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Implementation of GSM Remote Switching Using Locally Available Components in Nigeria

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--ABSTRACT--
In this research project, a GSM Remote Control System was implemented using locally available components in Nigeria. The system uses Mobile technology to control various units of the home, office or industrial appliances. The control component used in the circuit was the AT89S52 microcontroller, and its outputs were decoded by the CM8870 DTMF decoder. The microcontroller was programmed by simulation method using the 8052 simulator for windows. Printed circuit board (PCB) was developed out of a copper-clad board and used for the circuit. The system was tested after construction and its functionality was confirmed.

KEYWORDS: *appliances, dtmf decoder, gsm, microcontroller, mobile technology, remote control, pcb*

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I. INTRODUCTION

Recently, remote system product for intelligent home and industries is increasingly getting really common. By the help of increasing growth in technologies, there is increased comfort, greater safety and security in life. People spend most of their time at home, offices or on the road and with the advent GSM phones and network, communication between individuals and organizations is no longer limited by the barrier of distance.X10 is a protocol for communication; it was developed in 1975 by Pico Electronics of Glenrothes, Scotland, in order to allow remote control of home devices and appliances. It was the first general purpose domotic network technology and remains the most widely available. X10 remains popular in the home environment with millions of units in use worldwide, and inexpensive availability of new components (en.wikipedia.org), e.g. for scheduling the garden lights, or turning on the air conditioning via the Internet. Programmable sensors, such as Phidgets, allow programmers and hobbyists to develop their own applications using the sensors (e.g. temperature, pressure, light, etc.).A smart home has its appliances and various parts of the home, that make use of those technological advancements, work together to improve the quality of life of its occupants. The notion of smart homes has been around for quite some time now, and we can see it visualized by many artists in futuristic movies or in fiction novels ever since. However, not many people outside the academia may realize that smart home technologies are an active research topic and there are many interesting and useful applications that are available as a result, and some of them are in use today in our daily lives.

GSM TECHNOLOGY : GSM in details is **global system for mobile communication**; GSM is an international digital cellular telecommunication. The GSM standard was released by European Standard Telecommunication Standard (ETSI) back in 1989. The first commercial services were launched in 1991 and after its early introduction in Europe; the standard went global in 1992 (GSM Association, 2001). Since then, GSM has become the most widely adopted and fastest-growing digital cellular standard, and it is positioned to become the world's dominant cellular standard. Today's second-generation GSM networks deliver high quality and secure mobile voice and data services (such as SMS/ Text Messaging) with full roaming capabilities across the world. GSM platform is a huge successful technology and as unprecedented story of global achievement. In less than ten years since the first GSM network was commercially launched, it become, the world's leading and fastest growing mobile standard, spanning over 173 countries. Today, GSM technology is in use by more than one in ten of the world's population and growth continues to sour with the number of subscriber worldwide expected to surpass one billion by through end of 2003. Today's GSM platform is living, growing and evolving and offers an expanded and feature-rich 'family' of voice and enabling services. The GSM network is a cellular telecommunication network with a versatile architecture complying with the ETSI GSM 900/GSM 1800 standard. The GSM originated in the late 1940s. It was never a widely used system due to its limited frequency spectrum allocation and the high cost required for its equipment. But with its standardization by the European Telecommunication Standard Institute (ETSI), the GSM has subsequently been adopted worldwide as the international digital mobile standard. With the introduction of this system in Nigeria, study has shown that most Nigerians do not use up to 30% (thirty per cent) of the features in their phone. What Nigerians do is to make or receive calls with their phone and send short messages (SMS). Our thought about this work is to see how we can construct a device with a mobile phone embedded inside it which will work through any of the network providers like MTN (Mobile Telecommunication Network), GLOBACOM (Global Communication), AIRTEL (Air Telecommunication), ETISALAT (Emirates Telecommunication Corporation), etcetera, to control our appliances connected to the system.

CELL PHONE SMS BASED REMOTE HOME CONTROL SYSTEM : The system allows a user to control selected devices from a cellular phone and this will be broken down in three main parts: The cellular phone (serving as a platform for instructions and as a device status interface), the control unit (receiving, interpreting and issuing commands), and the controlled devices. The control unit will comprise a cellular module and a microcontroller. The basic device control scenario will start at the cellular phone, where the user will input a command in the form of a text message (SMS). At the control unit, the cellular module will receive the command and transmit it to the microcontroller. The microcontroller will then interpret the command and issue the appropriate control signal to the device to be operated. After the command is executed, the control unit will send a completion status message back to the cellular phone (Arturo et al, 2005).

DIAL TO OPEN GSM REMOTE CONTROL AND GSM ALARM : The Dial to open GSM is a remote control switch that connects to the GSM mobile phone network. It enables one to open automated gates, alarm and garage doors using a mobile phone. Simply 'speed-dial' the dial to open which identifies you as an authorized user and the automatic gate, barrier or door opens. There is no call costs incurred when calling the unit, it will recognize an authorized telephone number calling it and reject the call without answering. It is programmed by SMS text message, authorized telephone numbers can be added and deleted as required, which can execute just one command.

TECHNICAL DETAILS OF GSM : GSM is a cellular network, which means that mobile phone can be connected to it by searching for cells in the immediate vicinity. GSM network operate in four different frequency ranges. Most GSM network operates in the 900MHz or 1800MHz bands. In 900MHz band, the uplink frequency band is between 890-915MHz and the downlink frequency band is 935-960MHz. In the 1800MHz band, the uplink frequency is between 1710-1785MHz and the downlink is between 1805-1880MHz. Also in 1900MHz band, the uplink frequency band is 1850MHz- 1950MHz. In GSM 900MHz, the band allocation is 25MHz band width which is subdivided into 24 carrier frequency channels, each spaced is 200 kHz apart. Time division multiplexing is used to allow eight-fall rate to sixteen half-rate speech channels per radio frequency channel. There are eight-radio time slots (giving eight burst per odds). Half rate channels use alternate frames in the same time slot. The channels data rate is 270, 833kbit/s and the frame duration is 4.615ms. The transmission power in the handset is limited to a maximum of 2craffs in GSM 900 and 1waH in GSM 1800/1900.

FEATURES OF MOBILE PHONE : A mobile phone is simply a GSM with a workable SIM card inside; every mobile phone on the standard of public telephone network is connected to the mobile switching or exchange office. Any two people can communicate to each other by the help of switching unit in the phone exchange office. There are two methods of sending phone numbers to the switchboard, first one is by dial pulse system and the other is multi frequency system. The phone of which keypad information is sent by audio tone is used to remote control devices. This is also called dual tone multi frequency (DTMF) and every button on the keypad has different frequency. When the button is pressed, its relevant frequency is sent to the switchboard. These button identification signals are transmitted through mobile line or telephone line with voice signal. DTMF codes are decoded by appropriate DTMF decoder and then button information is found.

CONCEPT OF AUTOMATIC SPEECH RECOGNITION (ASR) DEVICE : Automatic speech recognition (ASR) is the process by which a computer maps an acoustic speech signal to some form of abstract meaning of the speech. Automatic speech recognition (ASR) applications focus on public services such as operator automatic assistance voice activated information retrieval, voice doing and many other similar tasks. Speech recognition should not be confused with a dial tone (DTMF) application where the user must select from numbered options or spell out a number using the telephone keypad. A speech recognition application allows the user to answer questions and provide information using a normal speaking voice many companies have already invested early in human powered call centers or DTMF (touch-tone) interactive voice response (IVR) systems. They are changing or adapting to ASR applications, because of cost savings and improvement in customer satisfaction and experience. It has been shown that automatic speech recognition applications are far more popular with callers than DTMF menu systems. In general, ASR system consists of a signal processing front-end, an acoustic modeling, and a language modeling.

PHONE KEYPAD TONES AND ITS FREQUENCY : The keypad of the handset is a common but interesting feature on every phone. The keypad has tones, each with unique frequency (hence sounds). Once a call is acknowledged by the receiving phone, the speakers of the two phones (the transmitter and the receiver) are automatically activated to receive keypad tones when the buttons of any of the phones is depressed. Every phone irrespective of manufacturer has twelve (12) keypads. The twelve keypads are Key 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, asterisk (*) and the hash (#). These tones are automatically transmitted and received as the keypad tones. With four different frequencies in each group but the phone only uses 12 of the possible 16 tones, each button could be used to transmit command to the control equipment. Thus several independent commands could be generated using this approach. With the trend in technology where microcontroller has gained wide appreciation, the controls are not limited to twelve (12). The keypad tone is used to generate the necessary command that will activate electromagnetic or solid state relays for switching ON and OFF and the accessing of the STATUS of several appliances.

DUAL-TONE-MULTI-FREQUENCY (DTMF) : The Dual Tone Multi-Frequency, (DTMF), is a method for instructing a telephone switching system of the telephone number to be dialed, or to issue commands to switching systems or related telephony equipment. The DTMF is the basis for the telephone system (Boylestad and Nashelsky, 2002) and it traces its roots to a technique developed by Bell Labs in the 1950s called MF (Multi-Frequency) which was deployed within the AT&T telephone network to direct calls between switching facilities using in-band signaling. In the early 1960s, a derivative technique was offered by AT&T through its Bell System telephone companies as a "modern" way for network customers to place calls. AT&T described the product as "a method for pushbutton signaling from customer stations using the voice transmission path" (AT&Ts Compatibility Bulletin No. 105).

The DTMF keypad is laid out in a 4×4 matrix, with each row representing a low frequency, and each column representing a high frequency. Pressing a single key (such as ‘1’) will send a sinusoidal tone of the two frequencies 697 and 1209 hertz (Hz), which is the row and column frequencies respectively. Since the DTMF decoder has 16 distinct tones. Each tone is the sum of two frequencies, one from a low and the other from high frequency group. The original keypads had levers inside, so each button activated two contacts. The multiple tones are the reason for calling the system multi-frequency. These two tones identify the key you pressed. If a DTMF keypad is used to remotely control equipment, the tones can identify what unit is to be controlled, as well as which unique function is to be performed. Table 1.1 shows corresponding row and column frequencies of keypad digits.

Table 1.1 DTMF KEYPAD ROW AND COLUMN FREQUENCIES

Frequency (Hz)	**1209**	**1336**	**1477**	**1633**
697	**1** 1906	**2** 2033	**3** 2174	**A**
770	**4** 1979	**5** 2106	**6** 2247	**B**
852	**7** 2061	**8** 2188	**9** 2329	**C**
941	* 2150	**0** 2277	**#** 2418	**D**

The tone frequencies were selected such that harmonics and inter-modulation products will not cause an unreliable signal.

THE DUAL-TONE-MULTI-FREQUENCY SPECTRUM : The frequency spectrum as shown in fig 1.1, illustrates, each tone must fall within the proper band pass before a valid decoding will take place. If one tone falls outside the band pass spectrum, the decoder will become unreliable or not operate at all. The purpose of DTMF decoding is to detect sinusoidal signals in the presence of noise. In many cases, the DTMF decoder I.C interfaces with a microcontroller. Here it is logical that the microcontroller should not be used to decode the sinusoids. Because the typical microcontroller based decoder requires an A/D converter. In addition, the signal processing associated with the decoding is usually beyond the scope of the microcontroller's capabilities. So the designer is forced to use the dedicated IC or upgrade the microcontroller to perhaps a more costly digital signal processor.

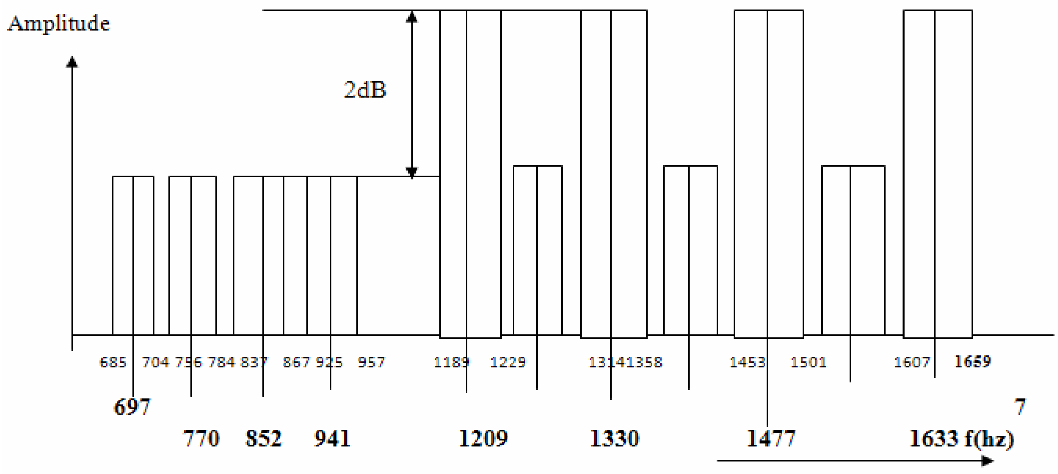

Fig.1.1: Dual Tone Multi Frequency (DTMF) spectrums.

AT89S52 MICROCONTROLLER : AT89S52 microcontroller is a great family compatible with Intel MCS-51. It's created by Atmel AT89S52, indicated by the initials "AT". This microcontroller has low power consumption, but CMOS 8-bit gives high performance with an internal flash memory of 8 Kilo Bytes. This is done using technology and high-density non-volatile memory that belongs to and is compatible with the standard Atmel 80C51. Chip Flash allows the internal memory to be programmed or reprogrammed by a non-volatile memory. By combining an 8-bit CPU with Flash memory programmable monolithic kernel, Atmel AT89S52 is very powerful microcontroller which has high flexibility and is therefore the perfect solution for many embedded applications. The AT89S52 microcontroller and its pin configuration are shown in Fig.1.2.

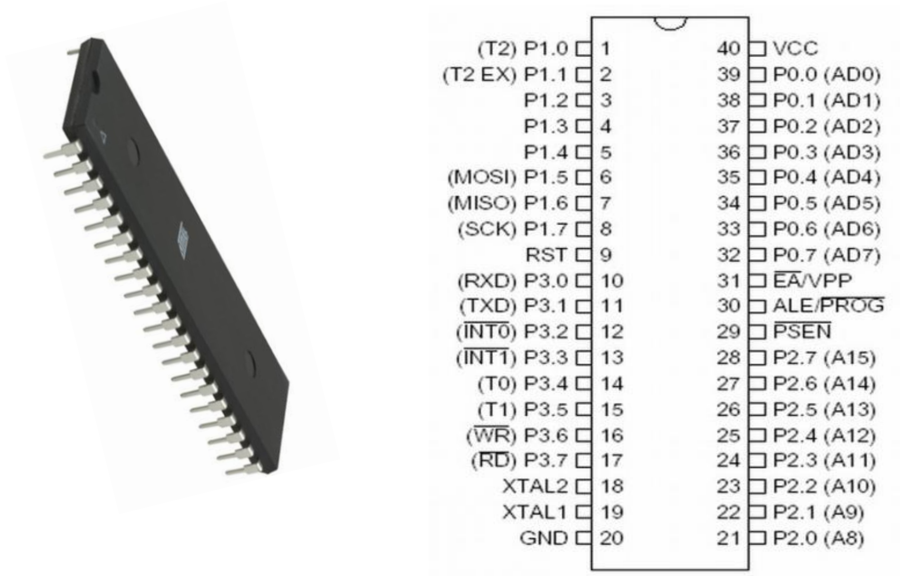

Fig. 1.2: The AT89S52 microcontroller and its pin configuration

CM8870 DTMF DECODER

The CAMD CM8870C provides full DTMF receiver capability by integrating both the band split filter and digital decoder functions into a single 18-pin DIP, SOIC, or 20-pin PLCC package. The CM8870C is manufactured using state-of-the-art CMOS process technology for low power consumption (35mW, max.) and precise data handling. The filter section uses a switched capacitor technique for both high and low group filters and dial tone rejection. The CM8870/70C decoder uses digital counting techniques for the detection and decoding of all 16 DTMF tone pairs into a 4-bit code. This DTMF receiver minimizes external component count by providing an on-chip differential input amplifier, clock generator, and a latched three-state interface bus. The on-chip clock generator requires only a low cost TV crystal or ceramic resonator as an external component. The CM8870 DTMF decoder and its pin configuration is shown in Fig 1.3.

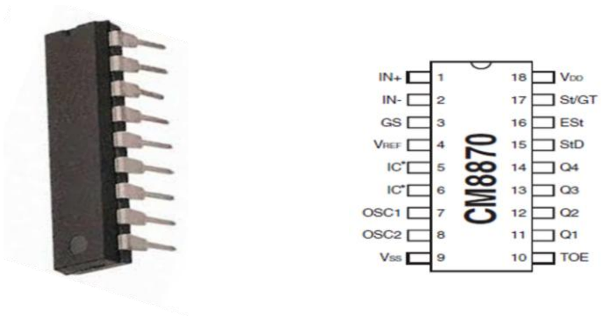

Fig 1.3: The CM8870 DTMF decoder and its pin configuration

This I.C detects the dial tone from a telephone line and decodes the keypad pressed on the remote telephone. The dial tone we hear when we pick up the phone set is called Dual Tone Multi-Frequency, (DTMF). The name was given because that we used to hear over the phone is actually made up of two distinct frequency tone, hence the name dual tone. The DTMF tone is a form of one way communication between the dialer and the telephone exchange. A complete communication consists of the tone decoder. In my work, I used IC CM8870, the main component to decode the input dial tone to 5 digital outputs. These digital bits can be interface to microcontroller for further application like remote control and phone line transfer.

AIM OF THE GSM REMOTE CONTROL SYSTEM PROJECT

To implement remote switching system using GSM phone and any preferred network operator.

OBJECTIVES

- Design and construction of a workable GSM remote circuit system
- To co-ordinate appliances and other devices through phone calls.
- To effectively transmit data and receive data through keypad tones and head phones respectively.
- Achieve an automated call back confirming “task properly executed”.
- Testing of the constructed circuit

II. MATERIALS, METHODS AND TECHNIQUE

There are many modules that combine together to form the full work. This discrete parts or component on their own are made up of smaller components. The modules are combined in a definite pattern to form the overall circuit design.

SYSTEM DESIGN

The first step in any system design is the articulation and development of block diagram to represent the system. The block diagram for the system is as given in Fig. 2.1.

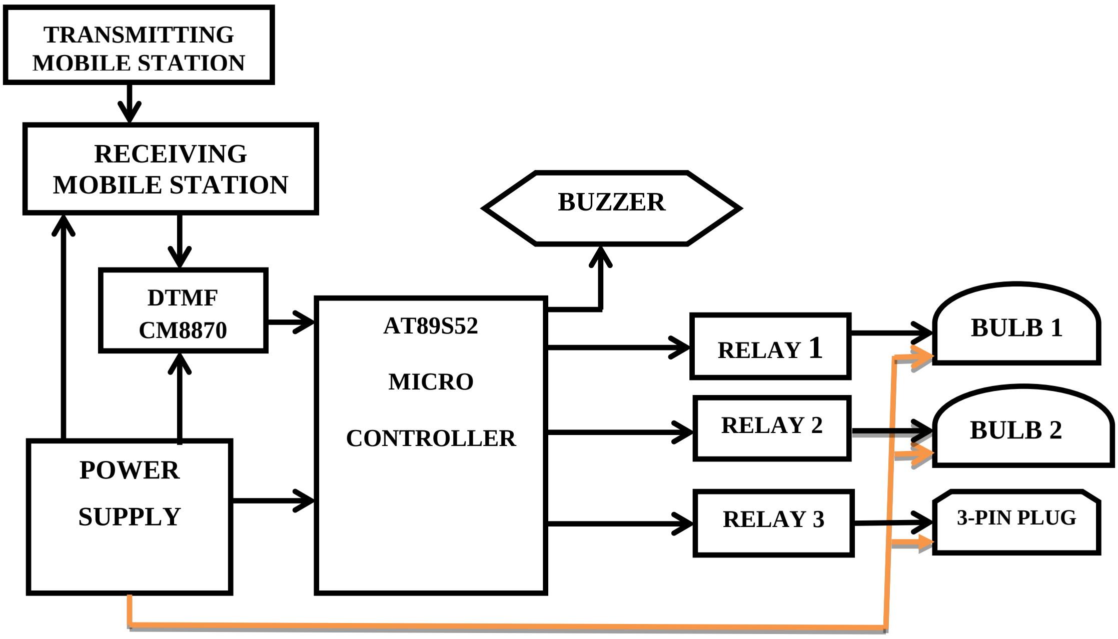

Fig 2.1 Block diagram of GSM remote switching system

The different units were then designed and put together to form the circuit of the system as given in Fig. 2.2.

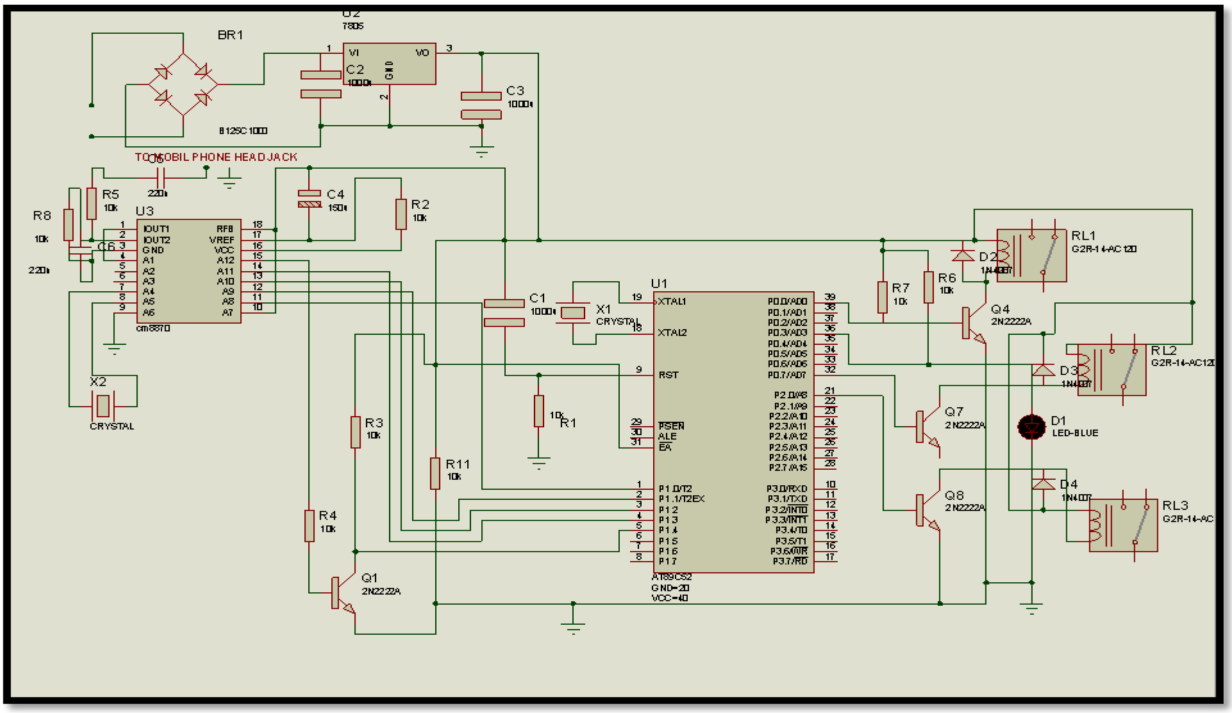

Fig 2.2: The complete circuit diagram

MATERIALS

Table 3.1 shows the list of materials and components to be used for the construction of the circuit.

TABLE 2.1: List of Materials, Specification and Quantity Required

S/N	COMPONENT / MATERIAL	SPECIFICATION	QUANTITY
1	STEP DOWN TRANSFORMER	12v (Big Size)	1
2	DIODE	IN4007(Signal Diode)	9
3	40 PIN SOCKET	Microcontroller Seat	1
4	18 PIN SOCKET	DTMF seat	1
5	MICROCONTROLLER	AT89S52	1
6	DTMF DECODER	CM8870	1
7	LIGHT EMITTING DIODE (LED)	Red Color	1
8	RESISTORS	100Ω 1k Ω 10k Ω 100k Ω 300k Ω	10 6 2 1 1
9	CAPACITORS	0.4µF 10µF (16V) 100µF (16V) 1000µF (25V)	2 1 1 1
10	RELAY	12V (5 Amps)	4
11	MOBILE PHONE	NOKIA 1280	1
12	REGULATOR	L7805 (5V)	1
13	CONNECTION/JUMPER WIRES	2 different colours	1 yard
14	SOLDERING LEAD	Tiny	1 roll
15	BUZZER	Round shaped	1
16	GLOSSY PAPER	white	1
17	FERRIC OXIDE CHEMICAL	Liquefied	30 ml
18	COPPER CLAD BOARD	3*2 inches	1
19	TRANSISTORS		3
20	CRYSTAL OSCILLATOR	3.579545MHz, 11MHz	1 each
21	PIN CHARGER WIRE	Nokia small pin type	1
22	MOBILE PHONE HEAD JACK	Nokia big pin type	1
23	LAMP HOLDER		2
24	ELECTRIC BULB		2
25	3 PIN SOCKET		1

III. CONSTRUCTION

The construction of the circuit commenced with the preparation of the printed circuit board. After this, the components were installed on circuit board and soldered into place. IC carriers were soldered in place of the AT89S52 microcontroller and the CM8870 DTMF decoder to avoid damage to the ICs. At the end of the construction, the ICs were plugged-in to their carriers after the programming of the microcontroller.

PRINTED CIRCUIT BOARD DESIGN AND DEVELOPMENT

The material used for the PCB preparation include: Pad2pad electronic PCB software, Laser printer, Glossy paper, Copper-clad board/laminate, and Ferric oxide chemical.
The steps followed to prepare the PCB include:

The circuit diagram was designed on the pad2pad software, as shown in Fig 2.3, after which it was now printed on a glossy paper using LASER printer, as shown in Fig. 2.4.

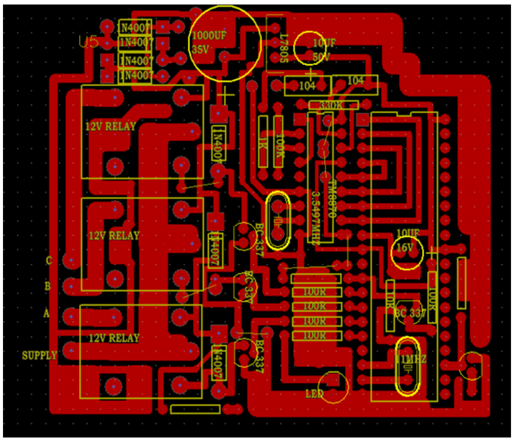

Fig. 2.3: The designed printed circuit board

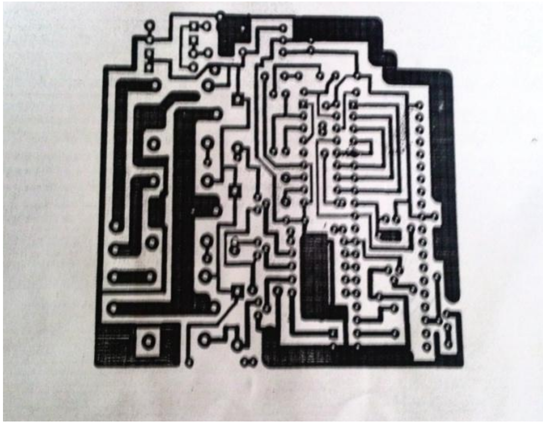

Fig. 2.4: The circuit printed on a glossy paper

[1] The circuit printed on a glossy paper was pressed to a copper-clad board with the help of electric iron.
[2] The paper was washed off from the board using water.
[3] The board was placed in a warm Ferrite oxide chemical and stirred, as shown in Fig 2.5, after which the chemical was washed off in water and cleaned with a retarding chemical. The board is shown in Fig. 2.6.

Fig. 2.5: The board in a warm Ferrite oxide chemical

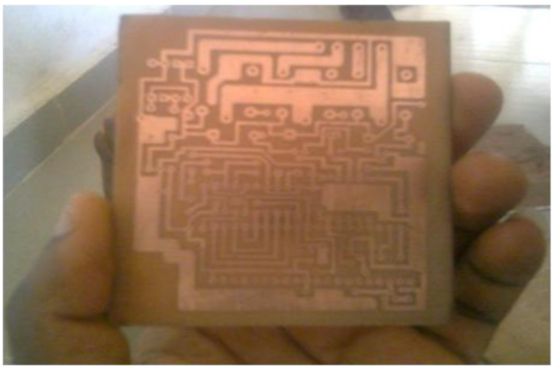

Fig 2.6: The etched and cleaned copper clad board

The pin holes were drilled with a drilling machine.

COMPONENT INSTALLATION

The electronics components were carefully soldered into the drilled printed circuit board, starting from the passive to active component and finally the microcontroller seat, as shown in Fig. 2.7.

Fig. 2.7: Installed components on the circuit board.

MICROCONTROLLER PROGRAMMING

The AT89S52 microcontroller was programmed to perform the required task by simulation method using the 8052 simulator for windows. The simulated program as given below was burnt into the microcontroller.

Note: The square brackets, which were used to compress the length of the program, represent different lines of the program.

;;; GSM HOME AUTOMATION CODE;;;
;; RUNING @ FRQUNCY OF 11MHZ CRYSTAL;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
[OUTPUT DATA 0B0H], [INPUT DATA 090H], [FLAG DATA 020H], [DELA_REG1 DATA 005H], [DELA_REG2 DATA 006H], [DELA_REG3 DATA 007H], [DELA_REG4 DATA 008H]
;;;
[RELAY1 BIT OUTPUT.3], [RELAY2 BIT OUTPUT.4], [RELAY3 BIT OUTPUT.5], [LED BIT OUTPUT.6], [BUZZER BIT 0A0H.2], [CALL_BACK BIT 080H.0]
;;;
[FLAG_RELAY1 BIT FLAG.0], [FLAG_RELAY2 BIT FLAG.1], [FLAG_RELAY3 BIT FLAG.2], [FLAG_BUZZER BIT FLAG.3], [FLAG_CALL BIT FLAG.4], [ORG 000H], [AJMP INIT_COMPUNENT], [ORG 009H], [INIT_COMPUNENT:], [MOV SP,#00AH] [MOV INPUT,#00FH], [MOV A,INPUT], [MOV FLAG,#000H], [MOV DELA_REG1,#00], [MOV DELA_REG2,#00], [MOV DELA_REG3,#00], [MOV DELA_REG4,#00], [MOV IE,#10000001B], [CLR RELAY1], [CLR RELAY2], [CLR RELAY3], [CLR CALL_BACK], [SETB LED], [SETB BUZZER], [SETB LED], [CALL DELAY], [CLR BUZZER], [CLR LED], [CALL DELAY], [SETB BUZZER], [SETB LED], [CALL DELAY], [CLR BUZZER], [CLR LED], [CALL DELAY], [SETB BUZZER], [SETB LED], [CALL DELAY], [CLR BUZZER], [CLR LED], [CALL DELAY], [CPL LED], [AJMP CODE_START], [CODE_START:], [MOV A,INPUT], [LCALL DELAY_WAIT], [CALL RESPONDS], [JB FLAG_BUZZER,BUZZ_], [AJMP CODE_START],
;;;
LOAD_INPUT: [MOV IE,#10000000B], [MOV A,INPUT], [LCALL DELAY_WAIT], [CLR LED], [AJMP CHECK_CODE]
RESPONDS:, [JNB FLAG_CALL,EXIT], [SETB CALL_BACK], [SETB LED], [CALL DELAY], [CLR CALL_BACK], [CLR LED], [CALL DELAY], [SETB CALL_BACK], [SETB LED], [CALL DELAY], [CLR CALL_BACK], [CLR LED], [CALL DELAY], [SETB CALL_BACK], [SETB LED], [CALL DELAY], [CLR CALL_BACK], [CLR FLAG_CALL], [SETB LED],
EXIT: [RET]
BUZZ_ : [SETB BUZZER], [SETB LED], [CALL DELAY], [CLR BUZZER], [CLR LED], [CALL DELAY], [SETB BUZZER], [SETB LED], [CALL DELAY], [CLR BUZZER], [CLR LED], [CALL DELAY], [AJMP CODE_START]
CHECK_CODE: [CJNE A,#00CH,CHECK_1], [CLR RELAY1], [CLR RELAY2], [CLR RELAY3], [CLR BUZZER], [MOV A,#000], [SETB FLAG_CALL], [AJMP CHECK_1]
;;
CHECK_1: [CJNE A,#001H,CHECK_2], [LCALL DELAY], [JB FLAG_RELAY1,OFF_OUTPUT1], [SETB RELAY1], [MOV A,#000], [SETB FLAG_RELAY1], [SETB FLAG_CALL], [AJMP CHECK_END]
OFF_OUTPUT1: [CLR FLAG_RELAY1], [CLR RELAY1], [LCALL DELAY], [MOV A,#000], [AJMP CHECK_END]
;;
CHECK_2: [CJNE A,#002H,CHECK_3], [LCALL DELAY], [JB FLAG_RELAY2,OFF_OUTPUT2], [SETB RELAY2], [MOV A,#000], [SETB FLAG_RELAY2], [SETB FLAG_CALL], [AJMP CHECK_END]
OFF_OUTPUT2: [CLR FLAG_RELAY2], [CLR RELAY2], [LCALL DELAY], [MOV A,#000], [AJMP CHECK_END]
;;
CHECK_3: [CJNE A,#003H,CHECK_4], [LCALL DELAY], [JB FLAG_RELAY3,OFF_OUTPUT3], [SETB RELAY3], [MOV A,#000], [SETB FLAG_RELAY3], [SETB FLAG_CALL], [AJMP CHECK_END]
OFF_OUTPUT3: [CLR FLAG_RELAY3], [CLR RELAY3], [LCALL DELAY], [MOV A,#000], [AJMP CHECK_END]
;;
CHECK_4: [CJNE A,#004H,CHECK_HASH], [LCALL DELAY], [JB FLAG_BUZZER ,OFF_OUTPUT4], [MOV A,#000], [SETB FLAG_BUZZER], [SETB FLAG_CALL], [AJMP CHECK_END]
OFF_OUTPUT4: [CLR FLAG_BUZZER], [CLR BUZZER], [LCALL DELAY], [MOV A,#000], [AJMP CHECK_END]

```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
CHECK_HASH: [CJNE A,#00AH,CHECK_END], [SETB  RELAY1], [SETB  RELAY2], [SETB  RELAY3], [MOV A,#000], [SETB FLAG_CALL]
CHECK_END: [SETB  LED], [MOV IE,#10000001B], [RETI]
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
DELAY: [MOV DELA_REG2,#05], [MOV DELA_REG1,#10;20]
DEL: [CALL DELAY_WAIT], [DJNZ DELA_REG1,DEL], [DJNZ DELA_REG2,DEL], [RET]
DELAY_WAIT: [MOV DELA_REG4,#02], [MOV DELA_REG3,#03]
DEL2: [DJNZ DELA_REG3,DEL2], [DJNZ DELA_REG4,DEL2], [RET]
END
```

III. OPERATION OF THE SYSTEM

The user can perform the operation of ON/OFF using two mobile phones which one will serve as transmitter and the other as receiver. The user picks up any mobile phone which has an enabled keypad tone and dials the number of the mobile phone in block “B”. The phone in block “B” must be enabled to pick calls automatically (i.e. Auto Answer feature must be enabled). When the phone picks the call, the user notices that by seeing the call timer in his phone count. He will then press a key or series of keys in his phone depending on the device configuration while still on call, the tone of the keypad pressed will be receive by mobile phone in block “B” and sent to the DTMF tone decoder which decodes it and gives a binary equivalent as output. The binary output is then sent to the microcontroller which process it based on its program and determines whether to energize the relay or not. The completed project work as remotely controlled is shown in Fig. 2.8.

Fig 2.8: Completed project, as remotely controlled by the GSM phone.

IV. CONCLUSION AND RECOMMENDATION

CONCLUSION : Mobile phones have become an indispensable part of our life. This system uses a controller and a GSM cellular phone for its operations. With this, any device that requires turning ON and OFF can be controlled from any part of the World so long as there is GSM network there. The constructed system was tested and its operation confirmed.

RECOMMENDATION : This control system is recommended for every homes, offices, laboratories, hospitals and industries to aid those working or living in those places when it comes to controlling their appliances, equipment. This control system has to be perceived by the society and the world at large as a necessary and vital technological upgrade. Any future work on this control system should incorporate a backup power supply so as to keep the system running in an event of power failure as is regularly experienced in some developing countries. It was noticed that the call back system, incorporated and installed, could not work, because the mobile phone used does not have a solderable panel to the dialing switch. I therefore recommend a further research on mobile phone with such feature, when further work is to be done on this topic.

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