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GSM Based Interactive Voice Response System for Wireless Load Control and Monitoring

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Abstract:

With the current advancement in wireless networks and various technologies implemented for automation, more innovative and improved ideas are developed to build automation systems facilitating remote controlling and monitoring of devices. In this paper, a GSM based wireless home automation system is proposed and deployed which executes its function of controlling and monitoring appliances remotely. It is compliant, costeffective, low power consumption; highly efficient GSM (Global System for Mobile Communication) based wireless home system. The Interactive Voice Response System (IVRS) is improvised toembellish the system's security and ease of operation. With the help of this system the user can access his home appliances from anywhere and at anytime as per the requirement aiding convenience. The system permits the user direct devices through his mobile by sending voice commands using IVRS system. It also enables the user to monitor the status of loads with SMS update. A detailed system analysis is carried out and presented in this paper.

Keywords - Automation, mobile, control, GSM (Global System for Mobile Communication), Interactive Voice Response System (IVRS), wireless network, SMS (Short Messaging Service).

1. INTRODUCTION

Wireless technology has served in the field of automation since a long time. With the advent of technology and introduction of network enabled automation system in every sector, devices can be controlled and managed from remote location. This can be achieved by implementing networks with the support of various wireless technologies such as ZigBee, Bluetooth, DTMF based mobile and UWB etc. There has been a rapid expansion and a potential augmentation of such automated systems since it facilitates the user to organize the appliances and devices as per his convenience. Such automated systems deals with providing a network in an environment which links computers peripheral equipment, smart chip bearing appliances and sub-systems. With such deployed system, it promises controlling of

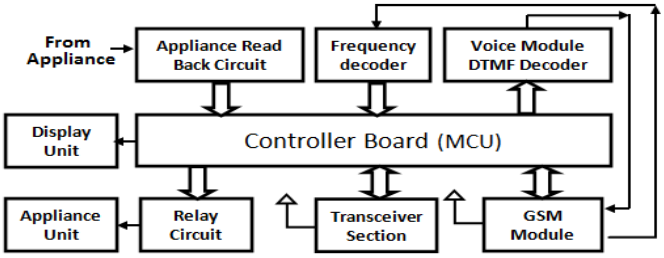

Fig. 1. Block Diagram of the ACU System

electricity operated devices cautiously in real time even being physically away from the site. But again these implementations require either radio link communication or wired communication to direct the devices to operate accordingly. Be it wired or radio link communication, each has its own limitations such as complex wire deployment, maintenances, range restrictions, low data rate, high cost, software arrangements etc. The different systems have been proposed and implemented in area of automation. The

[1], [2] have illustrated the DTMF tone generated automation system that suggests a method for controlling electronic systems remotely. An effort has been made to tackle issues related to automation system based on dual-tone multi-frequency remote control method for industrial and domestic applications. The paper proposing another such system is implemented using ZigBee wireless personal area network[3] which facilitates intrusiveness of the respective system installation. Also home automated systems based on Bluetooth technology enabling devices to be controlled using Personal Area Network (PAN) is presented in paper [4]. The network examples mentioned in [4], [5], [6], [7] communicate the information to remote users via Internet. All these papers suggesting systems have certain limitations since the nodes deployed can cause network congestion, entire infrastructure has to be laid down from initial stage which is time consuming and is complex in nature. Hence we have implemented the GSM based IVRS incorporated system which enables user to control and monitor the loads/appliances remotely. The GSM based home automation system is developed and implemented which exploits the well developed infrastructure of GSM cellular system. Moreover, the user do not require dedicated transceiver as the GSM mobile can be used as commanding device. As a result, no extra device has to be purchased from the user side. The GSM network that relies on radio wave communication conveying information in a real-time process to control devices remotely is the most apt alternative among all the wireless technologies.

2. SYSTEM METHODOLOGY

The system consists of two main sections namely; the transmitter side Commanding Unit (CU) which is basically a GSM enabled mobile phone and the receiver side Appliance Control Unit (ACU). The system is as depicted in Fig.1. The ACU manages devices and loads those need to be monitored and controlled through IVRS voice commands. The set of commands for turning On and turning Off the appliances and for status check are configured in micro controller and each symbol or combination of two & more symbols of mobile keypad are assigned for particular command. Whenever any appliance has to be controlled; the user calls on GSM Subscriber Identity Module (SIM) number. The IVRS system sends the prerecorded voice messages to user viz. 1.To turn On load1 press *1* 2.To turn Off load1 press #1#. Then user can proceed with an appropriate command using CU which would be received at ACU via GSM. These commands, in particular the Dual Tone Multiple Frequency (DTMF)) encoded instructions; directed towards the frequency decoder. These commands are further processed by the MCU and the relay circuitry is controlled accordingly. Ultimately the particular load/appliance is turned on or turned off which action would be notified to user. For the status update, SMS feature of the GSM is exploited in the system. As depicted in block diagram, the system consist of various Units which are elaborated further.

A. GSM Module

In our system GSM sim300 module [5] is used which is ace in application such as remote control, SMS alerts, sensor monitoring etc. The GSM module is interfaced with MCU via RS232 interface. The cardinal two purposes of this unit are: Whenever GSM module receives any call, system verifies the user with password authentication and allows only the legitimated user. Then appropriate voice message is transmitted from voice module to the user via GSM for appeasing the various control actions. Afterwards the authenticated user commands are transmitted to the DTMF decoder. According to the command number and present status of the unit, an control action is executed. If the modification in the parameter

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viz. Appliance On/Off occurs the MCU gets interrupted which in turn wheels the GSM to endow the status update SMS to the programmed cell phone number

B. Transceiver modules

Transceiver modules can be incorporated in this system in order to share the present status of the parameters in between the two or more ACU units during the ongoing exchange of messages which helps MCU in execution as well as in termination of the user process. The system is implemented with the CC1000 UART modules. Its a true single-chip UHF transceiver [8] designed for very low power (-20 to 10 dBm) and very low voltage (2.1V to 3.6V) wireless applications. It has the frequency range of 300 to 1000MHZ.

3. IMPLEMENTATION OF IVRS SYSTEM

This section is well elaborated in [11]. Implementation of IVRS section enables the user to take appropriate control action according to the present status of parameters such as fan ON/OFF, Water Tap status, AC coolness etc. Block diagram of IVRS system is as depicted in Fig. 2. It also enables the user to interact with the system, so that ambiguity in performing selected tasks is avoided and the process is synchronized.

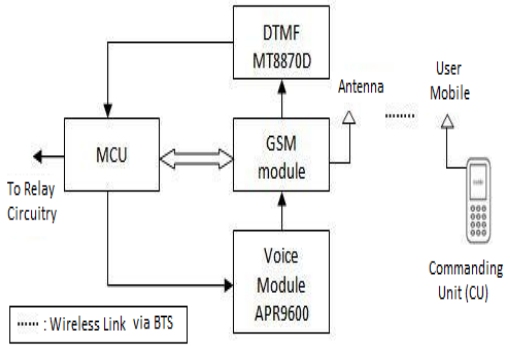

Fig. 2. IVRS system

In order to assist the user various messages are pre recorded as well as stored on the Voice IC APR9600 which is the heart of IVRS system. Whenever the legitimated user calls on the SIM card no. which is inserted in GSM, the prerecorded
messages are transmitted to user via GSM network radio link. In our system MOD8 [11] is selected which provides capacity
to record 8 messages which are as follows:

1. Immediately after call: Enter your password.
2. If password is wrong: Password wrong, try again.
3. For inappropriate user input: Command error, try again.
4. If password is right: Select the room to control its appliance.
5. After selection of the room select the which appliance to control.
6. If device is Off: Press 1 to switch On the device.

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7. If device is On: Press 2 to switch Off the device. Interfacing diagram of Voice Module APR9600 [10] with main PCB is as depicted in Fig.4. Circuit is designed to provide various functions such as:
8. Mode selection viz. MOD8, MOD4, MOD2 accordingly 8, 4, 2 messages can be recorded.
9. MIC interfacing for audio input.
10. Voice quality control, determined by sampling rate which can be varied from 4 to 8 KHz and it depends on pot PR1
as depicted in fig. 4.
11. SW1 to select Read or Write mode.
12. SW2 to select the chip.
13. SW3 to enable the message recording.
14. 8 messages can be recorded by closing SW3 and connecting jumper from M1 to M8 pin respectively.
In our system by default MOD8 [11] is selected by connecting MSEL1 and MSEL2 to Vcc as shown in Fig 3. The messages can be recorded in any regional language hence

4. HARDWARE IMPLEMENTATION

The hardware implementation of Appliance Control Unit which is to be implemented at the home is as depicted in Fig.3. All the subsections such as transceiver unit, Voice modules, As the system is designed to control the loads of two rooms on a floor, below which particular key on the DTMF keypad is used to control thedevices. The Fig.3 depicts the hardware implementation of relay circuitry board. When loads need to be remotely turnedon, the commands are entered by user .

Fig.3.Hardware implementation

These commands are received by GSM unit and further processed by the ACU. The latency involved in the system is crucial parameter in the performance evaluation of the system. Especially in automation systems like HAS, BAS etc, control actions have to be executed within the hard deadlines. While executing such commands, missing a single deadline may lead to catastrophic events. Various papers have demonstrated the designing of such automation systems for real time controlling and monitoring purpose. The propagation delay Tp is negligibly small, and adds only a few milliseconds of latency. The processing time at each BTS depends on the manufacturers specifications. Furthermore, the Tpro adds a significant latency in case ofexecution of complex control command. This is because each machine cycle contributes few micro-seconds which depends on the clock frequency of the controller. Suppose, the complex execution of the control commands involves more than 400 instructions with multiple interrupts

subroutines, then it results in significant delay of operation thereby increasing the processing time. The Tuser is the time required by the user for authentication process and selecting the particular command.

CONCLUSION

The system elaborately described in the above sections makes efficient use of the latest technology to aid users in order to control the operation of the desired appliance or load in real time from remote location. It can be contemplated as an incredible solution to the woes faced by the occupants of the house who are not physically present at the location but can control the devices providing a real-time automation. The paper provides the designing and implementation of GSM based real time automation system. It also elaborates the Interactive Voice Response System (IVRS) designing integrated with Voice IC circuitry which is the unique feature of the implemented system. Furthermore, the latency involved in the execution of the operation is estimated and the detail analysis is demonstrated. Hence an IVRS based system facilitates user to interact with the system and it enables the user to control the loads remotely.

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