© 2017 IJSRST | Volume 3 | Issue 1 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

A Survey on GSM based Automation Cum Surveillance System using DTMF Technology

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ABSTRACT

In this paper we have proposed a method to make a base for the monitoring of systems. The monitoring of systems could be from monitoring of movements in any particular area to the monitoring of any external electrical, mechanical device. The goal is to find an improvement over the previous surveillance systems. The facilities provided by it such as easy handling, a secrecy support, an immediate action are granted. A prototype is built in the Windows platform using C# to demonstrate the functioning of the entire system. The methodology of DTMF (Dual Tone Multi-Frequency) with GSM module is used for designing our robot. Robot is controlled by a mobile, through this we can make our robot communicate on a large scale over a large distance even from different cities or place. Various home automation technologies considered in our work include context-aware home automation systems, central controller-based home automation systems, Bluetooth-based home automation systems, Global System for Mobile communication or mobile-based home automation systems, Short Messaging Service-based home automation systems, General Packet Radio Service-based home automation systems, Dual Tone Multi Frequency-based home automation systems, and Internet-based home automation systems.

Keywords : GSM, Modem, C#, Monitoring System, AT Commands, DTMF.

I. INTRODUCTION

Global System for Mobile Communications (GSM) is the standards developed by the European Telecommunication Standards Institute (ETSI)to describe the cellular network. Mobile phone is a revolutionary invention of the century. It was primarily designed for making and receiving calls & text messages, but it has become the whole world after the Smart phone comes into the picture. Grinteret.et. al., showed in [1] that in addition to home automation technology and devices, a modern home relies on three to seven services or companies to provide them with infrastructure support like Internet, telephone, electricity, gas, etc. Another study done by Chetty and Grinter on different homes showed that people choose the "Site" of the home based on factors like the availability of uninterrupted power, high speed Internet, etc., excluding other factors like property prices and neighbors, which are beyond the scope of this work [2]. In this project we are building a home automation system, where one can control the home appliances, using the simple **GSM based phone**, just by sending SMS through his phone. In this project, no Smart phone is needed, just the old GSM phone will work to switch ON and OFF any home electronic appliances, from anywhere. Based on NSIC13 [3]. There exists some systems which makes use of the dual tone multi frequency used in telephone lines. System uses standard public-switched telephone lines. The system includes three components, first is the DTMF receiver and ring detector. Maqbool and Sajaad have proposed a method to make a base for the monitoring of systems [4]. The monitoring of systems could be from monitoring of movements in any particular area to the monitoring of any external electrical, mechanical device. Jose and Malekian [5] presented a comprehensive description about different home automation systems and technologies from a security stand point. Ahmed et. al., explained how the system allows complete security and is based on microcontroller [6]. The design objective of this project is to make a DTMF based remote monitoring system which can be used to acquire different parameters of any process or machine and send the data obtained to a distant logging system running on a PC so

that the data can be represented in a user friendly manner. Radhamani gave an idea on, "Intelligent Home Automation and Security System Mobile devices are ideal in providing a user interface in a home automation system and this paper evaluates development of a low cost surveillance system using different sensors built around the microcontroller [7]. In this system, Arduino is used for controlling whole the process. Here we have used GSM wireless communication for controlling home appliances. We used some commands like "#A.light on*", "#A light off*" and so on for controlling AC home appliances. After receiving given commands by Arduino through GSM, Arduino send signal to relays, to switch ON or OFF the home appliances using a relay driver. This paper is organized as follows: Section 2 explained the home automation system followed by GSM module in section III. Section IV and V presented the circuit description and code description respectively. Section VI described the DTMF technology and its construction described in section VII. Section VIII concluded this paper and Referencesare listed after conclusion section.

II. METHODS AND MATERIAL

1. GSM Based Automation System

This paper is motivated from the GSM based home automation system which is actually suitable for the both home and industry. This section presents the overview of how communication among various devices used in automation system is established. This automation system considers three options for communication in GSM: SMS-based home/industry automation, GPRS-based home/industry automation, and Dual Tone Multi Frequency based home/industry automation [5].

Figure 1, shown below is from the work of A. Alheraish [12]. It shows the logical diagram of how a home's sensors, electrical, and mechanical devices interact with the home network and communicates through the GSM module using a Subscriber Identity Module (SIM). The system uses transducer (in the form of sensor) which transforms the machine functions into electrical signals. Further the electrical signal is fed directly into a microcontroller. The microcontroller analyses these signals and converts them into commands that can be understood by the GSM module. Based on the received commands, the GSM module selects the appropriate communication method (SMS, GPRS or DTMF).

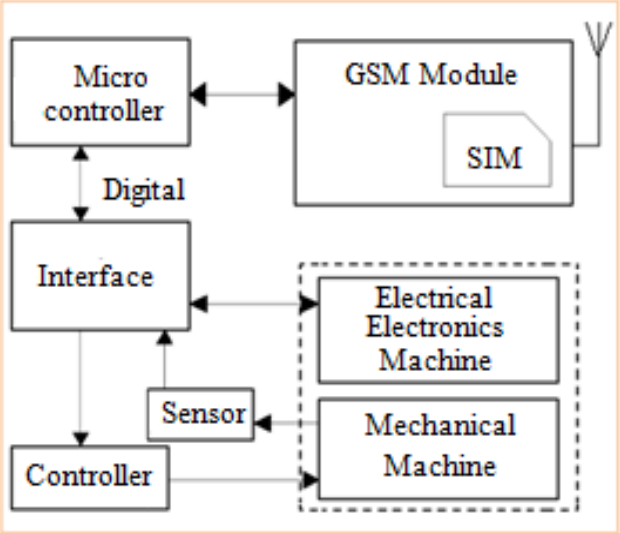

Figure 1. Home/Industry automation System

2. GSM Module

GSM module is used in many communication devices which are based on GSM (Global System for Mobile Communications) technology. It is used to interact with GSM network using a computer as shown in the Fig. 2. Mobile-based home automation is attractive to researchers because of the popularity of mobile phones and GSM technology. The work of A. Alheraish [12] proposes a home automation system using SMS also as explained in previous section. The proposed system detects illegal intrusions at home and allows legitimate users to change the passkey for the door and control lights in the home. The illegal intrusion into the home is identified by monitoring the state of the home door, which is done using Light Emitting Diode (LED) and infrared sensors. The passkey to the door can be any 4 digits, which can be set either by using the keypad or by using SMS from a registered user's mobile number. A user can control the lights in their home remotely using SMS from their registered mobile number; by turning the lights on in different rooms at random intervals of time, one can give the impression that the home is occupied, even when it is not Based on the received commands, the GSM module selects the appropriate communication method (SMS, GPRS or DTMF).

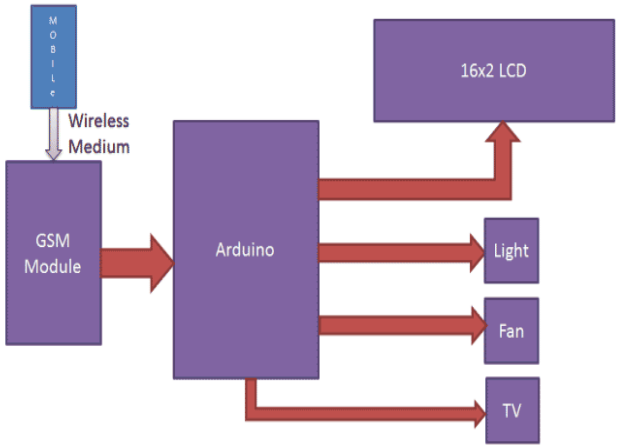

Figure 2. Interfacing GSM Module with Arduino

GSM module only understands AT commands, and can respond accordingly. The most basic command is "AT", if GSM respond OK then it is working good otherwise it respond with "ERROR". There are various AT commands like ATA for answer a call, ATD to dial a call, AT+CMGR to read the message, AT+CMGS to send the sms etc. AT commands should be followed by Carriage return i.e. \r (0D in hex), like "AT+CMGS\r". We can use GSM module using these commands as shown in Table I.

The **SIM900** is a complete Quad band **GSM/GPRS-Module** which delivers

GSM/GPRS850/900/1800/1900MHz performance for voice, SMS and Data with low power consumption. The work of M.S.H Khiyal et al. [13] proposes an SMS-based home security system called SMS-based Wireless Home Appliance Control System (HACS).

The work of U. Saeed et al. [14] also proposes an SMS-based home automation system. The system has a Java application running on the phone. In the work of A.R Delgado et al. [15], GPRS communication is used as a backup for an Internet-based home automation system. This adds to the fault tolerance of the system.

Table I. Command with its description

Command	Comment
ATE0 - For echo off	
AT+CNMI=2,2,0, 0,0 <ENTER>	Auto opened message Receiving. (No need to open message)
ATD<Mobile Number>; <ENTER>	making a call (ATD+919610126059;\r\n)
AT+CMGF=1 <ENTER>	Selecting Text mode
AT+CMGS="Mobile Number" <ENTER>	Assigning recipient's mobile number
>>Now we can write our message >>After writing message	
Ctrl+Z	send message command (26 in decimal).
ENTER=0x0d in HEX	

3. Circuit Description

Connections of this GSM based home automation circuit are quite simple, here a liquid crystal display is used for displaying status of home appliances which is directly connected to arduino in 4-bit mode. Data pins of LCD namely RS, EN, D4, D5, D6, D7 are connected to arduino digital pin number 6, 7, 8, 9, 10, 11. And Rx and Tx pin of GSM module is directly connected at Tx and Rx pin of Arduino respectively as shown in Fig. 3. And GSM module is powered by using a 12 volt adaptor. 5 volt SPDT 3 relays are used for controlling LIGHT, FAN and TV.A **relay** is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a **relay** is an electromagnet. And relays are connected to arduino pin number 3, 4 and 5 through relay driver ULN2003 for controlling LIGHT, FAN and TV respectively.

Figure 3. GSM Module 900A

4. Code Description

In programming part of this project, first of all in programming we includes library for liquid crystal display and then we defines data and control pins for LCD and home appliances.

A dedicated IP (Internet Protocol) is a unique Internet address dedicated exclusively to a single hosting account. This is in contrast to the normal configuration of several hosting accounts residing on a single server and sharing its IP address.

As seen above, we send an SMS from a mobile device, through the GSM network, to the GSM Module present in the automation system.The messages being sent for the control are pre-programmed into the Microcontroller as shown in Fig. 4. Thus, it compares the string with the message string, and performs the requisite action required. The 4 digit security passkey (used by A. Alheraish [12] and Saeed et al. [17]), in itself proposes a security vulnerability. An attacker could wait outside the home and peep through the window to learn the passkey. One can't expect the owner to be careful every time he or she enters the passkey. The user punches in the passkey routinely, so the probability of the user being careless is high.

Researchers Danaher and Nguyen [16] propose a home security system using GPRS. The work uses a webcam to stream video and pictures of the home to its owner's mobile through GPRS.The webcam detects movement by comparing frames for differences, including light intensity. Video streaming in the proposed work is done using the home Internet connection, not the GSM modem.

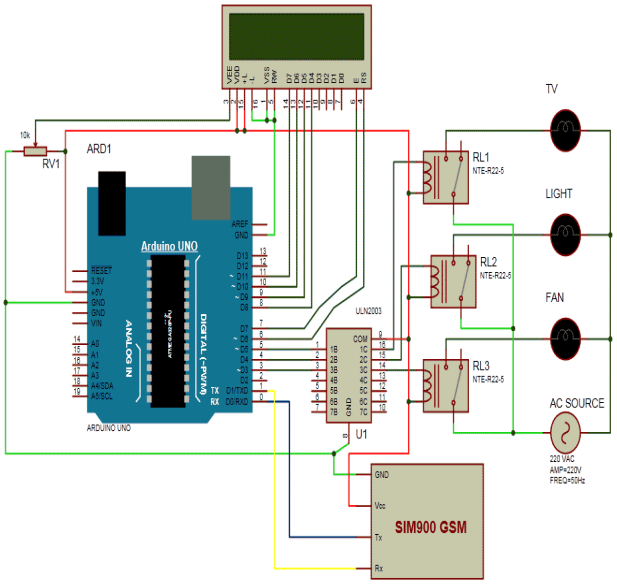

Figure 4. Circuit Diagram interfacing Arduino with GSM Module

For example, for controlling a television and a pair of lights, the string commands may be given as:

String TV_ON="TV ON";
String TV_OFF="TV OFF";
String LIGHT1_ON="Light 1 ON";
String LIGHT1_OFF="Light 1 OFF";
String LIGHT2_ON="Light 2 ON";

Now, if the above strings are sent through SMS, the GSM module receives the string, and stores the string in an array present in it, known as the STR array as shown in Fig. 5.

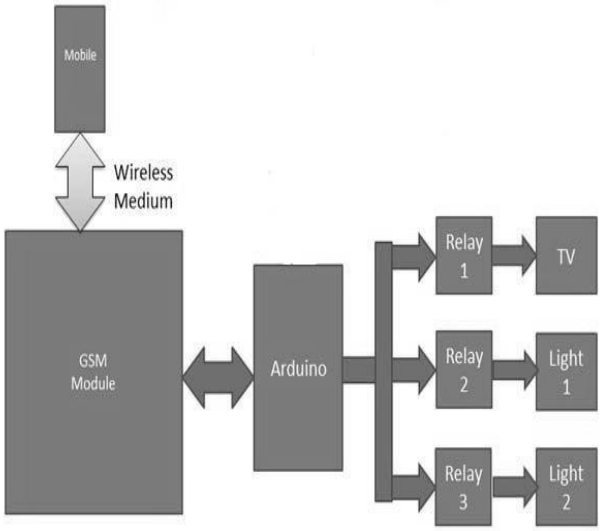

Figure 5. Block Diagram of DAC converter

The module then extracts the message and the mobile number from which it is sent. The message sent is stored within an asterisk and a hash symbol, that is, the message must be sent to the module in the format of *Light 1 ON#, such that the string comparison function may be performed. The separated message is then compared with the pre-programmed message in the Microcontroller, and if the strings are matched, then it perform.

5. DTMF Technology

Dual-tone multi-frequency signaling (DTMF) is an in-band telecommunication signaling system using the voice-frequency band over telephone lines between telephone equipment and other communications devices and switching centers. DTMF was first developed in the Bell System in the United States, and became known under the trademark Touch-Tone for use in push-button telephones supplied to telephone customers starting in 1963.

The early RF circuits based robots had controlled range of frequency and access to use the robot in which signals had early interference with noise and also there was a requirement of separate transmitters and receivers for transmission and reception of signals. The touch-tone system using a telephone keypad gradually replaced the use of rotary dial and has become the industry standard for landline and mobile service as shown in Table II. Other multi-frequency systems are used for internal signaling within the telephone network.

The work of L. Muhury and A.H.M.A Habib [11] describes the design and implementation of a DTMF-based home automation system. The user calls a SIM number assigned to the home and presses the digits on their phone's keypad to control the home's devices by generating a DTMF tone. The tone is received and decoded by the GSM module at home using a DTMF decoder. The decoded instructions are passed to the microcontroller so that user commands can be implemented at home.

Multi-frequency signaling is a group of signaling methods that use a mixture of two pure tone sounds. Various MF signaling protocols were devised by the Bell System and CCITT. The earliest of these were for in-band signaling between switching centers, where long-distance telephone operations used a 16-digit keypad to input the next potion of the destination telephone number in order to contact the next downstream long-distance telephone operator.

This semi-automated signaling and switching proved successful in both speed and cost effectiveness. Based on thus prior success with using MF by specialists to establish long-distance telephone calls dual-tone multi-frequency signaling was developed for end-user signaling without the assistance of operator.

Table II. DTMF Frequencies Ranges

	1209 Hz	**1336 Hz**	**1477Hz**	**1633 Hz**
697 Hz	1	2	3	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C

III. RESULTS AND DISCUSSION

Construction DTMF System

The construction of the robot is of three steps. They are IC circuit assembly, rover body and camera mounting on the designed vehicle. In IC circuit assembly, it is nothing but the PCB board which controls the movement of the vehicle according to the instruction given by the user. Here we are using three main IC's. They are,

A. DTMF Decoder

The IC MT8870 is known as the DTMF Decoder which gets the input frequency generated from the user mobile phone as DTMF tone, converts them into the binary digits and sends it to the microcontroller as inputs.The MT8870 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 16 DTMF tone-pairs into a 4-bit code. External component count

is minimised by on chip provision of a differential input amplifier, clock oscillator and latched three-state bus interface.

B. Microcontroller

The Microcontroller is the heart of the vehicle which controls the motion of the vehicle according to the user instructions. Here we are using AT89c51 microcontroller and the program coding was written in ASM program and fed into the microcontroller IC using KEIL compiler.

C. Motor Driver

Since the output supply from the microcontroller is not sufficient to run the motors hence a motor driver IC is used as shown in Fig. 6. The IC L293D is known as the motor driver IC which inherits H-Bridge concept and is able to run the two motors simultaneously at different directions.The voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor.

D. Rover Body

The rover body is the mechanical design of the vehicle which consists of motors, robotic wheels, steel and fibre glass sheets ,etc., The design of the vehicle is made as robust to withstand disturbances and vibrations carrying power supply, camera, IC circuit board, etc., on the vehicle.

E. Camera Installation

The Internet Protocol (IP) camera is used in this project for the surveillance purposes. This camera is properly configured in the user system so that it is able to view the pictures captured by the camera during the movement of the vehicle. The wireless antenna present in the camera is employed to transmit the data to the user system.Installation is as follows: Open the IP Webcam app on an Android device and make the necessary adjustments for resolution, quality, orientation, and FPS limit. After completion of the above job, scroll to the bottom and tap on Start Server. Copy the IP address that appears at the bottom of the screen on the Android device in Chrome or Firefox. Make sure that the port is included shown on the screen as well.

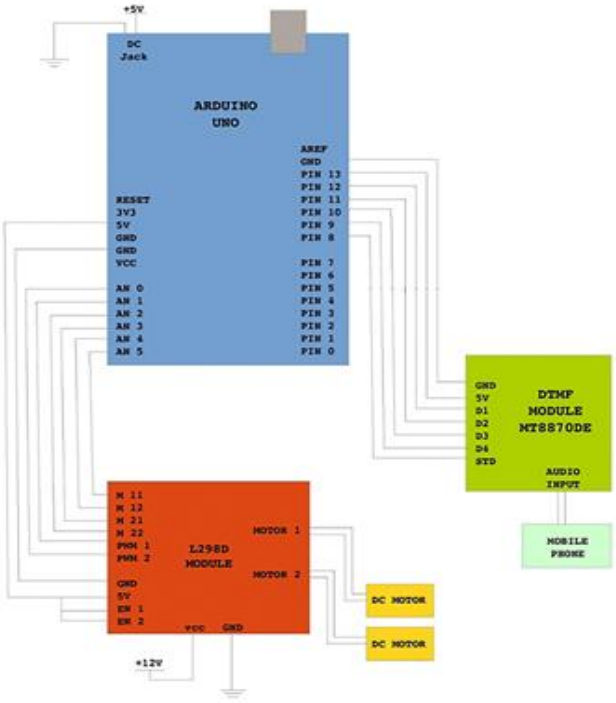

Figure 6. DTMF Block Diagram

IV. CONCLUSION AND FUTURE WORK

It can be seen that this is a very efficient method of Automation. The major advantage is that the appliances can be controlled from literally anywhere in the world. Since GSM connectivity is present worldwide, it is a very useful system.

Our work focuses on the security aspect of the existing home automation system and points out its flaws. It shows how the concept of security and meaning of the word "intruder" has changed in modern homes. The paper points out the shortcomings of existing automation systems in identifying and preventing sophisticated intruders in a home environment.

It is also very simple, and the strings used to control the appliances can be suitable modified according to the needs of the user. These GSM based Home Automation systems are inexpensive, and their ease and flexibility of usage is unparalleled. Futuristic homes may be attached with a main GSM module, where a SIM card may be installed, and connections may be provided to all the household appliances. Just by sending a simple SMS

message, all the devices and home appliances can be controlled. Such is the power of the GSM network.

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