MAKERERE  UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY

Department of Electrical and Computer Engineering

A REPORT ON FINAL YEAR PROJECT

**PROJECT TITLE:** ***SMART GSM CONTROL FOR AUTOMATIC GATES AND DOORS***

***BY***

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**Reg No: 17/U/422**

**A final year project report submitted to the Department of Computer and Electrical Engineering as Partial Fulfillment for the Award of the Degree of Bachelor of Science in Electrical Engineering.**

**DECLARATION**

I, **KISAKYE DEBORAH MARIA (17/U/422)** declare that IN COOPERATION with my project partner, **AYO BRIAN (17/U/18580) ,** did research, formulated, designed and implemented the project titled: **"SMART GSM CONTROL FOR AUTOMATIC GATES AND DOORS"**

I also declare that, No portion of the work in this document has been submitted in support of an application for any other degree or qualification of this or any other university or institution of learning. Except where specifically acknowledged, it is the work of the author.

I have abided by the Makerere University academic integrity policy on this assignment.

Date: 11TH **FEB 2022**

Signature: ……

**ACKNOWLEDGEMENT**

I would like to thank the Almighty God for the protection and his faithfulness throughout the process of carrying out the project.

I would like to thank Makerere University for the conducive environment that allows for research to take place and for the projects favorable policies in incubation of projects like the one I embarked on.

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SMART GSM CONTROL FOR AUTOMATIC GATES AND DOORS iv

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**Executive Summary**

The project we are embarking on explores the various potentials of remote-control systems using simple and cheap methods of GSM to control basic home access control systems like the doors and gates, which have systems that can be controlled through a relay. Over the past few months, we have embarked on various consultations among different homeowners in Uganda, especially in the upscale areas. They expressed interest in a cheap way to remotely access their homes.

The analysis of the project involves developing a GSM control module that will be integrated into a gate motor or a door access control system. The report explores the various results of the simulations carried out, and the results got to better the project results. After the project is implemented, the different homeowners who already have home access control devices will have an added advantage of having an easier way to control these systems without the need to use the remotes but rather through the convenience of their phones wherever they may be in the world. The homeowners will now conveniently grant access to their premises even at the convenience of their workplaces. The project focuses on the GSM protocol functionality allowing the user to control different systems using frequency bandwidths. The GSM system will be able to tell whether the door or gate is open or closed. We will be designing and prototyping a microcontroller-based relay system that is integrated to the GSM receiver. The system is implemented by testing two different door systems controlled by the relay. In the demonstration, a MAGLOCK was used to simulate the opening and closing the "Open" and "Close" State. In our simulations, we are targeting to get an accuracy of above 95% to consider it successful.

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# CHAPTER ONE

## 1.0 Introduction

The idea of controlling home access controls has been the desire of many Ugandan home Owners because they leave home for work early in the morning and do not return till late in the evening. Sometimes they even travel upcountry and unexpected visitors or service providers may find a hard time accessing their premises because they are not there. With a GSM Gate management System, the homeowner can send an SMS to open the specific doors and then close when the service providers are done with their services, including Garbage Collection and Meter reading. One of the most extensively used cellular technologies globally is GSM, which stands for Global System for Mobile Communications (Azid & Kumar, 2011). As the number of GSM users grows, research and development efforts to learn more about GSM deployment will be significantly aided by the project we embark on as we will be applying GSM for more practical home uses. The system's drawbacks include the inability to manage numerous appliances at the same time, and the door automation system can not confirm whether the system is operating in the right way or not. Using a GSM microcontroller, we designed and prototyped a rudimentary door automation system based on SMS technology which will be affordable for most Ugandans. The microcontroller links the GSM network, the sliding gate system, and door access control. Microcontroller. In addition to GSM, door automation systems can use the internet (LTE) and wireless communications(WIFI) for communication between home appliances and users (ElKamchouchi and ElShafee, 2012).

## 1.1 Why Use GSM Technology over Others?

The GSM network is favored among cellular technologies because of its extensive coverage, which keeps the whole system online virtually always. The use of GSM for door automation also benefits

from a high-security architecture that ensures optimum dependability by making it impossible for anyone else to monitor any data delivered or received (ElKamchouchi and ElShafee, 2012). In other words, this study uses GSM architecture to offer SMS-based home appliance control that doesn't need access to the local network. In Uganda today, many people can access a GSM phone because of its affordability rather than a smartphone because Uganda has not reached the middle-Income Status yet. Many people of the older generation also find it easier and Convenient to Use a GSM phone over a smartphone, and since our system uses SMS to open or close the door, it could not be any easier (Samuel et al., 2017).

### 1.2 Problem Statement

With the development in technology in the recent years and increased affordability, access control doors and automatic gates are a common scenery in many home settings today. However, granting remote access to these homes has been a challenge. There is need for a cheap, easy to use remote access control for these systems. The GSM based system allows for access controls to be operated remotely.

### 1.3 Research Question?

Developing low-cost GSM based access controls is key in the development of Homes Access Control in Uganda;

- How can GSM based Controls be better Utilized in Uganda?

Guided by the research Question, ways of utilizing GSM to Control automatic gates and doors is looked at.

## 1.4 Objectives of the Project

### 1.4.1 Main Objective

- To build a system that remotely grants access to automatic gates and doors.

### 1.4.2 Specific Objectives

- To assemble a remote based access control system based on GSM architecture.
- To train and develop a working model that controls relays in access controls.
- To build a working circuit setup.

## 1.5 Project Scope

Our project is limited to the development of a GSM based control that can be used for remote access of Access Control Automatic Doors and Automatic Sliding Gates that can be affordably rolled out to the people of Uganda.

## 1.6 Time Frame

From the time of the first Project proposal presentation, we have been working on the panel's recommendation and improving on our design; below is a Timeframe of our Project.

*Table 1: Time frame for the Project*

| **ACTIVITY** | **START TIME** | **DURATION** |
|---|---|---|
| Consultations and Survey | MAY | 2 Weeks |
| Digital System Design | JUNE | 8 Weeks |
| Simulations | JULY | 5 Weeks |
| Prototyping | OCTOBER | Two weeks |
| Assembly | NOVEMBER | One week |

| | | |
|---|---|---|
| Presentation and Project Finalization | JANUARY | 1 week |

### 1.7 Project Consultation

After consulting the various residents of Najera, Buziga, Kiwatule, Naalya, and Kiira who has either an automatic sliding gate system or a door access control system, most of them responded to us that they have often sent people to come and pick keys or remotes from their office to access their homes or they had to stay home that day altogether to be available when the service providers come. It has proven inconvenient to the homeowners as they waste a lot of time staying home or even waiting for these service providers (ElKamchouchi and ElShafee, 2012). We then asked them whether they would be interested in a GPS Based system to control the opening of their gates for service providers; 95% said they would be interested. This simple survey gave us the confidence to carry out this project as our project will offer a practical solution to the everyday problems facing the middle class in Uganda today. It also gave us confidence that if our device is cheaply assembled, it will be an affordable addition to these homeowners. (Samuel et al., 2017). Below is a pie chart to illustrate the above.

### 1.8 Proposed System Insights

A home automation system based on GSM is being suggested. However, the system that employs these technologies has a range of just around 120 meters. Using GSM technology, you may control your system from any location on the planet. SMS is used to manage and access the home appliances. As a result, remote control of household appliances is now possible at a low cost thanks to this technology. Because it is wireless, this system is both affordable and simple to set up. Using

GSM technology, a user may send a text message to manage their home appliances. The system is able to provide information on the health of the household appliances. In addition, the system uses a specific SMS pattern to verify the identity of a user. Radio waves are used to carry data between the mobile device and the GSM module. Wireless communication is used. SMS is used to convey instructions from the user. That signal is picked up by the GSM module. Connected to the Microcontroller via connector, the GSM module The RS232 logic converter is used to connect GSM and microcontrollers. The microcontroller is the central component of the home appliance control system. GSM technology is used to transmit instructions or commands. Matlab, a simulator program, is used to build the system. There are two types of tasks that the suggested system is capable of doing. First, it will automate the gadgets in the house, and then it will send SMS alerts to the user when a device is out of sync. GSM technology, through SMS, completes both tasks. GSM will be the basis for this project as it is widely used and has many control functions.

# CHAPTER TWO

## 2.1 Project Realization

Our prototype design is illustrated in the flow diagram below in Fig. The microprocessor-based architecture consists of a mobile phone with the user as the transceiver and the GSM modem as the receiver. In our design, an SMS is sent from the phone through the modem that sends a signal to the microprocessor-based relay system through a RS 232 interface system. The RS232 voltage levels are about 12V, but the microcontroller input and output voltage levels range from 0V to +5V on both the input and output sides. MAX232, which converts RS232 level impulses to TTL level signals, makes it possible to link the GSM modem and the PIC microcontroller, even though RS232 is incompatible with microcontrollers. The GSM modem will go a long way in offering an effective response to the signals (Samsung, 2016).

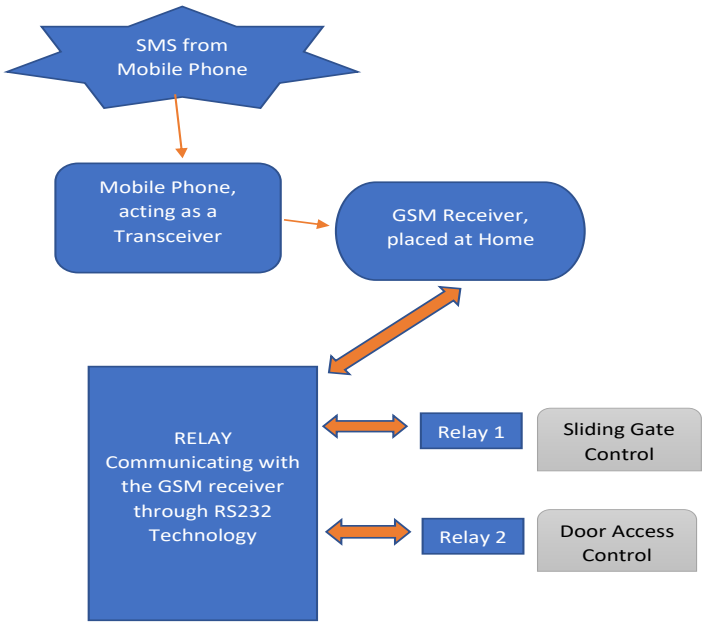


*Figure 1: Setup Schematic*

A microcontroller with eight bits, the PIC16F887, is composed mostly of timers, Analog to Digital Converters (ADCs), and a Universal Synchronous Asynchronous Receiver Transmitter (USART) (USART). When a microcontroller gets instructions, it decodes them to provide the device address and command. It sends appropriate signals to the driver of the power circuit, as suggested in this study effort (Samsung, 2016). In addition, the microcontroller guarantees that the gadget may be turned on or off with two distinct operating actions: turning it on and turning it off. The microcontroller will offer feedback on the state of any devices under control, regardless of whether they are turned on or off. The RS-232 interface standard defines it as the electrical and mechanical aspects of the interface between Data Terminal Equipment (DTE) and Data Communications Equipment (DCE), both of which use serial binary data exchange as their mode of communication.

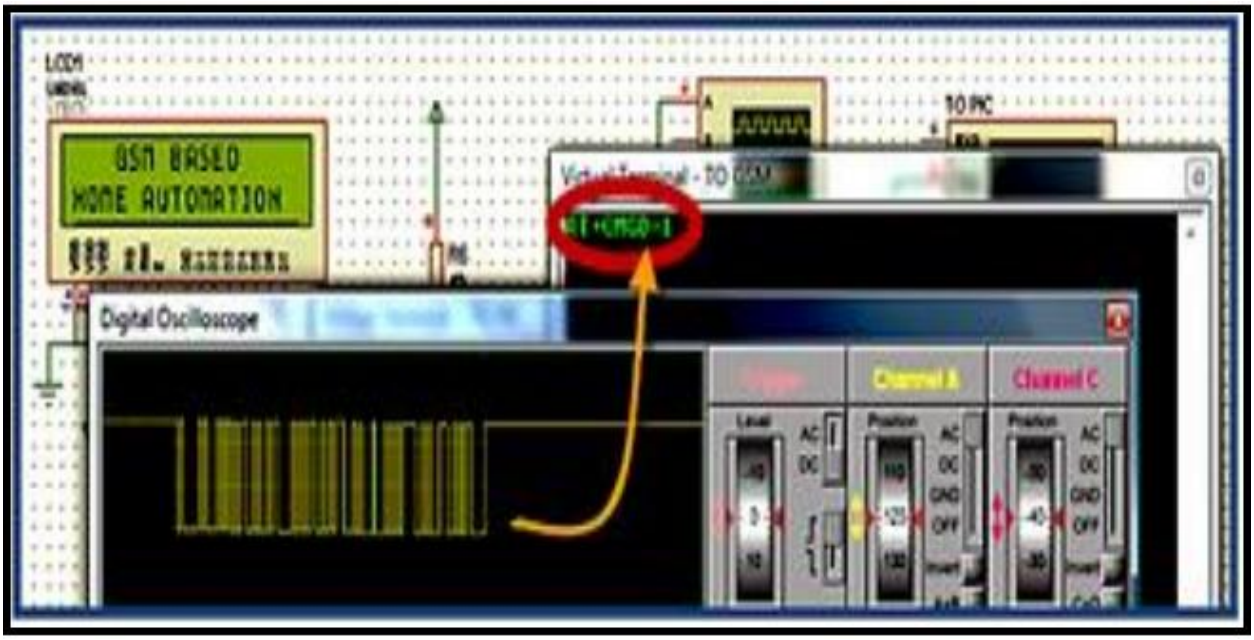


*Figure 2: GSM Based Automation Bit Rate*

Data Circuit Terminating Equipment (DCE) is referred to in the current standard edition as Data Circuit Terminating Equipment. Max232 will be used to physically interface between the

PIC16F887 and the GSM modem, which allows the RS232 standard to be loaded on the device. Due to the lack of a battery in the system design, an external power source is attached to the system to push a suitable current quantity via the circuit connections. Relays have been linked to the output loads to give steady electrical control since these relays can provide feeding for a variety of voltage levels on diverse loads (Kleineidam et al., 2016).

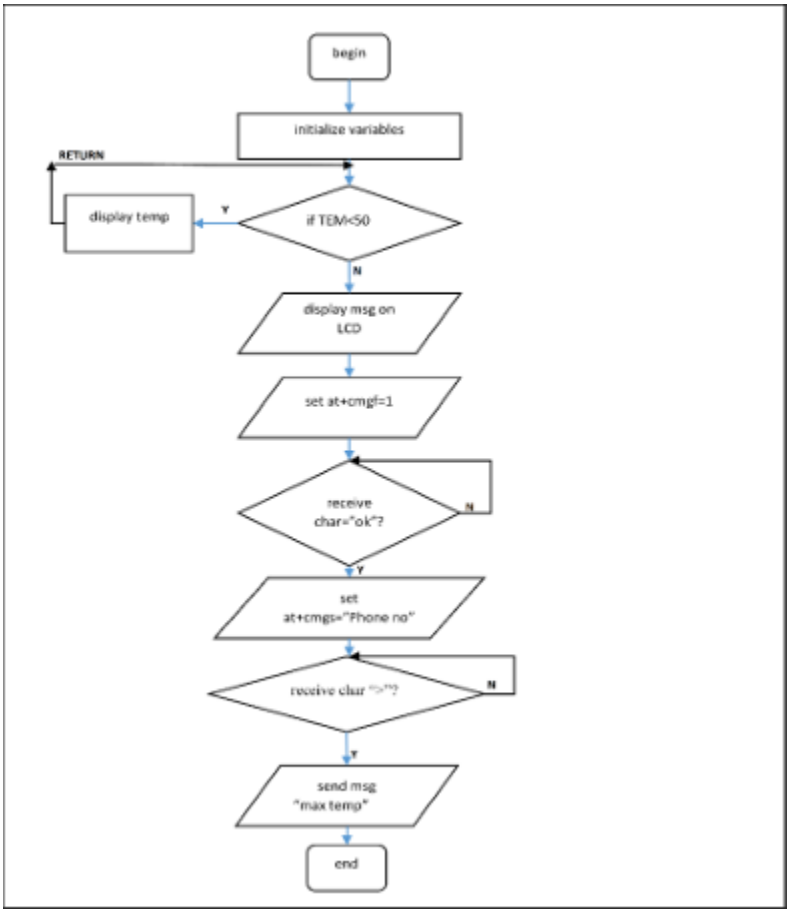


*Figure 3: SMS Sequency Flow Diagram*

As a result, selecting the output becomes simpler at any voltage level. Connections are made via the physical ports on the computer. MAX232 was installed to guarantee that data transfer between the two terminals was as smooth as possible. The text delivered from and to the PIC16F887 is

monitored by the virtual terminal, which also checks the transmission process and tests the algorithm. The oscilloscope is used to monitor the waveforms of the messages that are being delivered and received. During the simulation of the GSM modem, the "COMPIM" clock physically checks the responsiveness of the GSM modem by attaching it to a physical port on the computer's motherboard.

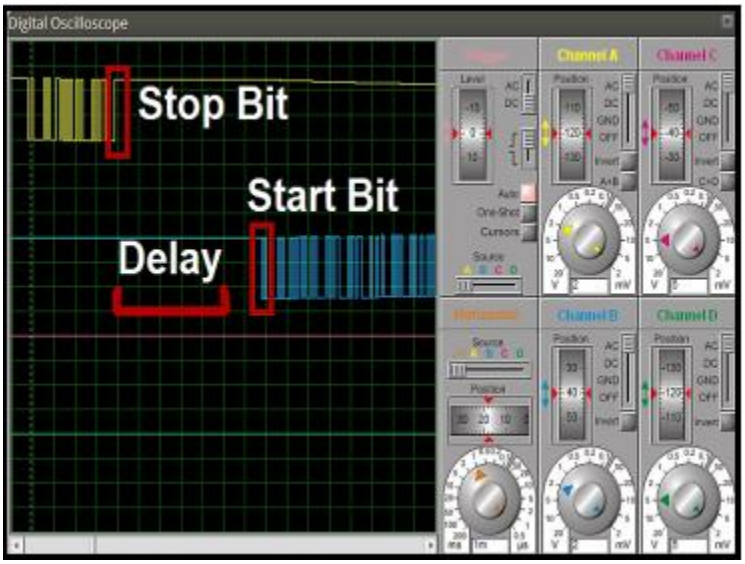


*Figure 4: Digital Oscilloscope*

**2.2 GSM and Other Network Bands Penetration in Uganda**

Approximately seven Ugandans out of every 10 have a mobile subscription in the first quarter of 2021, according to official government data from the Uganda Communications Commission (UCC) (67 percent ). More than three-quarters (75 percent) of Ugandans do not have access to a cell phone, according to AfterAccess. According to the GSMA, Ugandans would own 16 percent less smartphones in 2021 than the average for Sub-Saharan Africa, which is 30%.

According to Datareportal's January 2021 report, 60.3 percent of the country's population was connected to the mobile network, an increase of 4 percent from the previous year. GSMA's most recent Mobile Connectivity Index (2019) put the level at 61%.

In addition, coverage is expanding. Ugandans now have access to 2G networks almost everywhere, and 3G/4G mobile broadband systems cover more than 80% of the nation. Most people's first and only platform for accessing digital services is via their mobile devices. To link rural and poorly inhabited towns, mobile networks provide a cost-effective solution because of their wide area coverage.

To begin with, mobile technology enables access to vital communications services and the Internet. The expansion of mobile internet means that consumers may access feature-rich digital services on their mobile devices, which reduces the effect of considerably lower penetration of personal computers and other data-enabled devices.

As in other African nations, mobile phone internet connectivity is the primary means of connecting to the web. It is estimated that 46 percent of the population (unique) uses the internet through mobile devices. In 2020, over 70% of Uganda's internet connections will be mobile, according to Stat Counter. 90.8 percent of Facebook users exclusively use their mobile phones to visit the social media site.

The increasing dependence on the internet in Uganda is not without its problems. Daily tariffs on social media and the internet, such as those levied on Facebook, Instagram, Twitter, and WhatsApp, have been implemented. Experts believe that the social media tax may have had a detrimental influence on mobile penetration and social networking usage since social media sites are the primary drivers of Internet adoption in Africa because they are a viable replacement for

expensive voice and text services. During elections, the internet is shut down in Uganda, making it one of Africa's most heavily censored nations.

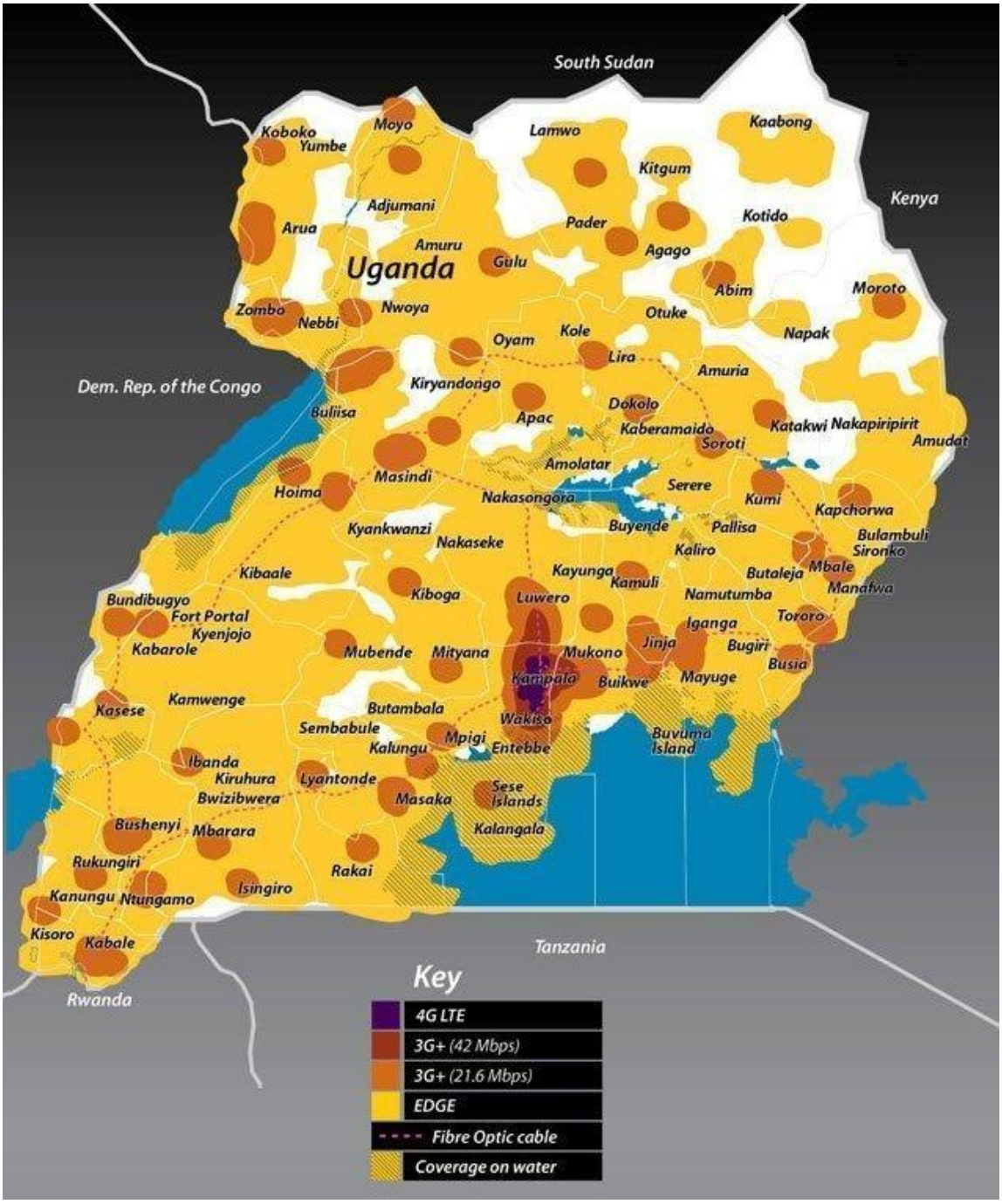


*Figure 5: GSM & Other Bands Network Coverage*

# CHAPTER THREE

## 3.1 Literature Review on Home Automation

Today's scientific world revolves on technological advancements. New items with diverse characteristics are being introduced on a daily basis. Modern smartphones are capable of enormous and sophisticated tasks. People want to be able to do everything by just touching a few buttons and keys. The progress of technology has also resulted in home automation. Home automation systems have necessitated a shift in domestic building design, according to Mark D. Gross (2011). Systems with a lot of moving parts need more complicated wiring and equipment, which may take up a lot of room in homes. As a result, extra consideration should be paid to the design of the structures. Simple and basic systems, on the other hand, may be secured just as effectively and don't need any additional care during construction.

Home automation and automated security systems have spawned a slew of academic papers and reports. Kaur gives an overview of the Arduino and GSM-based home automation and security solutions that are now available. In networking and automation systems, for example, some academics have employed Bluetooth technology; Sriskanthan has created a Bluetooth-based home automation application. Home automation systems used to be unclear and difficult owing to system hardware, but now these systems are utilized by a wide range of people throughout the globe thanks to contemporary technology. Wagh has created a GSM and ZigBee-based touchscreen home automation system. Singh's created appliance system makes use of GSM technology as well. Pawar has developed an Android app using an object-oriented programming language that is both inexpensive and capable of providing switching services. The suggested control and monitoring system for numerous appliances made advantage of the Internet of Things. GSM is extensively used in applications that control appliances, such as this one. The majority of workplaces,

platforms for business, and educational institutions in Pakistan do not have any equipment security systems that allow for device management through mobile apps on smartphones. As a result, there is no security control system operate in Pakistan. In nations such as Uganda, home security is a need.

Chitnis, conducted a poll of individuals from a variety of backgrounds to determine their understanding of the automated home automation system and its importance, especially in terms of security. Mali has developed and demonstrated a motion sensor and PIR sensor-based home security system. In addition to GSM, an Arduino board is utilized to process and send information. In addition, Chandra's automation system uses a low-power Bluetooth protocol with appropriate identification for the relevant individual. A PIC-based remote-control solution for smart homes, on the other hand, is offered by Erol. Electrical and optical isolation provide a high level of security. Pin-Check is a security method that has been implemented in developed systems.

The easiest and most cost-effective approach to make a house smart is via GSM-based home automation, according to a study published in the International Journal of Computer Applications by S- panalippan and his colleagues. Installation, upkeep, diagnostics, and debugging of this system couldn't be easier thanks to the readily accessible components.

In Uganda, companies like Stanbic bank, and most high-end hotels employ Access control systems but these require the use of biometric systems such as Fingerprints and RFID Tags or cards which require physical Presence. Our system solves that problem by allowing for the doors and gates to be opened remotely without any physical presence.

Home automation systems that employ voice recognition have been shown by Mr. Baris Yuksekkaya and his colleagues, however the accuracy of these systems is dependent on the sensors

they use and how individuals pronounce their sentences. This new technology has a significant quantity of unknown variables. The use of artificial intelligence for voice recognition increases the complexity of the system, which in turn increases the cost.

GSM-based home automation is the greatest option for a low-cost and simple system, according to a number of other studies. A good internet connection is recommended by most writers to provide a smooth and adequate functioning.

### 3.2 Available Literature on Biometric Systems

Many forms of access control been utilized as early forms of identification by humans to identify each other, as well as by the human brain to store information about each other's faces. Bertillon, a French police officer, pioneered scientific policing towards the end of the 19th century. To detect repeat perpetrators, he employed body measurements obtained of certain anatomical features.

For example, noise in the data, class variances and a restricted degree of freedom-antiuniversality, spoof attacks and an insufficient level of error detection are some of the issues that Unimodal biometric technology confronts according to (Kakkad et al., 2019). Multimodal biometric systems, which draw on information from a variety of data sources, may help alleviate some of these drawbacks. Attempts to improve individual matches' performance under these conditions will be a failure due to these underlying problems (Ahmad et al., 2012).

Some of these constraints may be alleviated by using multi-biometric systems, which give several proofs of the same identification. These systems aid in increasing productivity in ways that a single biometric signal may not be able to. In addition, anti-spoofing measures are included into multi-biometric systems by making it impossible to impersonate numerous biometric qualities at once.

The data, however, must be combined in the judgment of diverse domain experts in an effective manner (Solayappan and Latifi, 2006).

As stated by (Mondal and Bours, 2017), biometrics provides identity by employing bodily characteristics that may be detected. Data may be encoded or decoded by using bodily features as a tool. Existing biometric identification techniques include those based on physical characteristics like those found in the eyes and fingers (finger veins, for example), the face and voice (facial structure), and more (Jain et al., 2004).

When it comes to fighting identity theft on the Internet, biometrics may be an effective tool because to the above-mentioned characteristics that make each individual unique. There is a belief that employing biometric characteristics rather than credentials or PINs is a superior option since it is difficult to lose, hack, or reproduce biometrics. As a result of these traits, the theory goes that you are your own password. Soon, this kind of identification will be the standard. Because of the prevalence of online transactions, a person's identity must be validated before a computer will allow them to complete a transaction (Jacobsen and Sandvik, 2018). However, the existing options do not constitute an ideal manner of protecting personal information. Individuals misplace cards, lose countersigned paperwork, or write PINs down on pieces of paper so that others may obtain access to their accounts. A biometric identifier, which is a part of your body that has been recorded and may be used to verify your identity, is one method of safeguarding data. If the Internet is going to be a really secure place to buy using sensitive data, biometrics will be the next step in network security. It follows that numerous significant biometric security companies specialized in Internet technologies are currently on the rise. They want to be the next Baltimore Innovations of the Internet.

### 3.3 Other Methods of Access Control Available

People may be identified by their fingerprint, which is the pattern of ridges and valleys on the tip of their finger. Fingerprint identification is the most widely used biometric technology because of its exceptional properties of universality, permanence, uniqueness, accuracy, and cheap cost. In ancient Assyria and China, finger prints have been used for identification since 7000-6000 BC, according to archeological evidence (Maltoni et al. 2003). Henry Fauld introduced the minutiae characteristic for fingerprint matching in 1880, which created the scientific basis for current fingerprint identification. Minutiae-based, Ridge feature-based, correlation-based, and Gradient-based are some of the most common fingerprint identification methods in use today (Jain and Prabhkar, 2001).

Minutiae spots are used in most automated fingerprint recognition systems (Jain and Prabhkar). As a consequence of noise and distortion during the fingerprint collection and faults in the minutiae extraction process, a number of missing and false minute patterns are produced for each finger (Chikkerur et al. 2006). The ridge feature-based technique is used to overcome the problem of consistently extracting minutiae points from a low quality fingerprint picture. Ridgment is a pattern of lines on the end of a finger's finger. For fingerprint recognition, this technique employs ridge characteristics such as ridge orientation and frequency, ridge shape and texture information. Aside from that, the method's limited capacity to distinguish between different ridges is a drawback. Two fingerprint pictures are overlay using correlation-based algorithms, and the associated pixels are correlated (at the intensity level) for a variety of alignments. These approaches are very sensitive to non-linear distortion, skin condition, varied finger pressure, and alignment. Most of these methods begin by focusing on the tiniest details.

Unimodal biometric systems are those in use today that just need a single piece of information to be recognized (single-piece biometric systems). Unimodal biometric identification systems must contend with difficulties such as non-universality, spoofing, noise in sensed data, intra-class variances, and inter-class similarities. Some of the drawbacks of unimodal biometric systems may be alleviated by a multimodal alternative (Brunelli and Falavigna, 1995). A multimodal biometric system uses a variety of biometric data to identify a person. Using an effective fusion method, the accuracy of a biometric system may be significantly increased by merging information signals from many biometric sources.

It is possible to combine information from sensors, features, and scores in a number of ways when employing multibiometrics. Fusion at the sensor level is seldom used due to the difficulty in obtaining data from several biometric sensors that necessitates compatibility. The feature sets used by distinct biometric modalities may not be compatible, making it difficult to combine features from several biometric modalities. Because of the limited amount of data available, decision-making is overly rigid. Fusion at this level is preferred since there is sufficient information content and ease in getting and integrating match scores (Ross, 2007).

Many instances of the advantages of multimodal biometric verification systems may be found in the literature. As Brunelli and Falavigna, 1995, suggested, an auditory and visual fusion module may be used for personal identification purposes. Duc et al., 1997 proposed a straightforward averaging approach that combined face and speech data into a single average. In 1998, Kittler et al. merged face and speech biometrics utilizing sum, product, minimum, median, and maximum principles. It was found that the sum rule offered the best combination outcomes, as well as the most accurate ones. According to Hong and Jain, 1998, a multimodal approach to identity

verification combines the use of both facial and fingerprint data. The fusion approach assumes statistical independence when combining the evaluations of many experts. Ben-Yacoub et al. in 1999 proposed using SVMs, tree classifiers, and multilayer perceptrons to merge facial and voice biometrics. Pigeon and Vandendorpe, 1998, used fusion algorithms to incorporate face and voice biometrics in a multimodal person authentication system. In a multimodal person identification system proposed by Choudhury et al., 1999, unconstrained audio and visual information is merged using a Bayes net. Sum, decision tree, and linear discriminant-based summation techniques are used by Ross and Jain to integrate biometrics of face, fingerprint, and hand geometry. According to certain assessments, the sum rule outperforms its competitors. Some research has demonstrated that utilizing more than one biometric modality together enhances performance over using them alone (Jain and Chu, 2005; Chen and Chu, 2005; Nageshkumar et al. 2009).

# CHAPTER FOUR

## 4.1 Methodology

The setup for demonstration purposes was put on a board with a 4.5 ah Battery system to act as the backup and a 240V/12V stepdown transformer to act as the controls of the system. The design involved testing door maglocks connected to the system of a MAGLOCK as seen below;

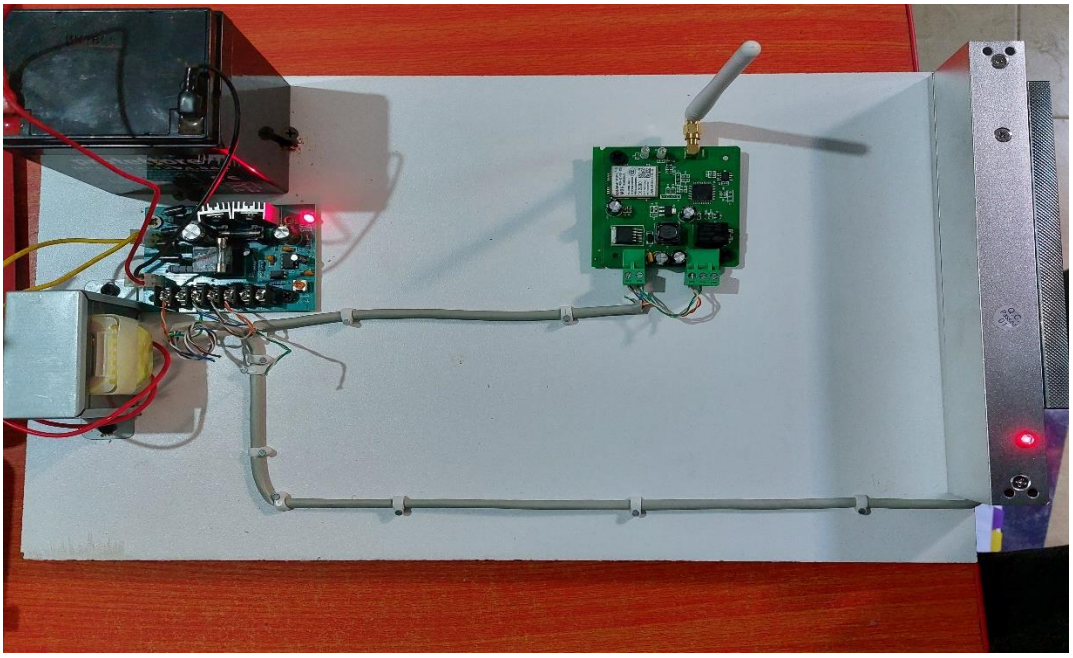

*Figure 6: Practical Setup of the system*

### 4.1.1 Wave Form from the Simulation

When the command is transferred from the PIC16F887 to the GSM modem, a waveform is formed in the digital oscilloscope and shown on the screen. The deletion of the first message from the SIM card's memory will be carried out due to this instruction. The software enters a sleep state while it awaits the arrival of new incoming text messages, after which it compares the text message with the previously stored instructions. The intended command will be executed if both the incoming

text message and the previously saved instructions match. This command will be the turning on or off of the output terminal (Kleineidam et al., 2016).

The responsiveness when interacting with the GSM modem was observed using a simulation result, which was done. When the program starts up, the AT command is sent from the PIC16F887 to the GSM modem. The answer from the GSM modem is received after a concise amount of time that does not exceed 500 microseconds, which is quick enough to identify the incoming message from the modem. To indicate when the PIC is sending the signal, the display was employed (Kleineidam et al., 2016).

The PIC16F887 is first used as a transmitter, and subsequently, it is used to receive the answer from the modem. When the text is transmitted and when the response is received is less than 500 microseconds. Thus, the delay time is disregarded since the data provided is restricted to instructions that do not exceed 4 or 5 characters in length. However, if the quantity of data sent is really large, the response delay time becomes essential and must be thoroughly investigated and assessed. The latency that must be regulated for this project is limited mainly by the SMS protocol and does not exceed 2 or 3 seconds, as shown in actual testing (Hu Yang, et al., 2016).

### 4.1.2 Considerations

Many considerations need to be made while installing Virtual Terminal and connecting it to COMPIM, the DB9 connection on the PC terminal. Virtual Terminal. After receiving and saving the message to the SIM card, you'll get a notice SMS letting you know that it was successful.

*Table 2: Block Diagram for the GSM system*

| PIN NO. | SYMBOL | DESCRIPTION | FUNCTION |
|---|---|---|---|
| 1 | VSS | GROUND | 0V (GND) |
| 2 | VCC | POWER SUPPLY FOR LOGIC CIRCUIT | +5V |
| 3 | VEE | LCD CONTRAST ADJUSTMENT | |
| 4 | RS | INSTRUCTION/DATA REGISTER SELECTION | RS = 0 : INSTRUCTION REGISTER<br>RS = 1 : DATA REGISTER |
| 5 | R/W | READ/WRITE SELECTION | R/W = 0 : REGISTER WRITE<br>R/W = 1 : REGISTER READ |
| 6 | E | ENABLE SIGNAL | |
| 7 | DB0 | DATA INPUT/OUTPUT LINES | 8 BIT: DB0-DB7 |
| 8 | DB1 | | |
| 9 | DB2 | | |
| 10 | DB3 | | |
| 11 | DB4 | | |
| 12 | DB5 | | |
| 13 | DB6 | | |
| 14 | DB7 | | |
| 15 | LED+ | SUPPLY VOLTAGE FOR LED+ | +5V |
| 16 | LED- | SUPPLY VOLTAGE FOR LED- | 0V |

To see the waveform of a detected message as soon as it enters the GSM memory, the oscilloscope is linked to the PIC16F887 microcontroller's receiver side (RX). It is expected that the PIC16F887 will receive and decode the incoming message and then execute the appropriate instruction to turn on the loads. The whole procedure takes a little more than two seconds to complete. Time. The relay set will execute a switching operation from typically open to shut the circuit after getting the order to turn on the lights, enabling the current to flow (Hu Yang, et al., 2016).

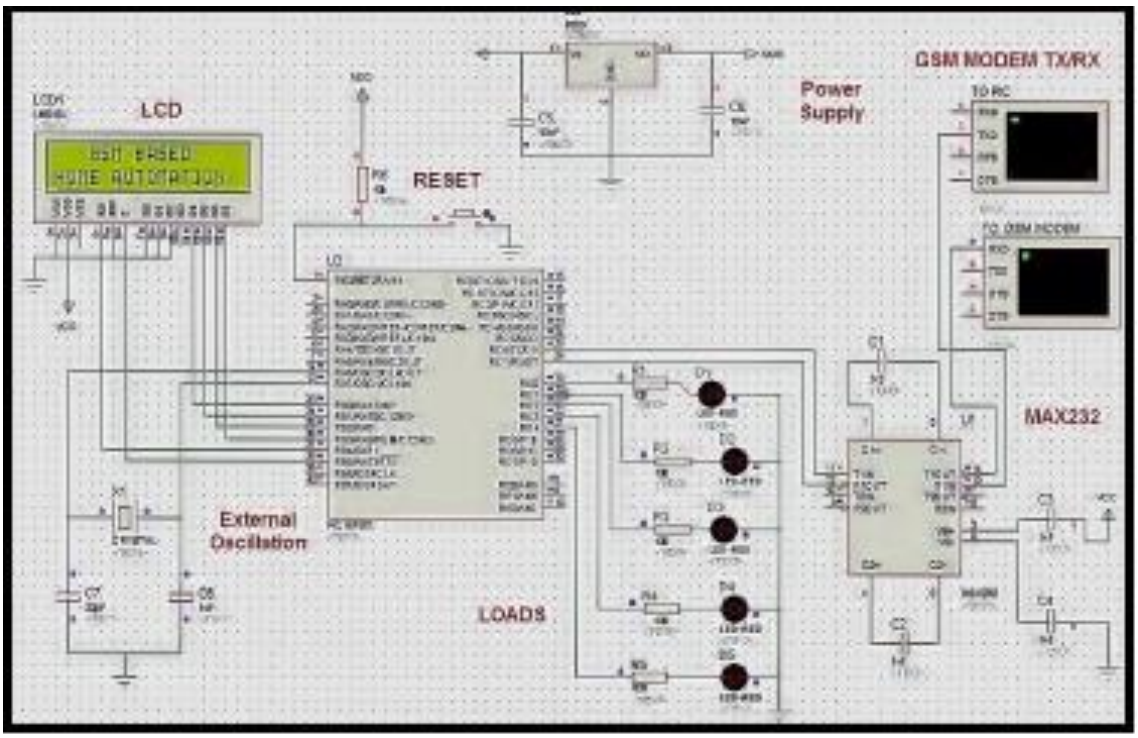


*Figure 7: Mat Lab Simulation Setup*

### 4.2 Results and Evaluation

To handle both asynchronous and synchronous EUSART operations, the Baud Rate Generator (BRG) uses an 8-bit or 16-bit timer. In 8-bit mode, the BRG is set to operate by default. Using a 20MHz FOSC and an 8-bit BRG, the PIC16F887 will output 9470bps with a baud rate error of 1.35 percent while using the asynchronous mode and 9600bps baud rate.

*Equation 1: Calculation for Baud Rate*

$$\boldsymbol{Calculated\ Baud\ Rate} = \frac{\boldsymbol{FOSC64}}{((\boldsymbol{SPBRGH}:\ \boldsymbol{SPBRG}) + \mathbf{1})}$$

The suggested GSM-based home automation system's prototype may be seen in the image below. To power the circuit, a 12V battery is connected to the voltage regulator. 232 MAX is linked to the GSM modem, and everything works well after that simulation.

*Table 3: Sync Data with Baud Rate*

| BAUD RATE | SYNC = 0, BRGH = 0, BRG16 = 0 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fosc = 20.000 MHz | | | Fosc = 18.432 MHz | | | Fosc = 11.059 MHz | | | Fosc = 8.000 MHz | | |
| | Actual Rate | % Error | SPBRG value (decimal) | Actual Rate | % Error | SPBRG value (decimal) | Actual Rate | % Error | SPBRG value (decimal) | Actual Rate | % Error | SPBRG value (decimal) |
| 300 | — | — | — | — | — | — | — | — | — | — | — | — |
| 1200 | 1221 | 1.73 | 255 | 1200 | 0 | 239 | 1200 | 0 | 143 | 1202 | 0.16 | 103 |
| 2400 | 2404 | 0.16 | 129 | 2400 | 0 | 119 | 2400 | 0 | 71 | 2404 | 0.16 | 51 |
| 9600 | 9470 | -1.36 | 32 | 9600 | 0 | 29 | 9600 | 0 | 17 | 9615 | 0.16 | 12 |
| 10417 | 10417 | 0 | 29 | 10286 | -1.26 | 27 | 10165 | -2.42 | 16 | 10417 | 0 | 11 |
| 19.2k | 19.53k | 1.73 | 15 | 19.20k | 0 | 14 | 19.20k | 0 | 8 | — | — | — |
| 57.6k | — | — | — | 57.60k | 0 | 7 | 57.60k | 0 | 2 | — | — | — |
| 115.2k | — | — | — | — | — | — | — | — | — | — | — | — |

### 4.3 Evaluation of the Effectiveness

Many Ugandan homes have been used to test the newly design RTU based system for opening gates and doors which are fully automated systems. Karachi, Sukkur, and Khairpur are the three cities that have been chosen for the performance assessment of the produced application and the hardware that is being used. Two most popular Telecons in Uganda Airtel and MTN Uganda were used to test the range of the system we implemented and have been chosen for comparison and analysis because they have less or more operations in the designated cities. In addition, the GSM Module's frequency is tested in three distinct locations around each city. In this study and comparison, we'll look at the range of signals available and the performance of the software

program we've constructed. A simple code illustrated below was developed to be used in the system in order to generate the opening and closing commands.

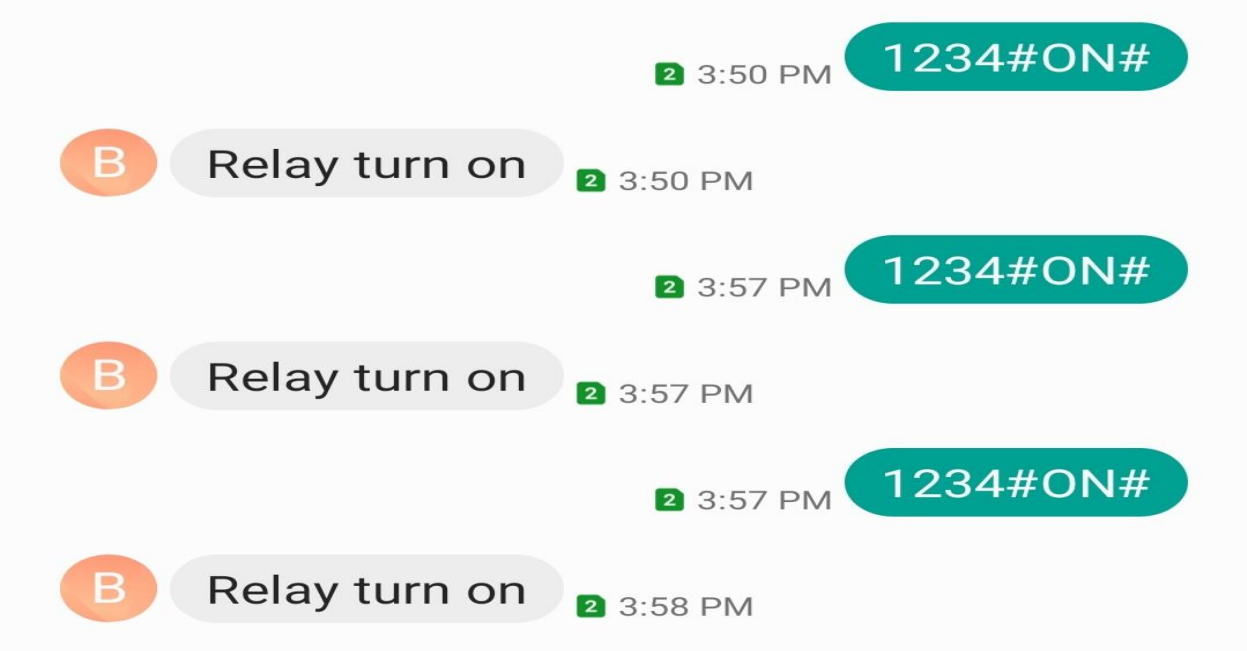


*Figure 8: Relay Control Feedback*

### 4.4 Prototype Consultation

After the computer simulations, we went to master electronics to find the Price of the Components we used in constructing the system. Some of the items we were able to find had the following prices;

*Table 4:Components and Prices*

| Component | Price |
|---|---|
| **GSM RECEIVER** | UGX 150,000 |
| **RELAYS** | UGX 11,000 each |

| | |
|---|---|
| **3 Pin Connectors** | UGX 1,200 |

### 4.5 Cost Evaluation for GSM based Systems

Experimentally and in practice, our project prototype is cheaper than the current systems that are available in the market today, It is because system implements a low cost RTU based GSM architecture that allows for the information to easily flow regardless of the type of phone a person is suing, A person does not require to have a smart phone in order to use the prototype developed unlike other systems that are available in the market that require the used of a smartphone to use the application. Because GSM is widely based and accessible, the system des not necessarily need to have LTE available in order for it to function.

This low-cost system makes our prototype economically viable in the Ugandan market since no new systems need to be installed in order for it to work. It already integrates with the existing access control systems to provide remote access. Based on considerations and analysis of other systems, ours is best placed for the Ugandan market because it is UGX 500,000 cheaper than the next available system on the market. Adoption of the system by home owners in many affluent areas will be easy.

### 4.6 Individual Contribution

In the course of this project, my contributions were in cost evaluation. Here, I gathered information about the general cost of the existing systems on market and compared them to the price of components we intended to use so as to solve the affordability challenge and ensure economic viability of the project.

I also did evaluation of effectiveness of the project. Here, I tested the module operation with sample of clients to confirm the problem faced earlier was actually solved by our project.

In addition, I worked hand in hand with my partner to assemble the prototype that was used for demonstration purposes.

Finally, I worked with my partner to do all the required simulations and result analysis for appropriate conclusions.

# CHAPTER FIVE

## 5.1 Conclusion

Home automation has recently emerged as a highly promising industry, especially in Uganda, due to the middle class expanding at a rapid pace and necessitating a wide variety of technological breakthroughs that may be used to the smart home idea. A smart GSM home's design and execution were taken into account throughout this project. The PIC16F887 microcontroller provides the 9600-bps baud rate with GSM for the smart, automated door system. With the use of a MAGLOCK as our simulations, we can demonstrate how the system will be used in the field and in real life applications in the different homes. Doing this project has broadened our knowledge in all the fields of engineering we have interacted with in the four years, It is a culmination of Electromagnetic Engineering, Analog Electronics, Electronics, Digital Electronics and the applications of Power systems.

## 5.2 Recommendations

The project has been good in expanding and broadening our knowledge in Engineering, However we got so many challenges along the way.

The project would better be placed if we could easily continue with the works in real life applications rather than stopping with it at the University.

Laboratory equipment’s used were not easily up to date with the current systems we wanted to implement. He University Laboratories should be better equipped to allow for more comprehensive research to be done.

More online resources need to be availed in the University online library to allow for more research to take place.

### 5.3 Future Works

After the project, we intend to continue with it in order to further reduce the costs and make it more economically viable and affordable to most of the Ugandans, having the project more economically viable makes it easy to market and reduces the costs of production.

We intend to develop better technologies and also incorporate the use of other bands like 3G, 4G, and 5G so that our system can control home access controls using an app and to be in line with the rapidly changing technology more so with the internet of things (IOT). IOT has changed the way many things are controlled but it is still expensive and not easily accessible by many Ugandans. Buy starting with our system and upgrading the already existing users at an affordable cost, We intend to add more system that can be used and controlled by the low cost “SMART GSM” system we implemented.

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**APPENDICES**

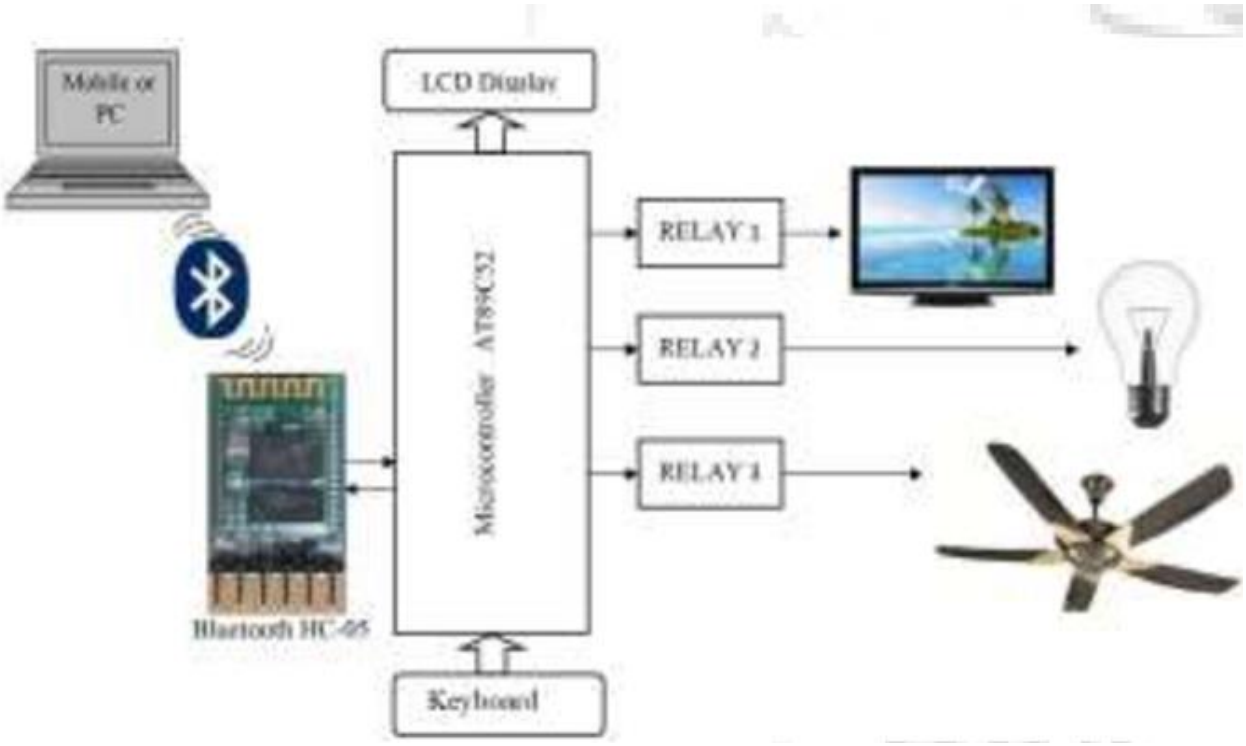


*Figure 9: Sample Bluetooth Control*

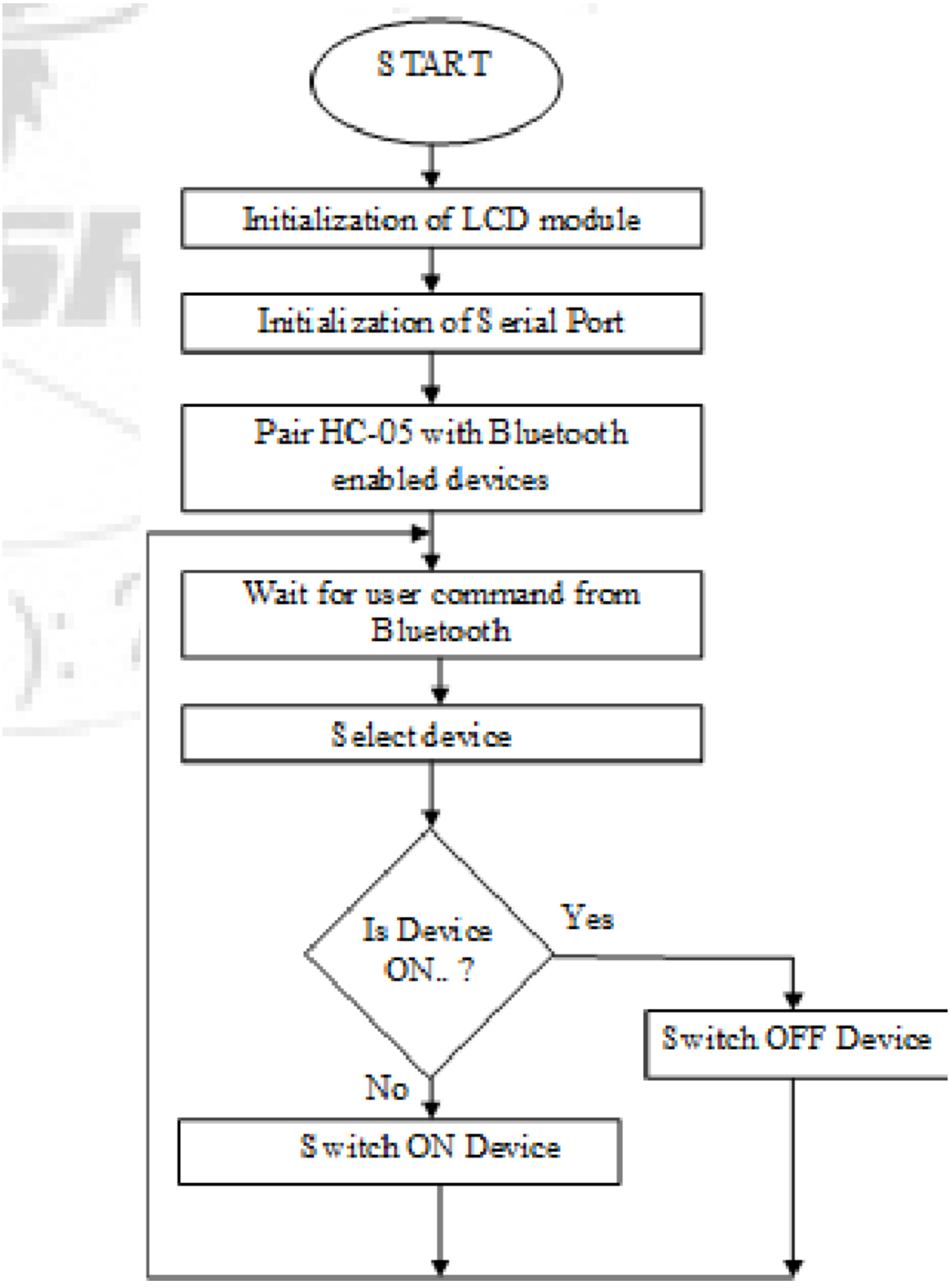


*Figure 10: Flow Chart of Bluetooth Control*

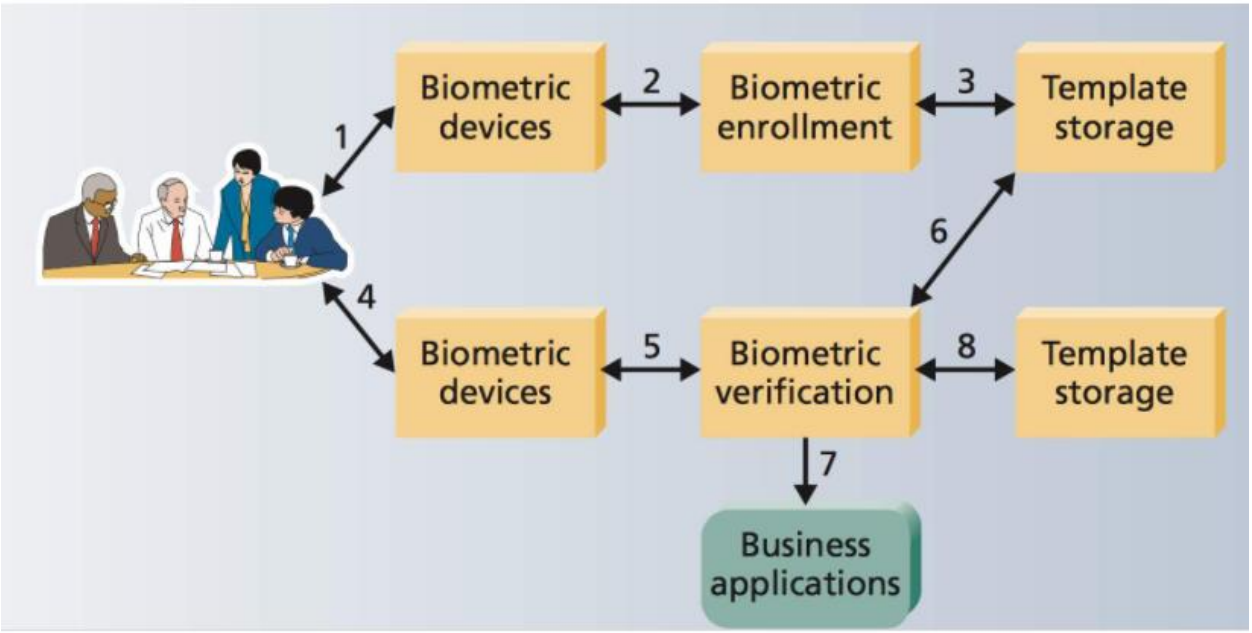


*Figure 11: Biometric Controls in Organizations*