INTERNATIONAL JOURNAL OF APPLIED SCIENCE RESEARCH
FEDERAL POLYTECHNIC OKO, ANAMBRA STATE

# GSM BASED CONTROL SYSTEM FOR DOMESTIC HOME APPLIANCES

**Anierobi Patrick Ogechukwu[1], Mgbechi Clectu Ekene[2] and [3]Otuu Obinna Ogbonnia**

[1, 2] Department of Electrical/Electronic Engineering, Federal Polytechnic Oko, Anambra State.

[1]patricklanierobi@yahoo.com, and [2]clectu.ekene@yahoo.com

[3]Department of Computer Science, Federal Polytechnic Oko.

obynoses@yahoo.com

***Abstract***

*GSM is one of the most used communication networks today. Almost every person has a mobile telephony these days, which are used as terminals for the voice calls. This paper presents the use of GSM Based Control System for Domestic Home Appliance networks to monitor and control the house/office appliances (such as lighting systems, washing machines, refrigerators, TV set, fan, and air-conditioner etc.) and other equipment locally using built-in input and output device. The key reasons behind the work is receiving the CALL and a fix DTMF TONE and processing it further as required to perform several operations. The type of the operation to be performed depends on the key pressed. The principle operation in which the work is based is fairly simple and making peoples' lives easy. Firstly, the system uses Dual Tone Multiple Frequency is sent via the mobile keypad and then it is decoded through a decoder and sent to the intermediate hardware that we have designed according to the command received in form of the Dual Tone Multiple Frequency. The DTMF TONE is sent from the mobile set that contains commands in DTMF form which are then processed accordingly to perform the required task. System development involves implementing the different hardware modules (power supply, GSM, microcontroller, relays, and loads) making up the system. Though these systems are good, unfortunately, they are only effective for short distances of 100km within a particular locality.*

**Keywords:** Home Automation, Dual Tone Multiple Frequency, 8051 Microcontroller and Relay

## INTRODUCTION

Automating a home makes it possible for users to be easily effectively controlled and monitor all electrical appliances (such as lighting systems, TV, Fan, washing machines, security, telecommunications, heating, air conditioning and refrigerators) (Kumar et al., 2019). Mobile phones are getting more advanced which allow people to develop applications that run on them. Currently mobile phones are gradually replacing PCs because of their ability to do almost all whatever computers can do (Abereola, 2017). The key reasons behind home automation are making peoples' lives easy, driven more by technology and effectively managed (Puri, and Nayyar, 2016). Today, home automation is an emerging new technology utilized by both the public and the private domains to ease people's standard of living and also end unanticipated casualties. Different technique can be used to develop home automation systems, example are Dual Tone Multi Frequency (DTMF) technology which involves using mobile cell phones tone to perform any operation function. SMS technology to send the command for a particular action. GPRS (General Packet Radio Service) technology to directly interface mobile phone and the computer (Abereola, 2017). In fact, sophisticated home automation systems are now being developed that maintain an inventory of household items, record their usage through an RFID (Radio Frequency Identification) tag, and prepare a shopping list or automatically order replacements. Home automation has made it possible to have what is often referred to as a smart home, a home where you can switch on the security lights at night and switch them off in the morning, heat water for bathe and tea. Nowadays, you can makes it possible to link security lighting, entertainment, burglar alarm, telecommunications, hi-tech security gates, heating, and air conditioning into one centrally controlled system. This allows you to make your house an active partner in managing your busy life. Though these systems are good, unfortunately, they are only effective for short distances (100meters maximum) automation within a particular locality.

**Related Works**

Implementing of home automation system were considered by (Ciubotaru,et al., 2006) and (Delgado,et,al.,2006) who presented designs and implementations of SMS -text based control .

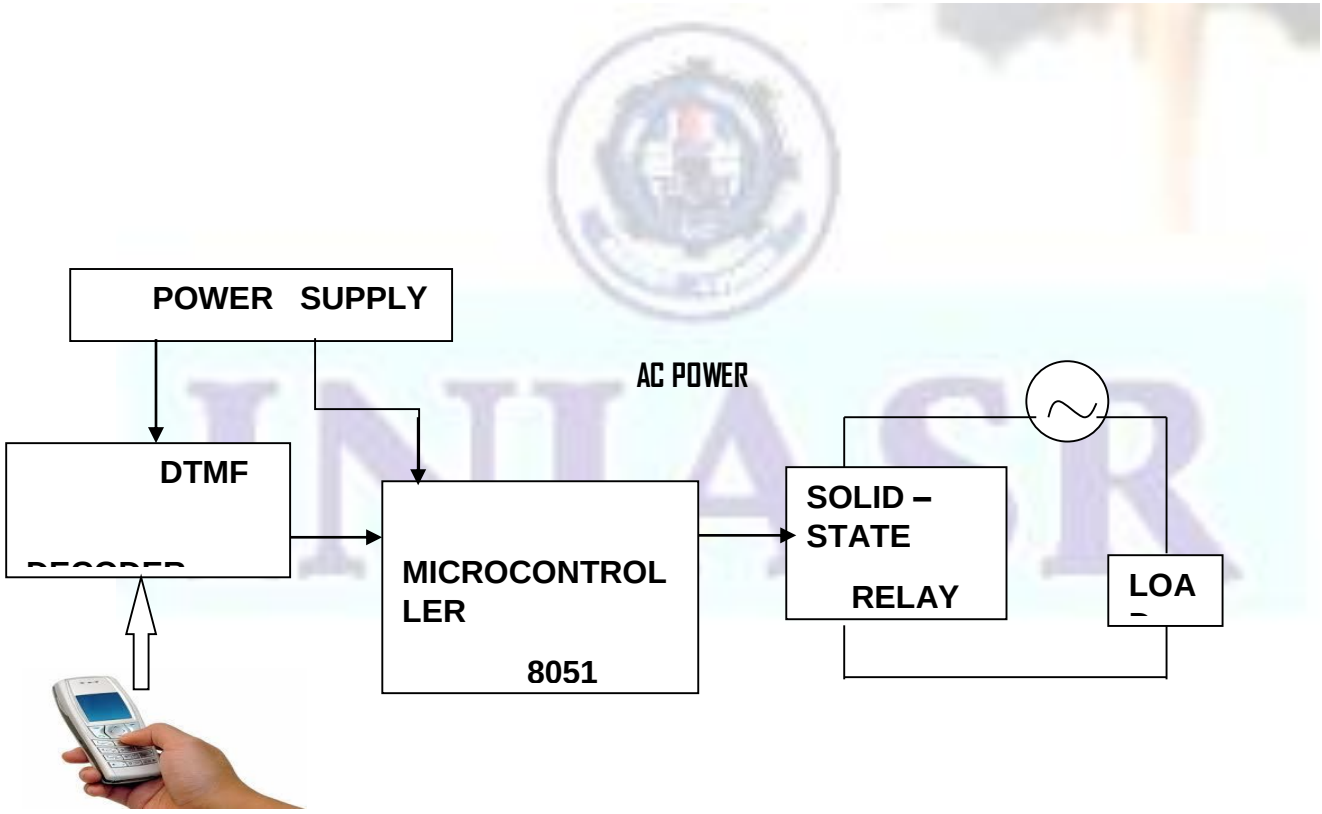
This work uses SMS – to control home appliances and this give the project a limitation because you will not know if the SMS gets to the phone in the project or not.

Yun and Jae(2008) proposed "Remote Robot control System based on Dual Tone Multi Frequency (DTMF) of Mobile Phone", The limitation of this project is that it only uses Android phone, means if you don't have an Android phone, you will not be able to control the home appliances, and the component used for this project is quite expensive.

Rifat et al., (2008), The limitation of this project is that it uses Bluetooth, which means you can only control any Home appliance when you are close to it, or depending on the kilometer radius that the Bluetooth can cover.

Mghawish et al., (2012), "Multi-Function Control System using GSM modem Based SM5100B Module". The limitation of this project is that you must be connected to the internet before you can control any Home appliance.

The limitation of this work is that it uses remote control that means if you don't have the remote, you can't control any home appliance.




**Mobile Connector**

Fig 1: block diagram home a GSM based control system for home domestic appliance

## MATERIALS AND METHODS

### a) Home Automation (HA)

Home automation it is a daily basic function of electrical devices used in homes (Rahman et al., 2015). Automated homes are equipped with special facilities to enable the occupant of the house to control electrical appliances and other devices using Wi-Fi, Bluetooth and Mobile

telephony (GSM).Consequently, the first Home Automation Systems (HASs) originated the concept of home networking full of possibilities, but this included also new factors to bear in mind. Some of these factors include Interoperability, Scalability, Acceptability, Security and limited Services.

Home automation becomes smarter if the controlling can be done effectively from any remote place. The available technologies for this remote communication are the Internet, Mobile Telephony, Zigbee, and Bluetooth.

**b) Dual Tone Multiple Frequency (DTMF)**

In our mobile phone keypad, each number (including "#" and "*") is associated with unique frequency, this frequency is the sum of a high frequency and a low frequency component, i.e. mixture of two pure tone, hence Dual Tone Multi Frequency. To be clearer, when a call channel is established, if you press a key on the keypad, you and the called party hear a distinct sound, this is the dual tone which is associated with that number pressed and is passed through the DTMF channel to the called party. Similarly, all 10 numbers (0-9), including "#" (hash) and "*" (asterisk) has a unique dual tone (INC 2006), associated with it. The 2 individual pure tones which constitute the dual tone for each number is as shown in table 1 below, wherein the corresponding rows give the low frequency tone and the columns, the high frequency tone(Conte, and Scaradozzi,2003). *A B C D was removed from standard keypads and is now used in military for priority call.

**Table 1: DUAL TONE MULTI FREQUENCY [DTMF] TABLE ANALYSIS**

| | 1209Hz | 1336Hz | 1477Hz | 1633Hz |
|---|---|---|---|---|
| 167Hz | 1 | 2 | 3 | A* |
| 770Hz | 4 | 5 | 6 | B* |
| 852Hz | 7 | 8 | 9 | C* |
| 941 | * | 0 | ₦ | D* |

If you press 4 as show in table 2 below, your phone sends a signal having frequency 770Hz + 1209Hz = 1979Hz and the receiver receives the same. The main advantage of such a concept is that the dual tone frequency is relatively higher than that of the average environmental noise; hence the DTMF channel only transmits the dual tone and not the relatively low noise frequencies. Also the receiving station can be automated. i.e. the receiving device can be designed (using pass filters) to receive and decode the dual tone using DTMF decoder (Murthy, 2008) and programmed to carry out specific functions corresponding to the number pressed.

**Table 2: DUAL TONE MULTI FREQUENCY [DTMF] TABLE ANALYSIS**

| | 1209Hz | 1336Hz | 1477Hz | 1633Hz |
|---|---|---|---|---|
| 167Hz | 1 | 2 | 3 | A* |
| 770Hz | 4 | 5 | 6 | B* |
| 852Hz | 7 | 8 | 9 | C* |
| 941 | * | 0 | ₦ | D* |

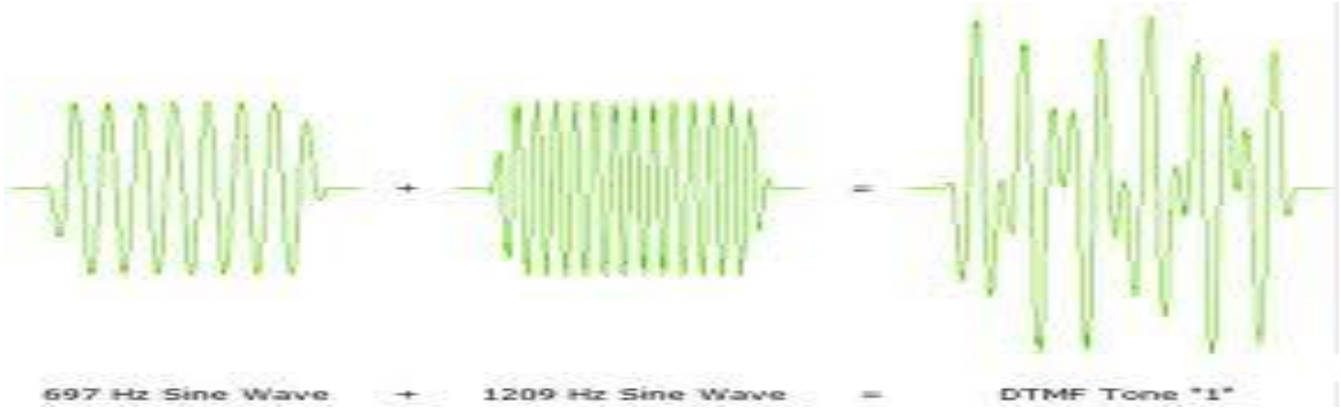



Fig 2: The corresponding signal produced

### c) DTMF DECODER

DTMF decoder is a very easy to use Integrated Circuit to decode DTMF dial tones found on telephone lines with touch tone phones. The frequencies used for the DTMF (dual-tone, multi-frequency) system, which is also referred to as tone dialling are 167, 770, 852, and 941 Hz at low pass filter and1209, 1336 ,1477 and 1633 Hz at high pass filter . These frequency signals are encoded as a pair of sinusoidal (sine wave) tones from the table below which are mixed with each other. So, we need to decode it for knowing which digit was pressed at the Encoder .DTMF is used by most PSTN (public switched telephone networks) systems for number dialling, and is also used for voice-response systems such as telephone banking and sometimes over private radio networks to provide signaling and transferring of small amounts of data.

### d) MT8870DE

The MT8870DE/MT8870C is a complete DTMF receiver integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 18-pin DTMF tone pairs into a 4-bit code. And the Latch is used to hold the output for some time. However, precautions should be taken to avoid application of voltages higher than the maximum rating. External component count is minimized by on chip provision of a differential input amplifier, clock oscillator and latched three-state bus interface.

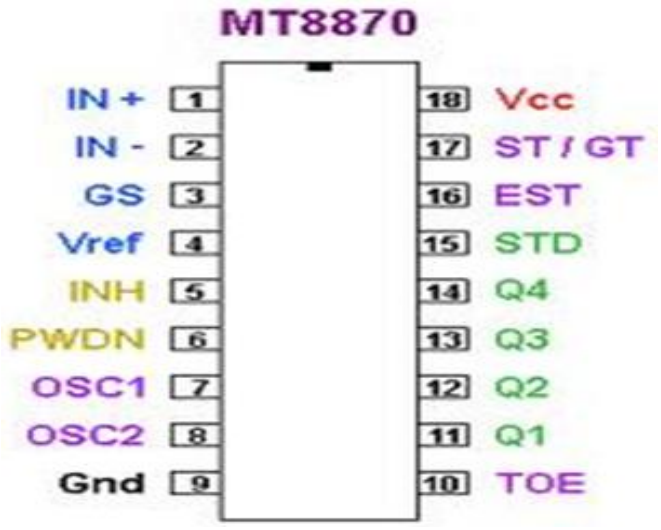


Fig 3: The PIN Diagram of MT8870DE

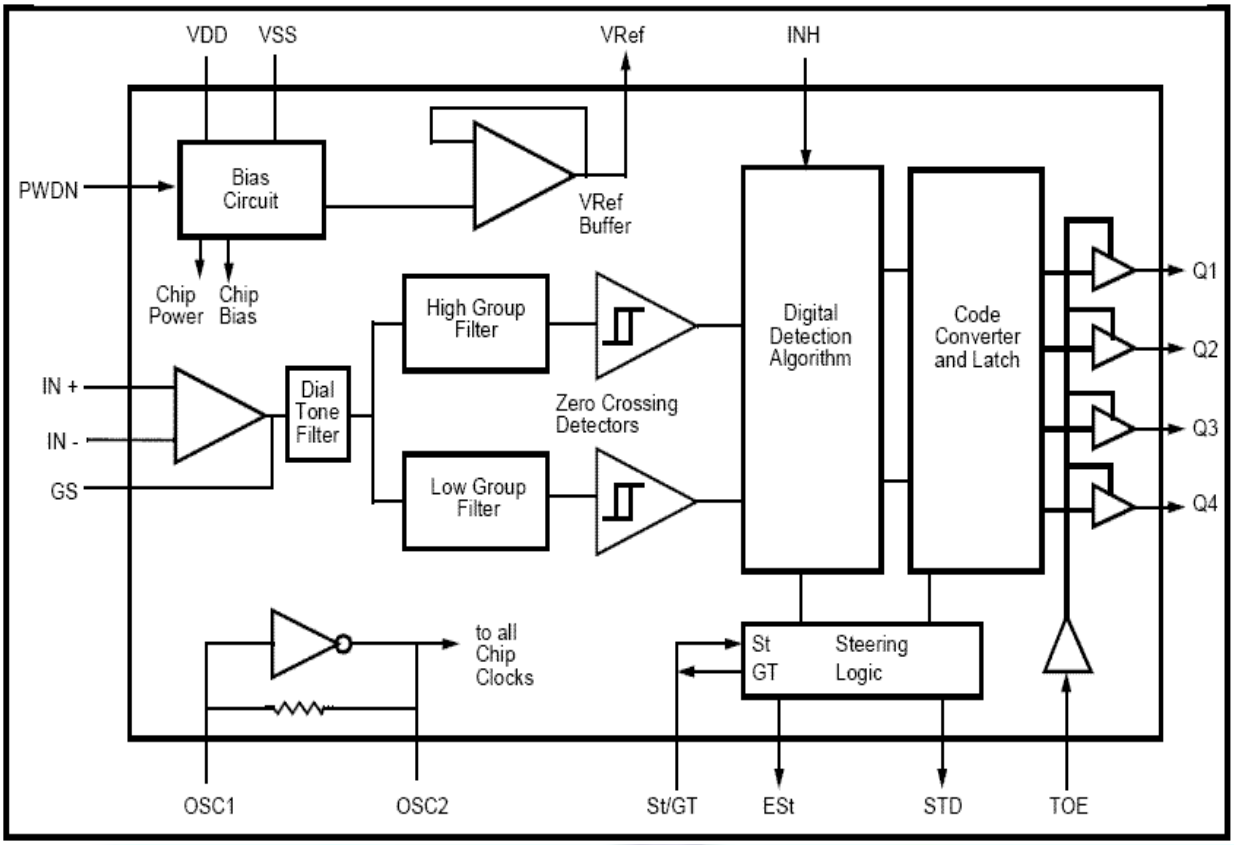



Fig 4: The Circuit Diagram of the MT8870DE decoder

**Table 3 Pin Description of MT8870DE**

| Pin # | | Name | Description |
|---|---|---|---|
| 18 | 20 | | |
| 1 | 1 | IN+ | **Non-Inverting Op-Amp (Input).** |
| 2 | 2 | IN- | **Inverting Op-Amp (Input).** |
| 3 | 3 | GS | **Gain Select.** Gives access to output of front end differential amplifier for connection of feedback resistor. |
| 4 | 4 | $V_{Ref}$ | **Reference Voltage (Output).** Nominally $V_{DD}/2$ is used to bias inputs at mid-rail (see Fig. 6 and Fig. 10). |
| 5 | 5 | INH | **Inhibit (Input).** Logic high inhibits the detection of tones representing characters A, B, C and D. This pin input is internally pulled down. |
| 6 | 6 | PWDN | **Power Down (Input).** Active high. Powers down the device and inhibits the oscillator. This pin input is internally pulled down. |
| 7 | 8 | OSC1 | **Clock (Input).** |
| 8 | 9 | OSC2 | **Clock (Output).** A 3.579545 MHz crystal connected between pins OSC1 and OSC2 completes the internal oscillator circuit. |
| 9 | 10 | $V_{SS}$ | **Ground (Input).** 0V typical. |
| 10 | 11 | TOE | **Three State Output Enable (Input).** Logic high enables the outputs Q1-Q4. This pin is pulled up internally. |
| 11-14 | 12-15 | Q1-Q4 | **Three State Data (Output).** When enabled by TOE, provide the code corresponding to the last valid tone-pair received (see Table 1). When TOE is logic low, the data outputs are high impedance. |
| 15 | 17 | StD | **Delayed Steering (Output).**Presents a logic high when a received tone-pair has been registered and the output latch updated; returns to logic low when the voltage on St/GT falls below $V_{TSt}$. |
| 16 | 18 | ESt | **Early Steering (Output).** Presents a logic high once the digital algorithm has detected a valid tone pair (signal condition). Any momentary loss of signal condition will cause ESt to return to a logic low. |
| 17 | 19 | St/GT | **Steering Input/Guard time (Output) Bidirectional.** A voltage greater than $V_{TSt}$ detected at St causes the device to register the detected tone pair and update the output latch. A voltage less than $V_{TSt}$ frees the device to accept a new tone pair. The GT output acts to reset the external steering time-constant; its state is a function of ESt and the voltage on St. |
| 18 | 20 | $V_{DD}$ | **Positive power supply (Input).** +5V typical. |
| | 7, 16 | NC | No Connection. |

**Table 4 The Outputs Pin of MT8870DE Generated at Q1 , Q2 , Q3 and Q4**

| Digit | TOE | INH | ESt | $Q_4$ | $Q_3$ | $Q_2$ | $Q_1$ |
|---|---|---|---|---|---|---|---|
| ANY | L | X | H | Z | Z | Z | Z |
| 1 | H | X | H | 0 | 0 | 0 | 1 |
| 2 | H | X | H | 0 | 0 | 1 | 0 |
| 3 | H | X | H | 0 | 0 | 1 | 1 |
| 4 | H | X | H | 0 | 1 | 0 | 0 |
| 5 | H | X | H | 0 | 1 | 0 | 1 |
| 6 | H | X | H | 0 | 1 | 1 | 0 |
| 7 | H | X | H | 0 | 1 | 1 | 1 |
| 8 | H | X | H | 1 | 0 | 0 | 0 |
| 9 | H | X | H | 1 | 0 | 0 | 1 |
| 0 | H | X | H | 1 | 0 | 1 | 0 |
| * | H | X | H | 1 | 0 | 1 | 1 |
| # | H | X | H | 1 | 1 | 0 | 0 |

## I. 8051 MICROCONTROLLER

An embedded microcontroller is a chip, which has a computer processor with all its support function (clocking and reset), memory (both program storage and RAM), and I/O (including bus interfaces) built into the device. These built in function minimize the need for external circuits and devices to the designed in the final applications. The improvements in micro-controller technology have meant that it is often more cost effective, faster and more efficient to develop an application using a micro-controller. Micro-controller is dividing into two types that are commonly in use. Embedded micro-controller is the micro-controller, which has the entire hardware requirement to run the application, provided on the chip. External memory micro-controller is the micro-controller that allows the connection of external memory when the program memory is insufficient for an application or during the work a separate ROM (or even RAM) will make the work easier.

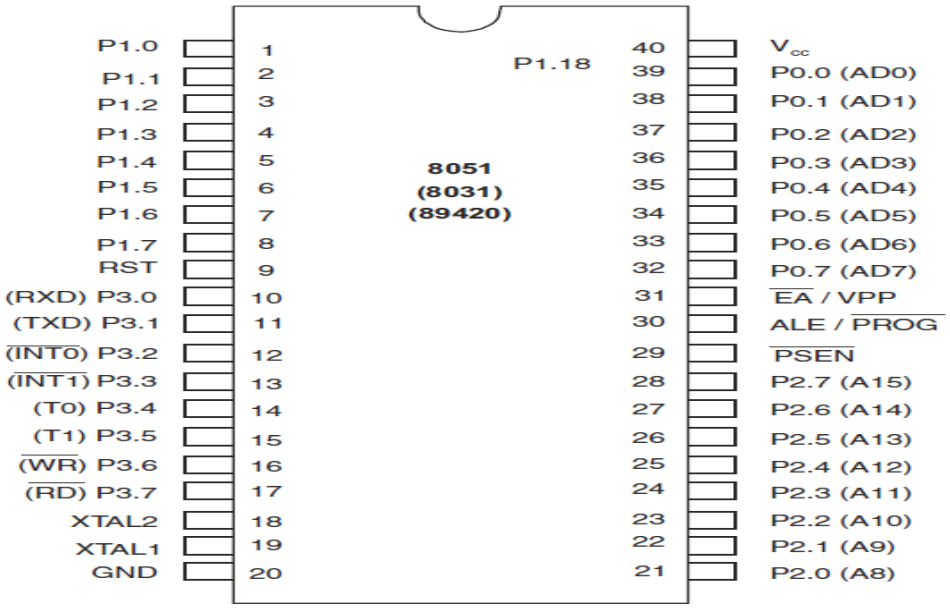



Fig 5: 8051 MICROCONTROLLER

**Table 5 Pin Description of 8051 MICROCONTROLLER**

| Pin # | Name | Description |
|---|---|---|
| 1 | **VCC** | Supply voltage. |
| 2 | **GND** | Ground. |
| 3 | **Port 0** | Is an 8-bit open drain bidirectional I/O port. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. **External pull-ups are required.** |
| 4 | **Port 1** | Is an 8-bit bidirectional I/O port with internal pull-ups. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. Port 1 also receives the low-order address bytes during Flash programming and verification. |
| 5 | **Port 2** | 2 is an 8-bit bidirectional I/O port with internal pull-ups. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit address. |
| 6 | **Port 3** | 3 is an 8-bit bidirectional I/O port with internal pull-ups. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. Port 3 also serves the functions of various special features of the AT89S51, as shown in the Figure above. Hence, Seldom used as I/O PORT. |
| 7 | Port **XTAL1** | Input to the inverting oscillator amplifier and input to the internal clock operating circuit. |
| 8 | **XTAL2** | Output from the inverting oscillator amplifier |

## II. Relay

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

### Relay Operation

All relays operate using the same basic principle. Our example will use a commonly used 4-pin relay. Relays have two circuits: A control circuit (shown in GREEN) and a load circuit (shown in RED). The control circuit has a small control coil while the load circuit has a switch. The coil controls the operation of the switch.

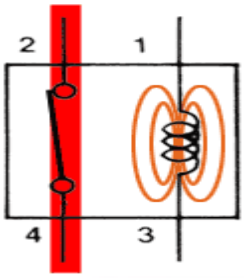



Fig 6: Relay Energized (On)

Current flowing through the control circuit coil (pins 1 and 3) creates a small magnetic field which causes the switch to close, pins 2 and 4. The switch, which is part of the load circuit, is used to control an electrical circuit that may connect to it. Current now flows through pins 2 and 4 shown in RED, when the relay is energized as shown in fig 6.

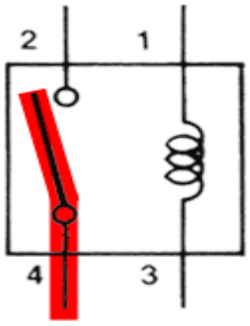



Fig 7: Relay De-Energized (Off)

When current stops flowing through the control circuit, pins 1 and 3, the relay becomes de-energized as shown in fig 7. Without the magnetic field, the switch opens and current is prevented from flowing through pins 2 and 4. The relay is now OFF.

## III. CONCULSION

The extensive capabilities of this system are what make it so interesting. From the convenience of a simple cell phone, a user is able to control any electrical devices, wherever is the range of GSM which has almost covered the whole globe. This makes it possible for users to rest assured that their belongings are secure and that the television, lighting bulb and other electrical appliances was not left running when they left the house to just list a few of the many uses of this system. The major drawback in this system is no feedback is available, so it may happen that you have Pressed a key for an action but You will not receive any acknowledgement whether it has happened or Not .

## REFERENCES

Effah E., Aryeh F. L. and Kehinde W. K. "GSM Based Home Appliances Control System (HACS) for Domestic Power Users in Ghana", (2016), 4th UMaT Biennial International Mining and Mineral Conference, pp. 58 - 64.

Rahman M, Zadidul Karim A.H.M., Nyeem S, Khan F and Matin G (2015), "Microcontroller Based Home Security and Load Controlling using GSM Technology", I.J. Computer Network and Information Security, 2015, Vol.4, pp. 29-36.

Yun C. and Jae W., (2008) "Remote Robot control System based on Dual Tone Multi Frequency (DTMF) of Mobile Phone", IEEE International Conference INDIN.

Rifat S., Enamul H., Sohan M, Iftekhar N, Mostafa A and Masud K, (2008) Department of Computer Science & Engineering Bangladesh University of Engineering & Technology, 6 Windows Mobile Division at Microsoft International journal of smart Home Vol. 2, pp

Afif M., Akram A., Mahmoud J., Mohammad A. (2012), "Multi-Function Control System using GSM modem Based SM5100B Module". ICITST- London, Technical Co Sponsored by IEEE UK/RI Computer.

Ciubotaru-Petrescu, B., Chiciudean, D., Cioarga, R., & Stanescu, D. (2006). Wireless Solutions for Telemetry in Civil Equipment and Infrastructure Monitoring. 3rd RomanianHungarian Joint Symposium on Applied Computational Intelligence (SACI) May 25-26, 2006. Retrieved from http://www.bmf.hu

Conference (INC 2006), University of Plymouth, 11-14 July 2006, pp. 357-366. Retrieved from http://www.newi.ac.uk

Conte, G., & Scaradozzi, D. (2003). Viewing home automat ion systems as multiple agents systems. RoboCUP2003,

Murthy, M. V. R. (2008). Mobile based primary health care system for rural India. W3C workshop

on Role of Mobile Technologies in Fostering Social Development.

Delgado, A. R., Picking, R., & Grout, V. (2006) Remote-controlled home automation systems with different network technologies. Proceedings of the 6th International Network Conference (INC 2006), University of Plymouth, 11-14 July 2006, pp. 357-366. Retrieved from http://www.newi.ac.uk

Kumar, S. S., Khalkho, A., Agarwal, S., Prakash, S., Prasad, D., & Nath, V. (2019). Design of Smart Security Systems for Home Automation. Nanoelectronics, Circuits, and Communication Systems, pp. 599-604. Springer. DOI:10.1007/978-981-13-0776-8_56

Puri, E. V., & Nayyar, A. (2016). Real Time Smart Home Automation based on PIC Microcontroller, Bluetooth and Android Technology. IEEE International Conference on Computing for Sustainable Global Development (INDIACom), pp. 1478-1484.

Abereola, O. (2017) Design and Construction of A Gsm Based Home Automation System thesis at Mechatronics Engineering Department, Federal University Oye-Ekiti, Ekiti State