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A Cellular Phone Based Home / Office Controller & Alarm System

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ABSTRACT

Remote management of several home and office appliances is a subject of growing interest and in recent years we have seen many systems providing such controls. In this study, we have developed a cellular phone based home/office remote controller equipped with power controllers, an alarm system, a voice memory and a back-up battery unit.

In traditional PSTN based remote controllers, the user always has the possibility of line cuts due to fires or professional burglars cutting the wires before getting to work. Our system eliminates such disadvantages with its unique properties.

Key Words: Home/office automation, cellular phone based alarm system, remote controller

1. INTRODUCTION

As we stated above, many remote home/office automation/control applications show the growing interest on the subject [1-4]. However, some of these systems need a PSTN connection which itself is a disadvantage due to necessary physical connection [2-4]. Some systems require a PC and a PSTN connection which increases the adverse properties of the proposed systems making them ill suited for real life applications [1]. Some different approaches can be adopted to set up such a control mechanism, namely, internet based control structure [5-8]. However, these approaches still have some drawbacks that are eliminated by our system's advanced properties. For instance, our system contains an alarm unit giving the user a remote on/off mechanism which is capable of informing up to 5 different numbers over telephony network about the nature of the event [9].

In the following section the overall structure of the system is described while section 3 lays out the instruction based program flow. Section 4 discusses the communication between the microcontroller and the mobile phone.

2. OVERALL SYSTEM STRUCTURE

Fig. 1 illustrates the block diagram of the system that has been designed. The system consists of an 89C51 microcontroller unit, a 8870 tone decoder, a cellular phone, an ISD voice message unit, driver circuitry for the power control of the home appliances, and finally an alarm unit embedded into the system structure. To activate the cellular phone unit on the system a call has to be made and following the response the user has to enter a 3 digit password to access the system in order to control it. In cases of false/null passwords the system switches back to its normal operation mode.

As we stated above the alarm system can be switched on/off by the remote user. When it is on, it continuously monitors fire and PIR (Passive Infrared) detectors. Up to 8 detectors can be used for this purpose. In case of any event the 89C51 microcontroller (MC) executes the alarm routine, and communicates with the mobile phone to call up to 5 different numbers including the fire brigade, the police, the owner of the premises, etc. giving the pre-recorded voice message.

The received DTMF (Dual Tone Multi Frequency) codes are decoded by the 8870 DTMF tone decoder . These codes are then fed to the microcontroller.

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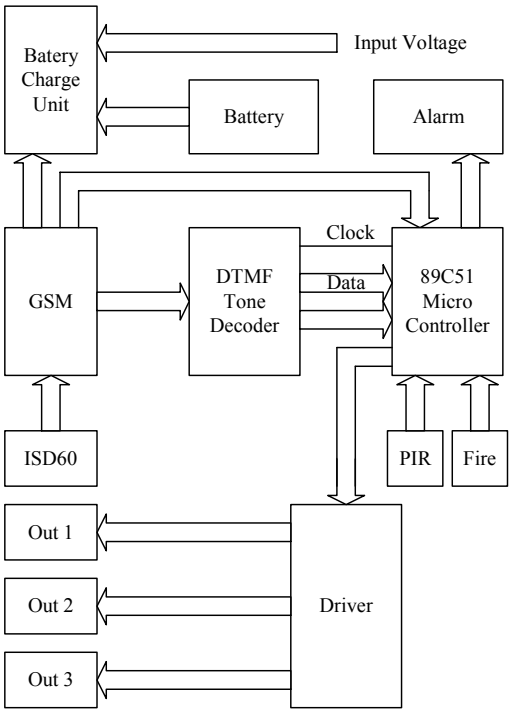

Figure 1. Block Diagram of the System

The voice message unit consists of an ISD60 voice memory that allows the recorded voice message to be played to the telephone numbers that are called in case of any event.

2.1. Voice Message Circuit

The circuit diagram for the voice message unit is shown in Fig. 2. When the microcontroller detects a triggering signal from the scanned units, the numbers recorded on the SIM card of the mobile phone are called sequentially and the MC activates the voice message unit. The MC also sends a deactivation signal when the recorded message is played back. This operation continues in the same manner until the last call is performed. The speaker output of the ISD is connected to the cellular phone speaker so that the recorded message is directly heard by the receiving end of the phone that has been called.

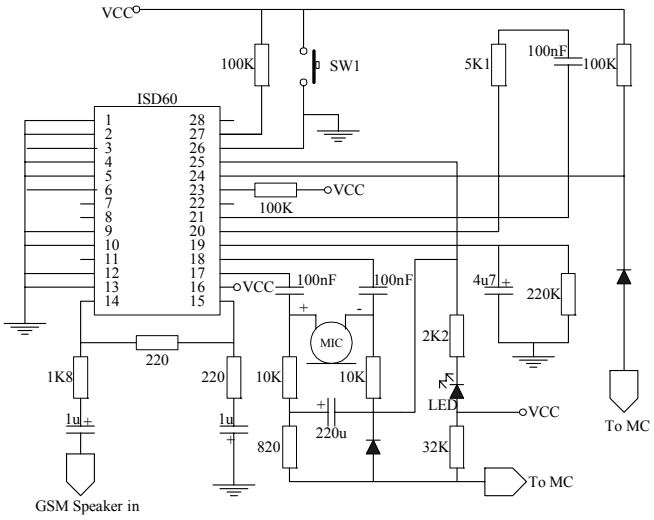

Figure 2. Voice Message Circuit Diagram

2.2. The UPS and Charging Unit

As stated above our installation works as a stand-alone system. Therefore, the power cuts, the cuts at the PSTN lines can not effect the operation of the system. This itself is an advantage over the other remote control and alarm mechanisms. One of the advantages of this aspect is to use a cellular phone and the other is the UPS unit; there is a maintenance free accumulator connected to the system. When the power is cut it provides the necessary power for the whole unit for up to 70 hours. The battery charging unit at Fig. 4 charges both the accumulator and the cellular phone batteries at the same time.

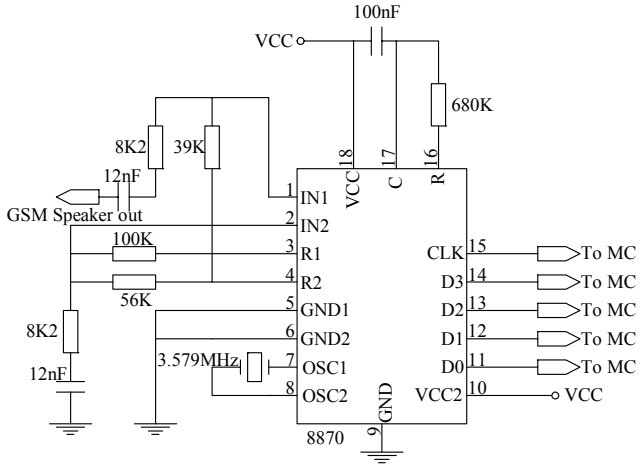

Figure 3. The circuit diagram for DTMF 8870 tone decoder

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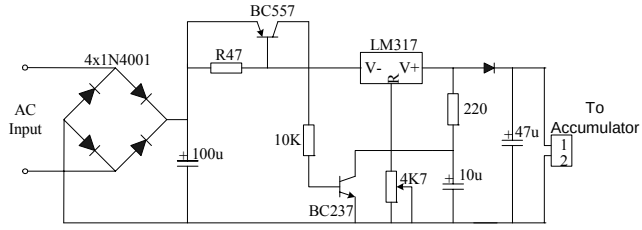

Figure 4. The battery charging unit

2.4.The Driver Circuit

The driver circuit consists of an opto-coupler component used for isolating the MC from the high level 220V signals (Fig. 5).

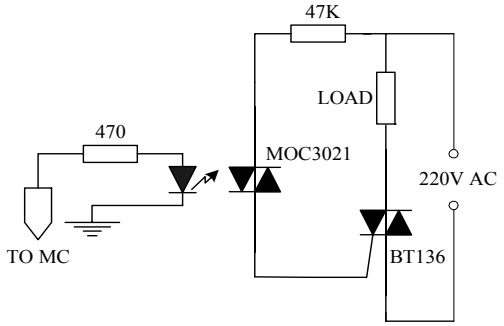

Figure 5. The Driver Circuit diagram for the power controls

3. THE PROGRAM FLOW CHARTS

The main program executed on the MC includes 3 units. The first unit contains the initializations and sequential monitoring of the equipped sensor devices. The second part of the program performs the telephone calls. Finally the last part contains the interrupt subroutine.

When the main program starts to execute, the MC's serial communication band is set to the cellular phone's communication rate (i.e. 9600 bit/sec). Afterwards a password and control sequence is accepted from the calling user. At the same time the ports which will be used as either input or output ports are along with the identification of the registers. Afterwards the system enters a loop to wait alarm activation.

At this point the user either activates the alarm or vice versa. Details of this can be observed in Fig. 6. In the main program the user can also be directed to switching subroutine that performs switch-on and switch-off for 3 different home appliances. In Fig. 7 the operation structure of switching device control flowchart is given.

In the event of an alarm, -either a burglar's entrance to the premises or detection of a fire- the initial response of the system is activation of a buzzer. Afterwards, the system initiates the alarm call subroutine, the sequential operation of which is given in Fig. 8. Depending on the nature of the message, the system performs up to 5 different telephone calls. It releases a 60 seconds alarm message recorded on the ISD60 voice memory.

The cellular mobile phones use standard communication commands. A brief explanation of some of these commands used in our application is given in appendix A.

4. THE COMMUNICATION PROTOCOL

The cellular phone uses a signal communication protocol called Universal Synchronous Asynchronous Receiver and Transmitter (USART). It is a well known two way serial communication protocol. Fig. 9 illustrates the basic operation principle that has been used in our application.

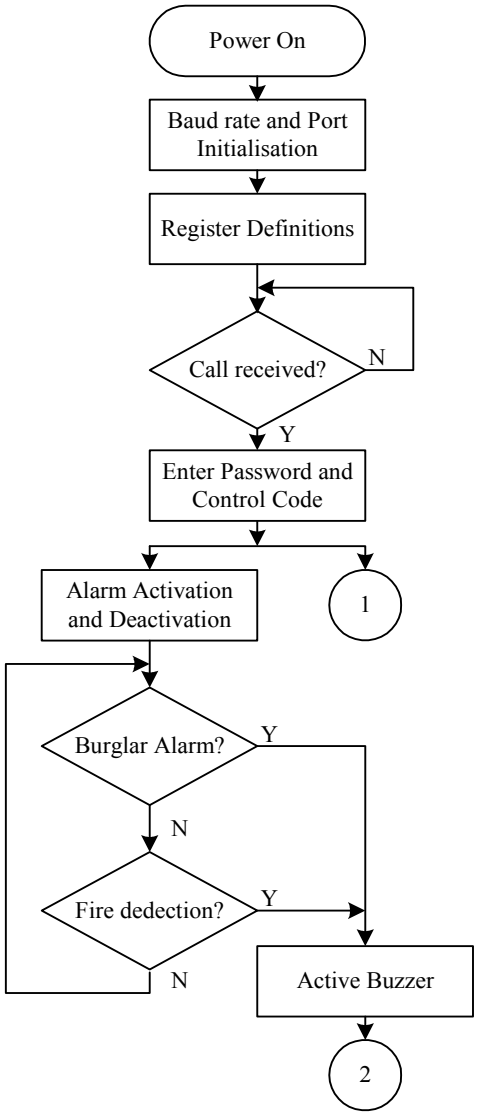

Figure 6. The main program flowchart

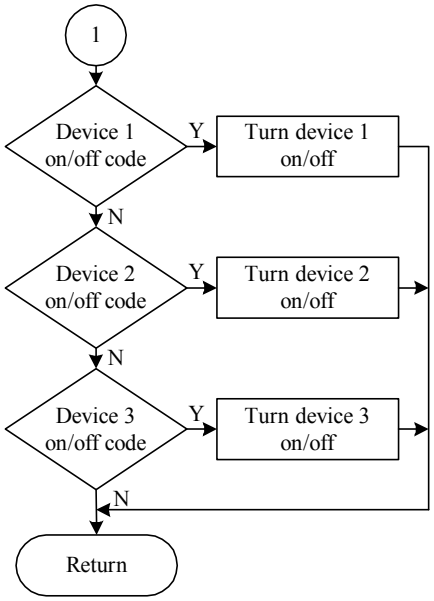

Figure 7. Device control subroutine

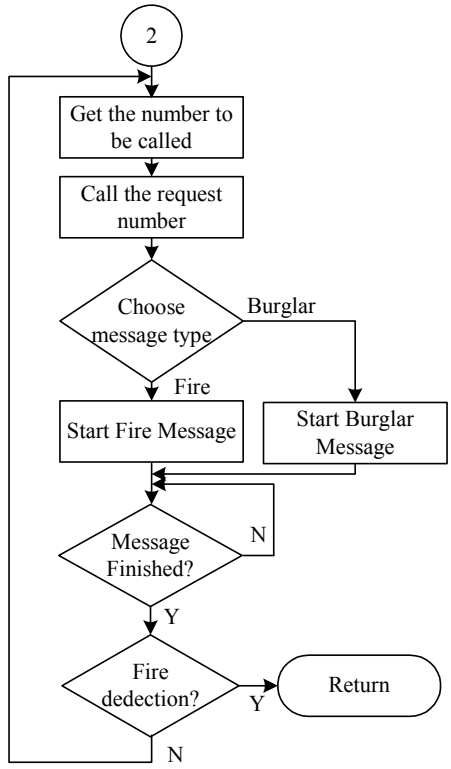

Figure 8. Alarm call subroutine

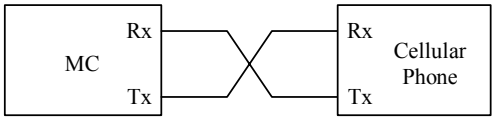

Figure 9. Usart communication protocol

5. RESULTS AND CONCLUSIONS

Mobile phones have become an indispensable part of our life. Our system uses a controller and a cellular phone for its operations. The systems can be used as a test bed for any application that requires on-off switching based applications. Several burglar alarm systems have been suggested by different solution providers. Each of them has their drawbacks - one requires the internet, some require an active PSTN connection, etc. We believe we have eliminated these disadvantages by incorporating such a system into a mobile communication mechanism. The system can be expanded to provide such control over the GPRS. In this way, the capabilities of the internet can be combined with the capabilities of our physical line free communication system. Furthermore, by adding a closed loop control facility, the system capabilities can be improved.

APPENDIX FOR SOME COMMUNICATION COMMANDS FOR CELLULAR PHONES

ATA (Answer Incoming Call)

Answers an incoming call.

ATD (Dial)

Causes the phone to dial a call. All characters appearing on the same command line after the D are considered part of the call-addressing information to be signaled to the network, or modifiers used to control the signaling process (collectively known as a .dial string.), up to a semicolon character or the end of the command line.

ATH (Hook Control)

Terminates an active call.

ATZ Reset to User-Defined Configuration

This command resets the values to default settings and closes all connections.

AT+CPBR (Phonebook Read)

Returns phone book entries in location number range <index1>...<index2> from the current phonebook memory storage selected by AT+CPBS. If <index2> is omitted, only location <index1> is returned. Entry fields returned are location number <index*n*>, phone number <number> in <index*n*>, and text <text> associated with the number.

AT+CPBS (Phonebook Storage)

Selects the phonebook memory storage <storage> that is used by other phonebook commands.

AT*EVA (Answer Incoming Call)

Signals the phone to answer a call. The command is followed by a final result code such as OK or ERROR and the command state is entered.

ACKNOWLEDGMENT

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