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Design of A Microcontroller Based Mobile Security Lighting Control System

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ABSTRACT
Security and automation is a prime concern in our day-to-day life. The approach to home and industrial automation and security system design is almost standardized nowadays. In this paper, an attempt was made to design a low-cost automated security lighting control system. The developed system functionality is controlled by an ATMEGA8 Microcontroller. An authenticated signal is sent from the user's cellular phone via Global System for Mobile Communication (GSM) network to the equipment. The signal consists of information made up of the function or action expected to take place i.e. whether the light should be switched Off/On. The receiver phone receives the SMS message that is sent from the user's phone and then sends it via the GSM modem which in turn sends the output digital signal to the microcontroller. Then the microcontroller, on receiving the signal, controls the different relays and triggers the required appliance.

KEYWORDS*: Automated, GSM Modem, Microcontroller, Security lighting.*

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I. INTRODUCTION

Security is critical for meaningful living and well-being. To get absolute peace of mind whether you are home or out of home there is a need to maintain security. This need has propelled the setting up of home security lighting control systems, which can be used to provide a security system for residential, industrial, and all domestic and commercial purposes using. In addition, an automated lighting system can minimize energy wastage.

Security is the degree of protection against damages, danger, loss and crime. A security system provides a form of protection that ensures the safety and security of the assets and the freedom from threat but is not limited to the elimination of either the asset or the threat (Mae, et al., 2011). Mobile devices, such as mobile phones, are becoming multipurpose devices. Imagine being able to control all the electrical appliances in a house from virtually any place in the world, GSM home automation may seem like an idea of the future; however, there are many possibilities of using it currently (Hillebrand, 2013). The technology works by allowing communication between a receiver in the house and a mobile phone elsewhere. That receiver can then be signalled to On or Off appliances in the house based on the command from the mobile phone. Through the use of a microcontroller, any electrical or electronic device such as lighting a bulb can be controlled from a distance (Ohaneme, Akpado, Ifeagwu & Ezeagwu, 2014, Tang, Kalavally, Ng & Parkkinen, 2017).

In this research, we present a design that permits a user to perform lighting switching operation from a remote location via GSM technology and its Short Messages Services (SMS) functionality. The developed system utilizes a microcontroller rather than the conventional Personal Computer. This ensures portability and flexibility.

Negligence in powering Off security light during the day when they are not required is a source of energy wastage. As mentioned by Bakare and Odeyemi (2015), "this wasted power directly affects the homeowner electrical bills. Another problem is that of the busy homeowners who will arrive home late at night; they may want to switch on their security lights from a distance" to protect themselves from burglars. So if a mobile device is programmed to send switching commands in the form of SMS to a GSM module interconnected with a microcontroller, home occupants "can control the system through his mobile phone by sending Attention (AT) commands to the Modem line and in turn, to the microcontroller".

In principle, the design will have the following merits To provide or develop a system to have wireless control of home electrical appliances.

- To eliminate the need of being physically present in any location for switching task.
- Minimize power and time wastage.
- To minimize power and time wastage
- o reduce the stress of the owners walking around the house to switch ON and OFF of the appliances in the house

The rest of this paper is structure as follows: In section 2, we present a review of related works. Sections 3 and 4 described the materials used and the result obtained. Finally, conclusions reached are highlighted in Section 5.

II. LITERATURE REVIEW

This part of the paper presents an overview of automated lighting control systems. Tang et al. (2014) "presents an intelligent lighting system prototype with enhanced security features for smart homes. The custom-built Android mobile application made use of the onboard ambient light sensor to run a novel closed-loop feedback algorithm to implement daylight harvesting. A cost analysis shows that the whole system setup is slightly cheaper than commercial products and due to its daylight harvesting capabilities, has potential for monetary savings in the long run, outperforming current commercial products". Li, Chen, Zhao & Liang (2014) also came up with an intelligent lighting control system based on the EnOcean technology. "The proposed system takes the mobile devices into account and designs the corresponding software to realize the communication between the mobile devices and the EnOcean network". Conceptually, EnOcean is a wireless technology with a very strict low-power design.

Suresh, Anusha, Rajath, Soundarya & Vudatha (2016) developed an Arduino based automatic lighting and control system for the efficient utilization of energy in classroom condition. The authors split the classroom into grids. Thus, when a particular grid does not sense the presence of students, the lights there will not switch On. Other than the use of relays, the authors made provision for mobility and remote command execution of the system via mobile App via Bluetooth to control lighting based on voice command.

A wireless networked, sensor-driven lighting system using occupancy and light measurements from the multiple sensors, a multivariable controller was developed by Pandharipande, Caicedo & Wang (2014). The system determines dimming levels of the light sources to realize an illumination distribution adapted to changing occupancy and day time luminance. As an embodiment service, the authors employed "presence sensor data for constructing occupancy maps and, in conjunction with light sensor data, to analyze the energy consumption patterns of lighting systems". Zou et al. (2018) present WinLight, another occupancy-driven lighting control system, whose goal is to minimize energy consumption without sacrificing the lighting comfort of residents. The system leverages the fine-grained occupancy information predicted from existing WiFi infrastructure in a non-intrusive manner. The information gathered is used by WinLight to "computes an appropriate dimming command for each lamp based on a novel lighting control algorithm. A centralized lighting control system assigns these commands to a zonal gateway, and occupancy-driven lighting control is achieved by actuating the brightness adjustment with a local controller integrated within each lamp". In addition, via an installed mobile app, occupants can customize their luminance preferences and control nearby lamps using their mobile devices.

Karapetyan, Chau, Elbassioni, Khonji & Dababseh (2018) proposed "an energy-efficient smart lighting control system using mobile light sensors for measuring local illuminance and assisting smart light bulbs to coordinate the brightness adjustments while meeting users' heterogeneous lighting preferences". The authors noted a key issue in these kinds of systems being the "presence of oblivious mobile sensors hampered by the uncertainties in their relative locations to light bulbs, unknown indoor environment and time-varying background light sources". Given this, Karapetyan e al. (2018) developed a model-agnostic control algorithm, which induces "continuous adaptive coordination of oblivious mobile sensors" in the absence of complete knowledge of the operational environment and parameters.

III. MATERIALS AND METHOD

The connection of the entire system is as shown in Figure 1. The security lighting control system consists of both the transmitting and receiving sections. A GSM phone capable of sending SMS comprises the transmitting section of the system. The receiving section is made up of consists of an ATMEGA8 microcontroller, a GSM modem, a buzzer, and other electronic accessories. When the GSM sends SMS, the GSM modem or module receives it and sends it to the ATMEGA8. The microcontroller accesses the SMS and changes the state of the appliances if the signal is an appropriate code. When this is done, the microcontroller sends a signal to the GSM modem to send back a reply to the GSM phone via SMS.

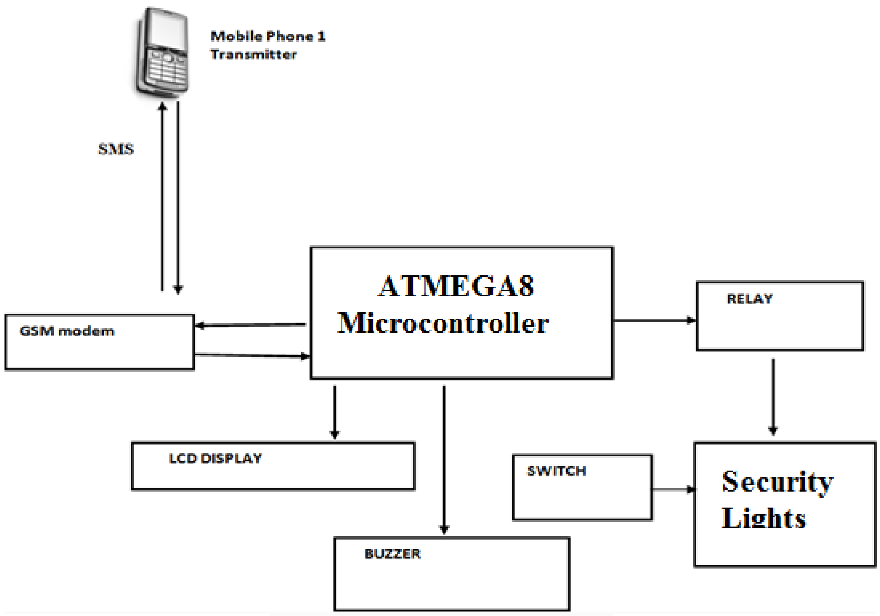

Figure 1: System block diagram

The switches are the alternative means of changing the state of the appliances. If the homeowner is close to the transmitting end, he/she can use the Switch buttons to change the state of the appliances. The buzzer is for notification: to notify when there is a change of state. So whether one uses the switches or the GSM phone, a sound will be produced to notify a change of state. The display is a Liquid Crystal Display (LCD) which displays the signal processing results. For the security aspect, if one presses any of the switches, the GSM modem will send a signal via SMS to the GSM phone, notifying that there is a change of state in a particular appliance. Another security aspect is that if the cable of any of the appliances is cut, the GSM modem will also send a signal via SMS to the GSM phone notifying that a particular cable has been removed.
The GSM modem communicates with the microcontroller via an interface. Outgoing message from the system containing the home appliances status is delivered to the mobile phone through GSM modem".

3.1. Power Supply

The calculated load demand of the entire circuit is approximately 400mA; hence a transformer that is about 1000mA and above can be used for the circuit. A transformer with a secondary voltage of 18V and a currentof 1000mA is used. The power supply circuit for the system is shown in Figure 2.

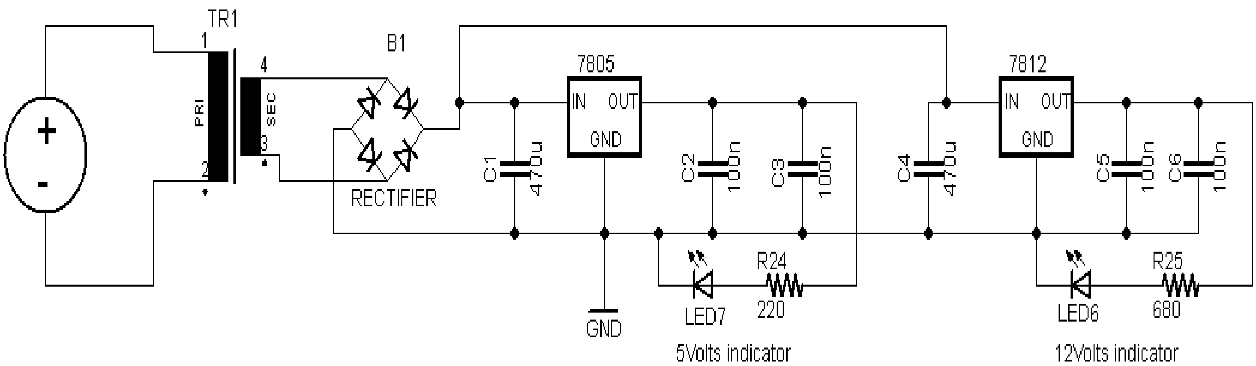

Figure 2: System power supply circuit

The GMS communication interface is shown in Figure 3.

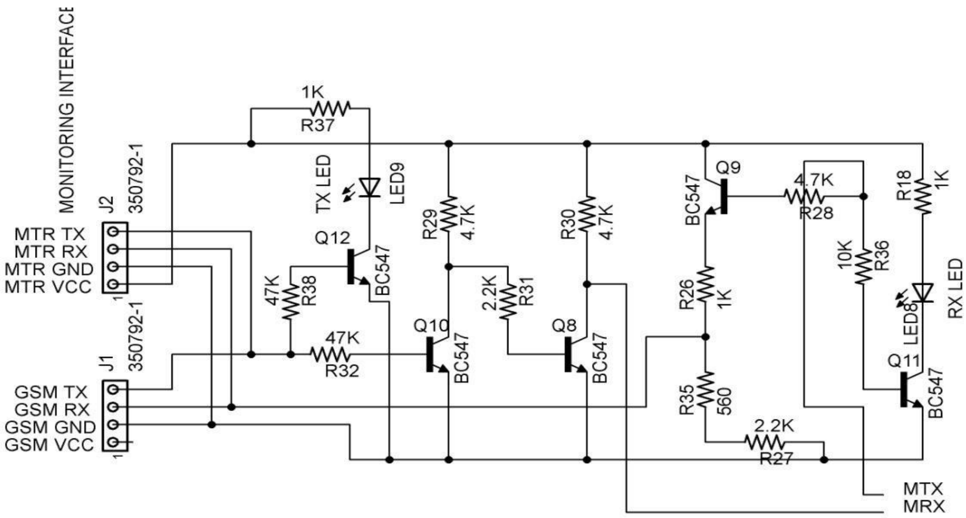

Figure 3: Circuit diagram for the GSM communication interface

As shown in Figure 3 above, the GSM interface is basic to guarantee that the for proper the mobile phone is properly connected to the microcontroller. The reason for this is that the microcontroller provides 5v but the GSM interface needs a 3.3v for transmitting and receive pins.

The comprehensive circuit diagram is shown in Figure 4. It consists of all sub-units used in realizing the automated microcontroller-based mobile security lighting control system.

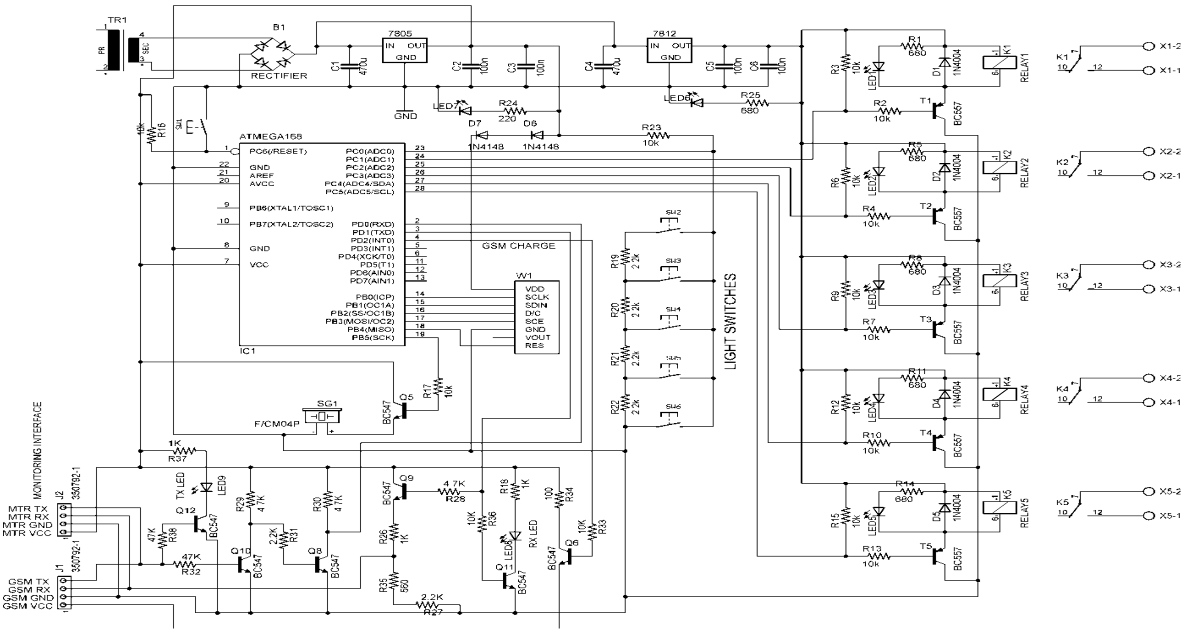

Figure 4: Comprehensive circuit diagram of the system

For the operation of the system, the microcontroller has to be programmed using embedded C language, AT command and visual basic 6.0. The flow chart of the program is shown in Figure 5.

AT commands: The communication between the GSM module and the microcontroller is achieved through AT(Attention) commands with a serial communication protocol of Universal Asynchronous Receiver and Transmitter (UART), with frame format parameters of 9600Baud rate, 8bit data, 1 start bit, 1 stop bit and no parity bit (Teymourzadeh et al. 2013).

The AT command and actions are shown in Table 1.

Table 1: GSM module Attention command

AT Commands	Actions
AT+CSCA	Set the SMS centre address. Mobile-originated messages are transmitted through this

	servicecentre.
AT+CMGS	Send a short message to the SMS centre
AT+CMGR	Read one message from the SIM card storage
AT+CSMP	Set additional parameters for Text mode messages
AT+CMGD	Delete a message from the SIM card storage
AT+CMGF	Select format for incoming and outgoing messages: zero for PDU mode, one for Text mode

All commands to the microcontroller are done with SMS, these messages have a format of COMMAND.SUBCOMMAND.PERIPHERAL#PIN
The command in this case is a switch operation.
The subcommand is either ON, OFF or TOGGLE.The peripheral is either of the seven lighting points.
The pin is a four-digit numeral personal identification number. A typical format will be, ***Switch.on.north light#8888***

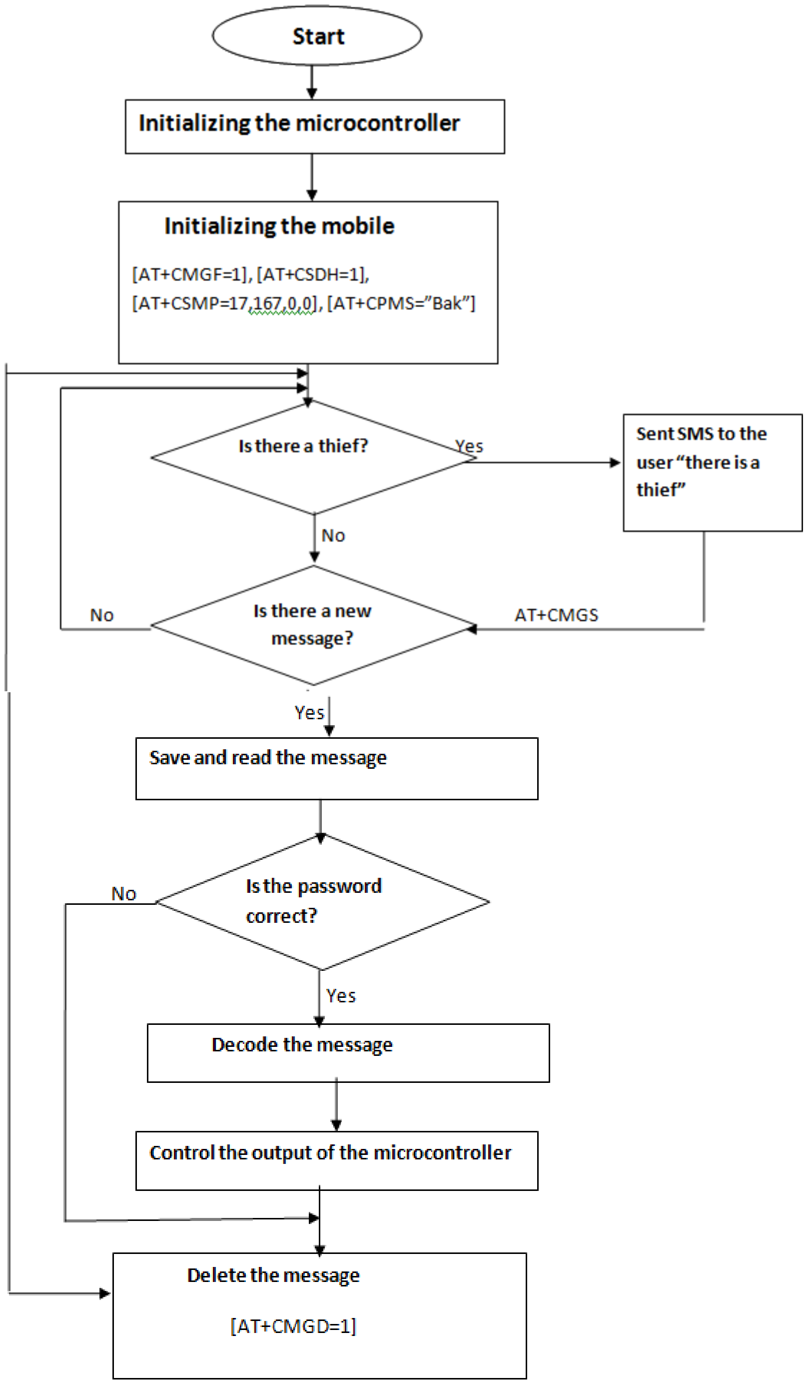

Figure 5: System flow chart. Sourced from Bakare and Odeyemi (2015)

IV. RESULT AND DISCUSSION

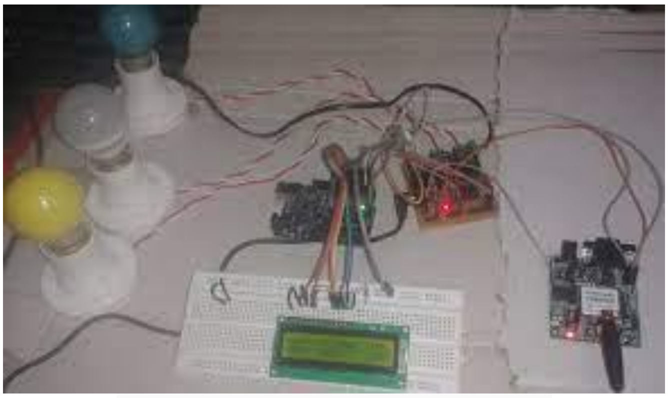

Figure 6: Image of the developed system

The image of the finished system is depicted in Figure 6. The time interval between the sent text and action is estimated to be lower than 500 µs. This delay time is acceptable for about five character command. But, if the amount of data transferred is very huge, the response delay time will become crucial and should be examined.

V. CONCLUSION

In this paper, we design a microcontroller-based mobile security lighting control system. The ATMEGA8 microcontroller was used with satisfactory performance. The proposed prototype was implemented and tested with a maximum of seven lighting points.

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