that can be voice-controlled, providing support for the elderly, disabled, and enhancing home security. The proposed system is designed to recognize human voice commands using a voice reader

Android application to control home appliances. Another key feature of this project is the detection of movement using an ultrasonic sensor. The sensor signal is converted into a message and sent to the mobile user via a GSM module. The system, which has an accuracy rate of over 95%, allows users to control their electrical loads using voice commands. To operate the system, the Arduino Mega must be powered by a 12V DC adapter and all AC power loads must be connected to the electricity. The proposed prototype of the smart home automation system has been implemented and tested on hardware, enabling users to control a certain number of home appliances using voice.

Malti Bansal et al. [6] proposed a Smart IoT-based Integrated Home Security System. This all-in-one system uses various sensors and modules to monitor the user's property and always ensure its safety. The system operates 24x7, regardless of whether the user is at home or not. It is designed to detect fire breakouts, gas leakages, or intruders, and informs the user in real-time via SMS. In addition to these features, the system also includes a camera that records ongoing events. These recordings are not stored locally but are uploaded to the cloud to minimize system costs. The user can access, view, or download these recordings at any time. In summary, the author has proposed and designed a 24x7 smart IoT-based integrated home security system that ensures safety and offers real-time updates.

Ahmed et al. [7] discussed the importance of energy conservation and proposed a system to prevent energy wastage. This system uses Raspberry Pi 3 and the WeMOS D1 mini as the main devices, supported by various microcontrollers like PIR sensors and gas sensors. The system works by ensuring the presence of humans before supplying power. If the PIR sensor does not detect a human for a certain period, the Raspberry Pi controls the relay module to disconnect the power, turning off lights and fans that may have been left on unintentionally. Conversely, when the PIR sensor detects the presence of a human or animal in a room, it turns on the power (e.g., lights, fans) through the relay module and informs the user about the presence. Additionally, if a gas sensor detects a gas leakage, it alerts the WeMOS, which then sends a signal to the Raspberry Pi. The Raspberry Pi immediately informs the user through the GMS module. This system allows users to prevent unauthorized access to their homes and protect their homes from potential accidents, contributing to a safer and more energy-efficient living environment.

Hakar Mosin et al. [8] came up with the significant evolution of network technologies in home environments. This evolution has enabled the use of digital technologies as home appliances, which can be remotely accessed and controlled using existing network infrastructure, leading to a direct integration of computing systems with the physical world. A key part of this network evolution is the Internet of Things (IoT), which expands the services provided by the internet. IoT can be applied in various fields, with home automation being one of its applications. This approach increases the connectivity between devices within and outside the home, enabling the automation of home appliances. The paper presents the design and implementation of a secure and automated house using a hybrid communication system, which includes IoT and mobile communication methods. The system uses an Arduino Microcontroller, GSM Shield, Ethernet Shield, and a variety of sensors. With the advancement of IoT, there is an increasing demand for real-time security. The proposed system secures the house via electronic devices and sensors, protecting it from various intrusions such as motion within the house and disasters like fire and gas leakage. The paper focuses on designing a robust and reliable home automation system to address these issues and alert the homeowner via a message when suspicious activities occur. The results contribute to the field of IoT by providing an efficient and reliable solution that considers various aspects, including fast processing, system cost, robustness, and precision, catering to modern technological needs.

Soniya Devar et al. [9] put forward the rapid expansion of smart home automation in the current era of robotics. This automation plays a crucial role in safety systems. A multitude of sensors are integrated into an Automated Smart Home system to manage and operate various functions such as flame detection and water level tracking, using technologies like Bluetooth and ZigBee. The existing system can be expanded to monitor a child returning from school and to enhance security systems. The author proposes a design for the smart home system that is particularly effective for individuals with mobility issues, enabling them to control every system with minimal effort. This proposed system aims to monitor children, control home lighting, regulate windows, and manage terrace gardening using the power of the Internet of Things.

A project by Chetana Nayyar, [10] aims to develop an efficient, low-cost automated energy management system for homes, which also includes a surveillance feature. The system was designed after evaluating the utility features of existing surveillance and energy management systems, with the goal of enhancing these features. The system provides a cost-effective solution for household energy management and includes features to respond to natural disasters like fires. The system is built on an Arduino UNO microcontroller board and uses embedded C as the programming language, facilitating easier coding for new features. This project represents an attempt to improve home automation and security while keeping costs low.

III. Implementation

The Home Automation and Security System using GSM is meticulously crafted, with each component serving a crucial function in creating a versatile and secure smart home solution.

The power supply section, comprising a transformer and LM7805 IC, ensures a stable +5V power source essential for all components' proper functioning. These components were carefully chosen to guarantee reliable power distribution, thereby mitigating potential damage from voltage fluctuations, and enhancing the system's longevity.

At the heart of the system, the microcontroller acts as the central processing unit, orchestrating operations, processing inputs, and controlling output devices. Its selection was deliberate, choosing a microcontroller with ample processing power, memory, and I/O peripherals to meet the system's

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diverse functionalities. This choice directly impacts system performance, responsiveness, and overall intelligence.

Facilitating communication with mobile networks, the GSM modem enables remote monitoring and control of the system. Chosen for compatibility and ease of integration, the GSM modem enhances system connectivity and accessibility. Integration of the GSM modem enables timely alerts and remote control via SMS or phone calls, enhancing system functionality and user convenience.

The driver circuit serves as an interface between the microcontroller and output components, regulating current flow for devices like lights and fans. Carefully selected for efficient current regulation and compatibility, the driver circuit ensures precise control of output devices. This optimization of power distribution enables seamless automation and reliable operation of output devices, enhancing system versatility and efficiency.

The LCD provides a user-friendly interface, displaying relevant information and feedback. Selected for versatility, low power consumption, and ease of integration, the LCD enhances user interaction and system accessibility. Its integration improves the user experience by providing real-time updates and status indicators, contributing to overall user satisfaction and system usability.

Sensors deliver real-time data on environmental conditions and security threats, enabling prompt system responses. These sensors are chosen based on sensitivity, accuracy, and suitability for detecting specific threats or events. Their integration enhances system intelligence and responsiveness, enabling proactive detection and mitigation of security risks and environmental hazards.

In addition to component selection, the system's intelligence lies in its code implementation using software like KIEL, enabling efficient device control via SMS commands sent through the GSM module. Thorough testing and debugging ensure robust functionality, supported by comprehensive documentation for ease of operation and troubleshooting. Continuous monitoring post-deployment allows for updates and improvements, ensuring the system remains reliable and effective in providing a secure and smart living environment.

A.Block Diagram

Power Supply: The power supply section is responsible for providing a stable +5V for the components to operate. The IC LM7805 is utilized to ensure a constant power output of +5V. The AC voltage, typically 220V, is connected to a transformer, which steps down the AC voltage to the desired DC output level.

Microcontroller: A microcontroller is a compact integrated circuit designed to control specific operations within an embedded system. It typically includes a processor, memory, and input/output (I/O) peripherals on a single chip.

GSM Modem: A GSM modem is a specialized type of modem that accepts a SIM card and operates based on a subscription to a mobile operator, similar to a mobile phone. From the mobile operator's perspective, a GSM modem appears just like a mobile phone.

Driver Circuit: A driver IC is a circuit or component used to regulate current flow and control another circuit or component. Acting as an interface between a microprocessor or microcontroller and the output component, the driver IC receives image data and delivers precise analog voltages to activate pixels on a display.

LCD: A liquid-crystal display (LCD) is a flat-panel display or electronically modulated optical device that utilizes the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals themselves do not emit light; instead, a backlight or reflector is used to produce images in color or monochrome.

Light: An electric light, lamp, or light bulb is an electrical component that generates light. It represents the most common form of artificial lighting.

Fan: A fan is a powered machine designed to create airflow. It consists of a rotating arrangement of vanes or blades, typically made of wood, plastic, or metal, which act on the air. The rotating assembly of blades and hub is known as an impeller, rotor, or runner.

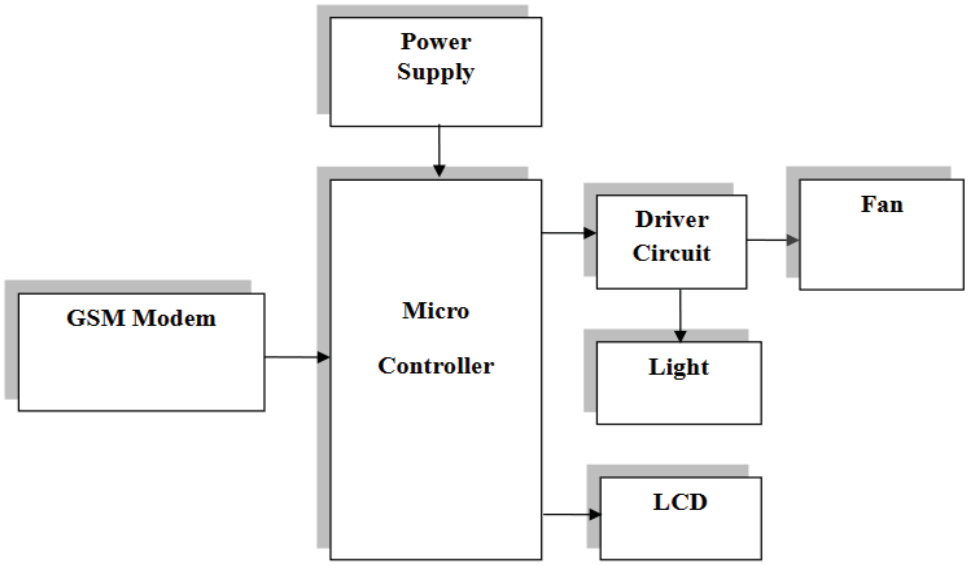

Fig. 1. Block diagram of GSM based home automation.

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B. Schematic Diagram

In Fig 2 is a schematic diagram for a Home Automation and Security System using GSM, diverse components and their connections are intricately laid out, offering a holistic view of the system architecture. At its core, the diagram would feature a power supply section incorporating a transformer and LM7805 IC, illustrating their connections to provide a stable +5V power source. The microcontroller, serving as the brain of the system, would be prominently displayed with detailed connections showcasing its role in managing system operations, including processor functions, memory utilization, and interactions with various I/O peripherals. Integrated into the system is the GSM modem, visually represented with connections that highlight its communication capabilities with mobile networks through a SIM card. A crucial aspect of the schematic would be the driver circuit setup, portrayed to showcase its function as an intermediary between the microcontroller and different output components. This circuit regulates current flow, controlling devices such as lights and fans. Additionally, the schematic would include an illustration of the LCD connections, demonstrating their integration with the microcontroller for displaying pertinent information in a user-friendly format. The inclusion of sensors, such as motion detectors and gas sensors, would be visually represented, indicating their connections to the microcontroller for real-time data acquisition. The diagram would further elucidate the implementation of code for device control via SMS commands through the GSM module, possibly using a flowchart to represent the logical sequence.

Security logic implementation is another critical aspect, with the schematic featuring connections and pathways that depict the system's response to security breaches, fire incidents, or gas leakages. The optional integration for Android mobile control might be presented with connections to both the microcontroller and GSM module.

The testing and debugging phase would be outlined in the schematic, showcasing a flowchart or series of steps to ensure the system's robust functionality. Sections for comprehensive documentation, including circuit diagrams and code snippets, would be visually indicated along with a user manual section for operational guidance and troubleshooting. Lastly, the continuous monitoring and updates segment will be depicted, illustrating the ongoing phase for system evaluation and potential enhancements post-deployment, ensuring the longevity and efficiency of the Home Automation and Security System using GSM.

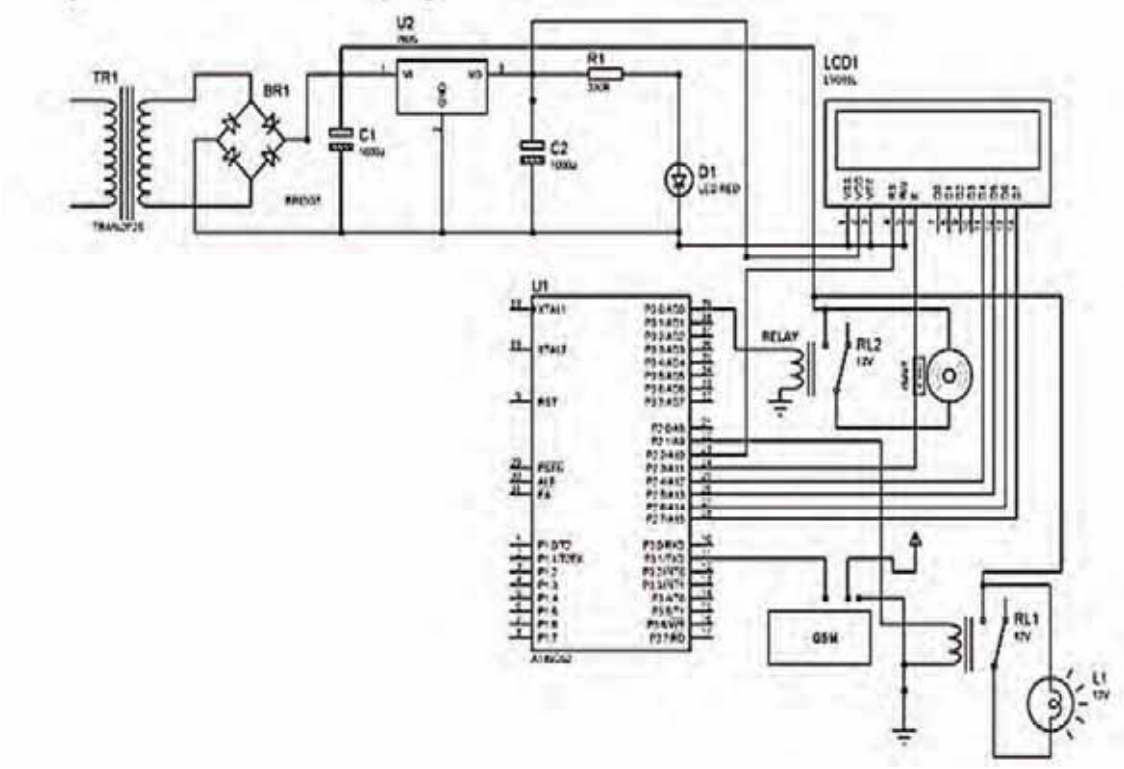

Fig 2. Schematic Diagram of GSM based home automation.

IV. RESULTS

The project's operational framework is delineated into three distinct facets: home automation, home safety, and the security system. The mechanism is initiated by employing a basic GSM-based phone to transmit SMS commands to the integrated GSM modem within our project setup.

Upon receiving the SMS, the microcontroller undertakes the task of extracting the message contents, deciphering the instructions embedded within. This decoded information is

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then employed to control the relay module, allowing for the activation or deactivation of appliances as per the owner's directives.

In the domain of home safety, the project integrates sophisticated sensors, including a smoke detector and an LPG gas detector. These sensors play a pivotal role in identifying the presence of gas or smoke. Once a potential hazard is detected, the sensors promptly communicate this feedback to the microcontroller.

Subsequently, the microcontroller orchestrates a multi-faceted response, including the dispatch of an SMS alert to the homeowner and the activation of an audible alarm. The results of this project demonstrate a seamless integration of home automation features, allowing for the remote control of appliances through simple SMS commands. Simultaneously, the home

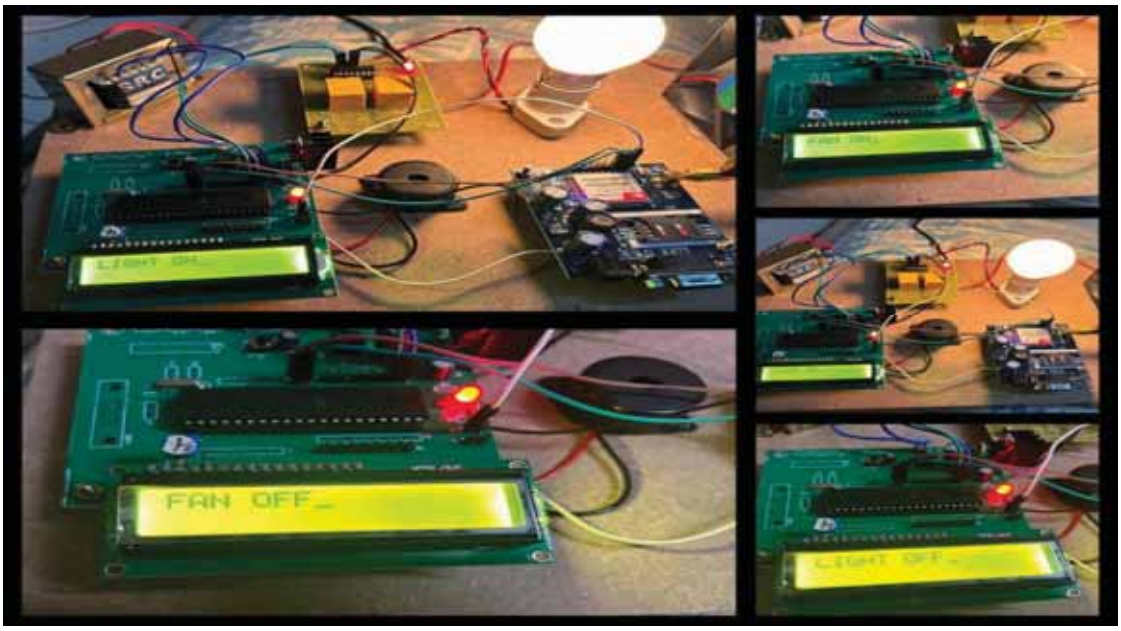

Fig 3. Hardware Setup of the system

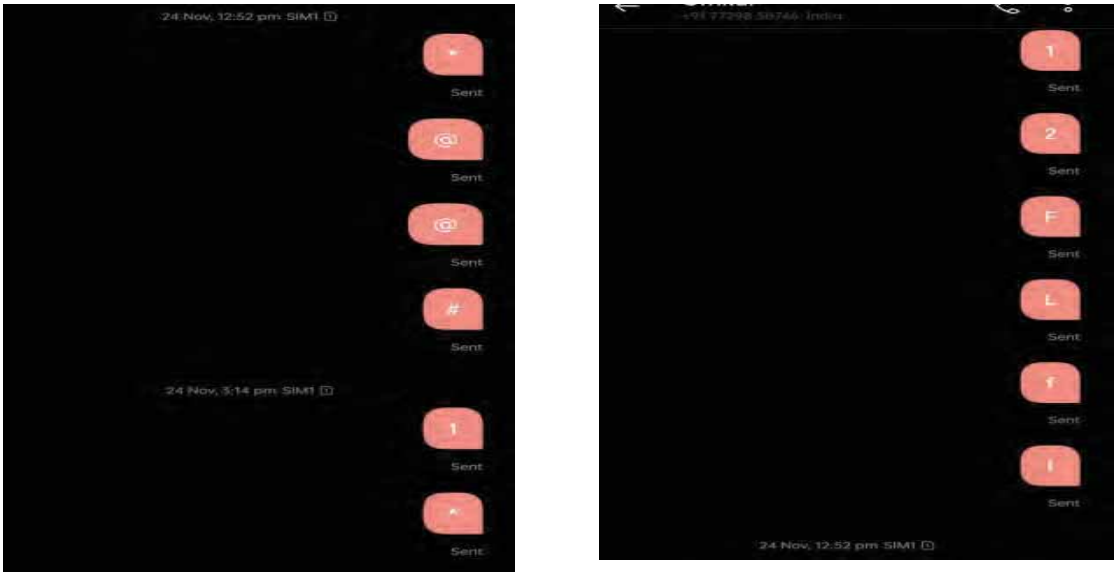

Fig.4. Android phone data

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V. Conclusions

This paper explores our cost-effective GSM-based home automation, safety, and security system, presenting a user-friendly solution that proves both practical and economical. The system offers a straightforward means of managing household appliances, enabling control through a simple SMS or an Android application. Notably, the versatility of The researcher's approach allows users to control devices with ease, whether through the safety-enhanced Android application or by sending a conventional SMS to the GSM modem in the absence of a smartphone. An overarching advantage of our system lies in its accessibility and ease of installation for safety and security features. The system can promptly alert the homeowner about potential fire hazards, gas leakages, or unauthorized access, providing peace of mind even when the owner is away from home. This dual functionality, blending convenience with enhanced safety measures, positions our GSM-based home automation and security system as a practical and inclusive solution for modern households.

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