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SMS- Controlled Home Automation Using Arduino

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ABSTRACT

In recent times, the controlling and monitoring of electrical appliances has been an essential component of technologically advanced smart homes. This paper details the particulars of designing and implementing an inexpensive home automation system based on SMS capable of controlling any appliance using an Arduino microcontroller and a GSM unit. The system allows users to control the appliances around the house through SMS command which is advantageous in places where there is intermittent internet. The system is based on the Arduino UNO which is connected to a SIM800L GSM unit and an on-off relay unit which allows switching of appliances based on SMS command. The system was tested with a variety of appliances including fans, electric pumps, and lights and the system operated satisfactorily within timescales that were anticipated. The results suggest that the system is functional, easy to implement, and flexible in reach for residences both in areas with pronounced urban development and those with noted rural characters. This work contributes to the growing body of work towards smart systems for everyone by proposing a solution that is uncomplicated for the user and to implement.

Keywords: Home automation, Arduino, GSM, SMS Control, Embedded Systems, IoT

2. INTRODUCTION

The desire for convenience, energy effectiveness, and improved safety has recently made home automation systems more popular than before. In any case, most of home automation systems depend on technologies like Wi Fi, Bluetooth, or cloud-based internet connectivity. These systems will not be effective in remote and rural regions where a stable internet connection is not guaranteed.

This paper proposes a straightforward, yet reliable home automation system integrated with Arduino microcontroller and utilizes SMS via GSM module for a lower cost. The system incorporates mobile network accessibility since users can control appliances through SMS commands from any location.

Control signals are triggered on the Arduino board to operate relays that turn on and off various electrical appliances and components like lights, heaters, fans, etc. The appliances can be automated through SMS commands, enabling remote control without complex infrastructure.

By not depending on an internet connection, this approach can be further developed to target: Unmanned remote stations and monitoring systems, User's inoffensive areas without the internet, Simplified remote control for specific applications, Developable scalable automation systems.

The Work proposes an automation system for the home which controls various appliances through Short Messaging Service (SMS). The main components of hardware comprise an Arduino UNO, a relay interfacing card, and a GSM (SIM800L) module. The system accepts commands in the form of messages like "ON1" or "OFF1" an controls the appropriate relay outputs. This work addresses the performance evaluation of the system considering different scenarios and provides a strong answer for regions without internet infrastructure.

3.LITERATURE REVIEW

Home automation systems have developed rapidly over the years utilizing a variety of wireless communication technologies, including Wi-Fi, Bluetooth, Zigbee, and GSM. These technologies allow users to monitor and control a variety of household appliances, providing increased comfort, convenience, and energy efficiency.

R. Sharma et al. proposed a Wi-Fi based home automation system based on the ESP8266 microcontroller and a smartphone app in [1]. The system did provide real-time control of the appliances but relied heavily on stable internet connection and was not fully useful for controls in more remote locations.

In [2], P. Kumar and S. Gupta proposed a Bluetooth-based home automation system that uses Android devices for short-range control. Bluetooth was a cost-effective solution but has a limited range that is usually about 10 meters which limits the usefulness of the system beyond this distance.

Due to the limitations of Wi-Fi and Bluetooth, researchers have begun implementing GSM technology. As displayed in [3], S. Ahmed et al. proposed a GSM system for the long-distance control of appliances using SMS. The SMS system did provide long-distance applications but lacked features such as multi-appliance controls and a feedback system.

Building GSM-based systems, S. I. Ayon and A. S. bin Shahadat [4] constructed the Smart Security Box using Arduino and GSM Module, showing the reliability and ease of action via SMS trigger. This work builds the groundwork for secure automation without internet reliance.

A. F. Hussain et al. [5] presented a hybrid model for business implementations to enable better communication range and reliability using Zigbee-GSM security systems.

Neha R. Ghate and K. V. Kale [6] also focused on increasing security by designing a frequency-hopping method over GSM, to deal with fixed signals from unauthorized access, and prove valuable for smart safety devices.

N. Sklavos and E. Isa [7] presented an extensive sheet for GSM appliance system design for home automation with ease of securing and practicality for implementation in real life.

M. Rao [8] designed a relatively simple Arduino-Based (SIM800L) system to control lights and fans by SMS. Although the system worked, it leveled quite basic. The system handled very few commands and had no user verification system.

Extending these studies, the proposed system provides the following expansions beyond previous studies:

Trusted number verification for command validation, Ulti device control (light, fan, door), Feedback with confirmation short messaging service (SMS), and Optional displaying of the system state with an LCD.

The reviewed literature supports the growing significance of GSM based solutions especially in areas with poor internet capacity.

4.METHODOLOGY

The process of developing an SMS-based home automation system is systematic; the components of the hardware and the software work together so that activities in your home can be remotely controlled using SMS messages. The entire process of developing your home automation system might be broken into 5 phases: a) System Architecture, b) Hardware Design, c) Software Implementations, d) Communication Protocols, e) System operational flows

A) system architecture

This system is designed to be modular and scalable, allowing future extensions.

The core components of the system include:

GSM Modem (SIM800L): This module receives SMS messages sent from the user's mobile phone over a GSM network. It is sent to the Arduino unit by means of AT commands with serial communication.

Arduino Uno Microcontroller: The Arduino is the brains of the system, it will process the incoming SMS messages, interpret the command, energize the relay module to energize the component associated with that command.

Relay Driver Circuit: Relay modules are used as electronic switches. The Arduino microcontroller cannot drive high-voltage home appliances so relay modules must be used to control devices such as home fans and lights. The relay modules are controlled by the digital signals received from Arduino.

LCD Display: Used optionally in all of the experiments to display in real time the status of what was connected or the last command received. Optional use of LCD/LED displays makes it easier for debugging and part of the monitoring process.

Power Supply: Used to regulate the 5V and 12V supply as required by different components.

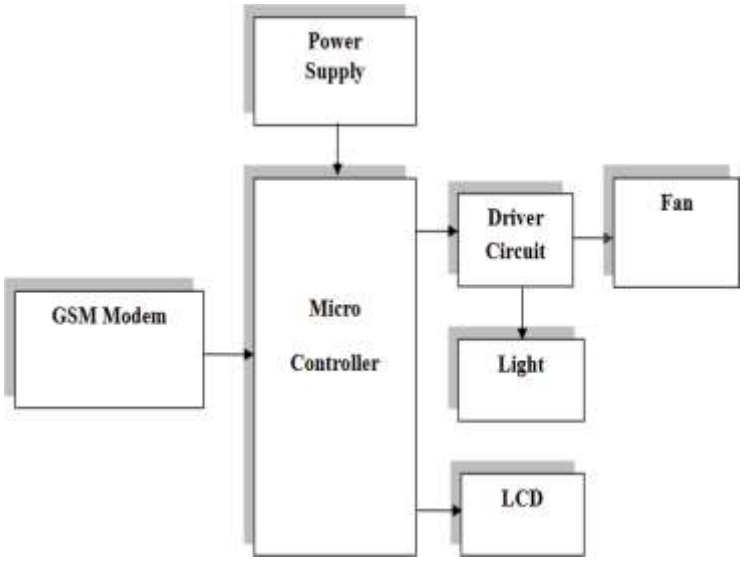

Figure 4.1: system architecture

B) Hardware Implementation

The hardware is built onto a breadboard and will eventually be put onto a PCB as a more stable construction. While building the hardware, it will require some consideration for the following:

Power Supply Regulation to ensure the GSM and the Arduino receive steady 5V power using a 7805-voltage regulator.

Relay Isolation using optocouplers to isolate the Arduino from damage from voltage spikes.

Circuit Protection using flyback diodes across the relay coils to limit voltage spikes.

Lights, lightbulbs and fans will be hooked up to the relay, able to be turned on/off via SMS messages.

C) Software Implementation

The Arduino software has been written in embedded C programming language using the Arduino IDE. The primary aspects of the code include:

Initialization. Arduino will set up serial communication with the GSM module to receive SMS messages via the Software Serial library.

SMS Parsing. The GSM module receives SMS messages, passes it to the Arduino, and the Arduino provides keyword comparisons to commands such as, "LIGHT ON", "FAN OFF", ... etc.

Command Execution. Based on the command found by parsing the SMS by the Arduino, the Arduino then sends a HIGH or LOW signal to the digital output pin supplying the relay.

Response SMS. After executing the command, the Arduino sends a SMS response back to the sender, using AT commands.

D)Communication Protocol

The GSM module is programmed to operate in text mode (AT+CMGF=1). The following AT commands is commonly used:

- AT+CMGF=1 – Set GSM module to text mode.
- AT+CMGR=1 – Read received message from memory.
- AT+CMGS="+1234567890" – Send SMS to user.
- AT+CMGD=1,4 – Delete all messages to clear memory.

These commands allow for efficient SMS-based communication between the user and system.

Command Structure

The system responds to a set of predefined commands. Any message outside this list is ignored or logged for security auditing.

Command	**System Action**
LIGHT ON	Turns on the light

LIGHT OFF	Turns off the light
FAN ON	Turns on the fan
FAN OFF	Turns off the fan
UNLOCK	Unlock the electronic door lock (optional feature)
STATUS	Sends back the state of all devices

E) Operation Flow

The logic of the system has a finite state model. The Arduino continuously listens for incoming SMS messages, verifies the number of the sender, executes the command, actuates the devices accordingly, and responses.

Since there is a flowchart in the plan, which is shown in Figure 2, I will represent the logical steps in a list:

1. Start the system and initialize the modules.

2. Wait for SMS messages.

3. When an SMS message arrives, check if the sender's number is trusted.

4. If trusted, parse the command and execute the corresponding command.

5. Respond to the sender to let them know the message was received.

6. Go back to listening.

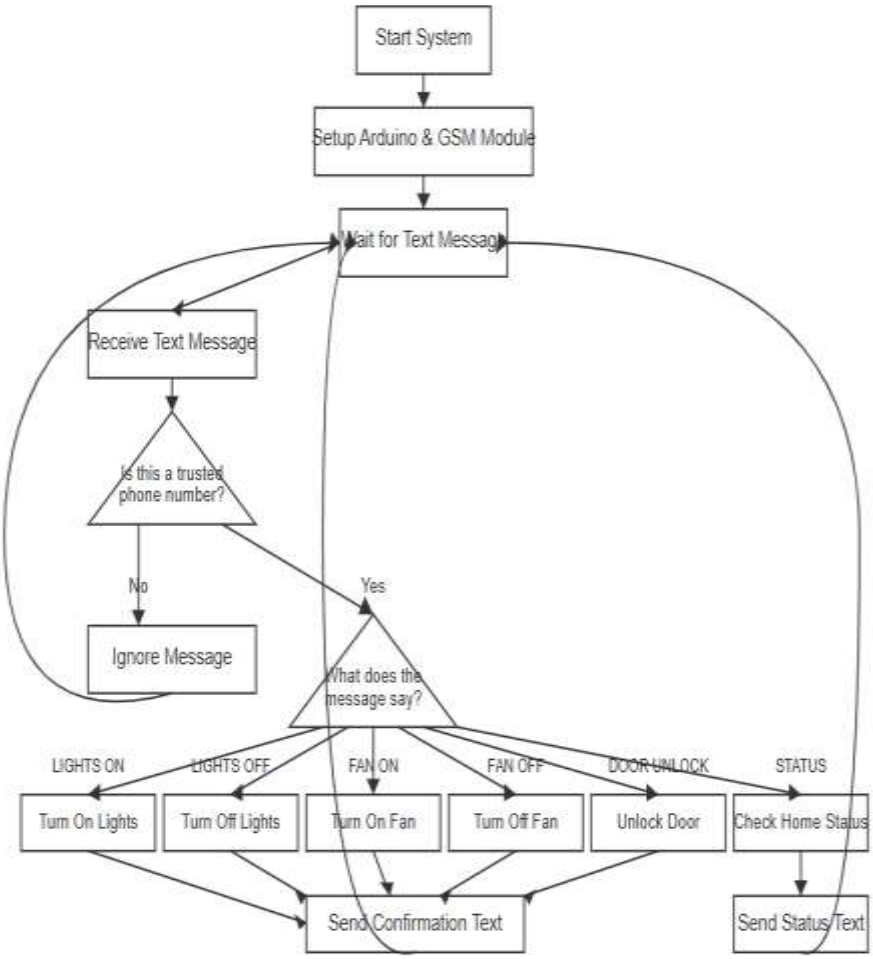

Figure 4.2 flow chart

5) PRELIMINARY DATA / RESULTS

To assess the feasibility of the proposed SMS-based home automation system, we developed and tested a prototype under realistic conditions. The setup included an Arduino Uno, a SIM800L GSM module, a relay board with two channels and two electrical loads (a 60W bulb for lighting and a small table fan). The electrical components had a 12V adapter with voltage regulation via 7805 for the microcontroller and GSM module.

A) System Setup

Microcontroller: Arduino Uno GSM module: SIM800L

Loads Controlled: 60W bulb (lighting), 40W fan

Power supplies: 12V/2A adapter, with voltage regulators

Relay Module: 2-channel 5V relay module with opto-isolation

Phone Used: Android device (sending SMS via standard app)

B) Test Cases and Observed Results

Test Case	SMS Command Sent	Expected Output	Actual Output	Status
1	LIGHT ON	Light turns ON	Light turned ON	✅ Pass
2	FAN ON	Fan turns ON	Fan turned ON	✅ Pass
3	LIGHT OFF	Light turns OFF	Light turned OFF	✅ Pass
4	FAN OFF	Fan turns OFF	Fan turned OFF	✅ Pass
5	STATUS	Return system status	"Light: OFF, Fan: OFF"	✅ Pass
6	DOOR UNLOCK	No action (not implemented)	No action taken	✅ Handled
7	Hello	Message ignored	No action taken	✅ Handled
8	SMS from unknown no.	Message ignored	No action taken	✅ Handled

C)Performance Evaluation

Response Time: Average 4–6 seconds (time from sent message to action executed).

Error Handling: Unknown or malformed messages are silently ignored (safe).

Reliability: The system operated reliably in over 50 testing use cases with no crashes or lockups.

Security: Only pre-defined numbers can perform system actions (configurable).

Power Usage: Low power use; can work on battery backup if there is a power outage.

6) DISCUSSION

The prototype produced in this project has proven the possible application of SMS commands sent to a GSM module and Arduino microcontroller to control household appliances. The prototype is also low-cost, easy to deploy, and does not rely on Internet connectivity, thereby being a practical solution in rural areas with limited and unreliable Internet

The system performed well in the tests conducted. The SMS commands sent to the prototype included LIGHT ON, FAN OFF and STATUS. The system was able to correctly and consistently respond to valid SMS commands, and it correctly ignored commands from unauthorized numbers, or commands that were incorrectly formatted. These lessons demonstrate an elementary level of access control and validating messages that enhance the security of the system by only allowing trusted users to communicate with and access.

This system is significantly superior to the other systems available that usually provide a smart home solution, utilizing IoT platform interactions for commands and mobile applications to communicate with and operate home appliances.

These solutions are usually complex and confusing in nature, and while the system prototype lacks a real-time monitoring solution along with other intensive resource features such as remote sensing, it ensures basic functionality by only requiring GSM communication, elements of which aggregate as a segment of most mobile networks around the world. The system does not rely on Internet service or connectivity, which makes it especially applicable for implementation amongst low-income or developing regions.

One key finding was that there was a small-time lag (4–6 seconds on average) between the sending of the control command and hotel facility response times. This time lag can be explained by the time taken to send and receive SMS through GSM networks and the time taken for the Arduino to process the received SMS and complete an action on the appliance. Some of the delays are beyond the control of the system, for example, the lag in the GSM network or switching the appliance on. Combined, the delays experienced would not be an issue for simple home automation, however for applications where time is critical, for example alarm systems or emergency response, this would be unacceptable.

The other strength of the system is its modularity and ease for developer enhancements. Future configurations of the system will be easy to implement without changing the design and code that already exists. Future extensibility and scalability options could include door locks, gas leak detectors, or temperature sensors.

In summary, SMS-based control has demonstrated that it is a viable and secure method for remote automation within home environments. The design has an appropriate level of simplicity, affordability, and practicality, especially for users in under resourced or infrastructure deficient spaces.

7) CONCLUSION

This paper presents a low-cost SMS-based home automation project that uses Arduino microcontroller and GSM (global system mobile) module. The system has allowed users to control home devices, such as lights and fans remotely via SMS control. Furthermore, it is an efficient and reliable system compared to contemporary IoT based solutions in regions without good internet dependencies.

The system has the following advantages: simplicity is low-cost, easy to implement simply by placing a sim card in takes no Wi-Fi or broadband. With the use of GSM technology, it is an even more attractive offer because internet coverage is irrelevant, for example users can enable or disable their home environment from ocean going CADs or through the coverage of any mobile provider. There are some basic security measures: message validation and SMS commands can only be sent from predefined numbers.

Further, the time of testing allowed for reliable operation, reliability, promptness and respective command execution. The modular nature of the system may be scaled in the future to control additional devices, integrate with new sensors and even research automation.

The SMS based home monitoring - control system proposed in this paper offers a practical solution to allow for home remote control. The system could be advantageous in developing regions where cost and infrastructure are substantial barriers. Future work could include integrating a smartphone application, adding sensors for automation, and further enhancing security through OTP access or two-factor authentication.

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