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Home Appliances Control Using Mobile Phone

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***Abstract*—Now a days mobile phone has become a part of our daily life. Due to low cost of mobile phones, mobile phones are widely used for home automation. In this paper a remotely operated mobile phone controlled home appliances system is proposed. It is a DTMF (dual- tone multiple-frequency) based system consists of two mobile phones, DTMF decoder and ATmega8 microcontroller. One mobile phone is used as remote which may locate at far distance from home and another mobile phone is located at the home which acts as a receiver. The control information are sent via the remote mobile phone as DTMF tone, this DTMF tone is received by the mobile phone located at home, the received DTMF tone is then decoded by DTMF decoder MT8870 IC. The output logic signal of the decoder is used as input to the ATmea8 microcontroller. The ATmega8 microcontroller is previously programmed to control home appliances according to output of the DTMF decoder.**

Keywords—Mobile phone; home automation; DTMF; decoder; microcontroller.

I. INTRODUCTION

A mobile phone has become an essential component in our day to day life. Home appliances control using mobile phone can give us flexibility as cellular networks has wide range of network coverage. So it is possible to control home appliances from a far distance. Conventional wireless control system such as radio frequency based systems, infrared remote based systems has limited working range. A mobile phone based control system can overcome this drawback, it also provides some advantages like no interference with other controllers.

In order to obtain a secure remote control operation considerable efforts should be given for the development of remote control for home appliances. A huge number of research work has been carried out to obtain a fast, secure remote control system. There are a number of telephone line based control system for home automation has been carried out, such as a telephone based control system for home automation using a hardware based remote controller [1][2] and telephone line with personal computer based systems [3] also developed. In telephone based system there was several drawbacks such as mobility problem, less flexibility and less friendly. With rapid growth of internet technology various internet based control systems for home automation has been proposed [4]-[7]. Internet based system is costly as it requires home server and personal computer. Again in an internet based system it is required to run the home server and computer all time. Internet based system gives worldwide coverage, one can control home appliances from anywhere. In internet based system there is a considerable energy loss in home server and personal computer. Again it is not required to control a home appliances from one country to another country. Bluetooth based control systems for home appliances control has been proposed [8][9]. Bluetooth based system has the limitation of short working range. Long range control is not possible using Bluetooth based system. A mobile phone based home automation system that consists of a mobile phone with Java capabilities, a cellular modem, and a home server has been presented [10]. This system requires a mobile phone that should have Java capabilities to control home appliances.

A DTMF based home appliances control using mobile phone is shown in Fig. 1. The control system consists of two mobile phones, one DTMF decoder IC (MT8870), electromagnetic relays and a ATmega8 microcontroller. The system consists of two sub-system Unit-I and Unit-II. Unit-I consists of a mobile phone which may locate inside or outside the home. Unit-II consists of a mobile phone which is connected to decoder circuit via a headphone, the output of decoder circuit is connected to ATmega8 microcontroller. ATmega8 microcontroller controls the electromagnetic relays in order to control home appliances. The ATmega8 microcontroller works according to the output logic combination of the decoder circuit. The decoder circuit has 4-bit output logic signal. Unit-II resides at home. Two mobile phones communicates with each other via cellular networks.

This paper is organized into four sections. Section II describes working principle. Hardware implementation is described in section III. System evaluation is described in section IV. Finally, Section V concludes the paper.

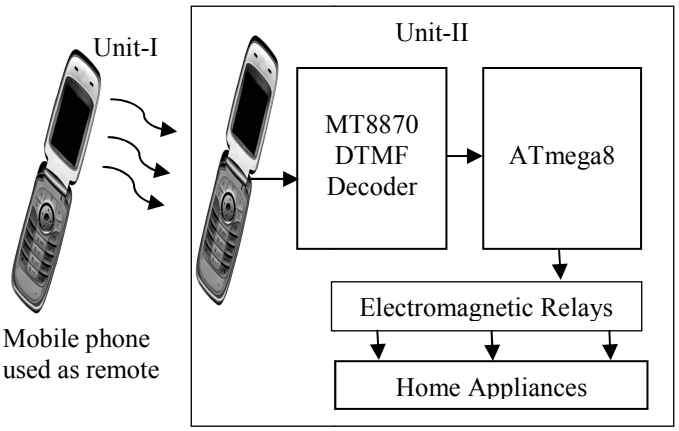

Fig. 1. Block-diagram of home appliance control system using mobile phone.

II. Working Principle

Communication is established between Unit-I and Unit-II by initiating a call from Unit-I to the Unit-II mobile phone that resides at home. Unit-II mobile phone is kept in auto answer mode so that the incoming call can be received automatically. When the incoming call is received by Unit-II mobile phone, in the course of a call, if any button is pressed by Unit-I mobile phone, a tone corresponding to the button pressed is heard at the other end of the call. This tone is called dual-tone multiple-frequency (DTMF) tone. The keypad tone of the Unit-I mobile phone should be on and should be in DTMF mode. The DTMF signal is then sent to the DTMF decoder circuit via a head phone attached to the mobile phone of Unit-II. The DTMF decoder IC MT8870 is a full DTMF receiver that integrates both band split filter and decoder functions into a single 18-pin DIP or SOIC package. Its filter section uses switched capacitor technology for both the high and low group filters and for dial tone rejection. Its decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into a 4-bit code. The received DTMF tone is processed by the MT8870 decoder IC and a set of digital output is produced corresponding to the keypad button pressed by Unit-I mobile phone. The output digital output of the DTMF decoder circuit is compatible to ATmega8 microcontroller. The output of the decoder circuit is used to tell the preprogrammed microcontroller which load to be turned on or off. Most of the household loads are alternating current (AC) load and microcontroller cannot control AC load directly. In order to control AC load electromagnetic relays are used. Again a microcontroller cannot drive a relay as microcontroller has low output current, so transistors are used to energies the relay coil for the purpose of load control. Electromagnetic relay driving circuit is shown in Fig. 2. The output of DTMF decoder circuit is 4-bit digital value with 12 distinct combination, so 12 different control signals can be obtained from the decoder circuit.

The mobile that makes a call to the mobile phone stacked in the home acts as a remote. So the proposed system does not require the construction of receiver and transmitter units. DTMF assigns a specific frequency, consisting of two separate tones to each key so that it can easily be identified by the electronic circuit. The signal generated by the DTMF encoder is a direct algebraic summation, in real time, of the amplitudes of two sine or cosine waves of different frequencies, "i.e." pressing '5' will send a tone made by adding 1336 Hz and 770 Hz to the other end of the line. DTMF keypad frequencies are shown in Table I.

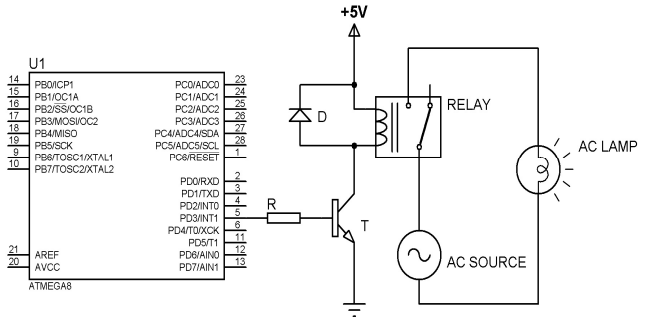

Fig. 2. AC load control using ATmega8 microcontroller and relay.

TABLE I. DTMF Keypad Frequencies

Frequency	1209Hz	1336Hz	1477Hz
697Hz	1	2	3
770Hz	4	5	6
852Hz	7	8	9
941Hz	8	0	#

III. Hardware Implementation

Hardware implementation requires design of DTMF decoder circuit and algorithm development for the control system.

A. Design of DTMF Decoder Circuit

The DTMF decoder circuit is designed using MT8870DE IC. The complete circuit diagram [11] is shown in Fig. 3.

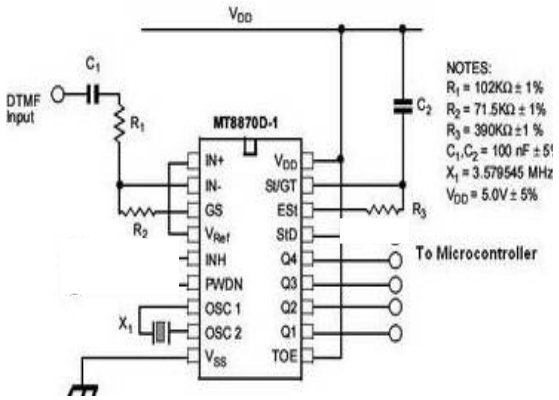

Fig. 3. DTMF decoder circuit using MT8870DE IC [11].

The output bit pattern of DTMF decoder circuit is shown in Table II.

TABLE II. Output Of The Decoder Circuit [11]

Digit (DTMF Tone)	Output of decoder circuit			
	Q1	*Q2*	*Q3*	*Q4*
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0

B. Algorithm Development

Depending on the bit patterns of the DTMF decoder circuit a suitable algorithm is developed and written for the purpose of controlling home appliances. The algorithm is written in Atmel Studio 6.0. Internal EEPROM of ATmega8 is used to store information of the load status. If a power failure occurs the microcontroller stores the present status of home appliances in its EEPROM. When the power is back the microcontroller takes the status of home appliances from its EEPROM and maintains the load status. The control algorithm for one home appliance control is given in Fig. 4. The algorithm can be further extended for all home appliances.

```
#include "decoder_output.h"
#include "eeprom.h"
uint8_t app_1;

int main()
{
DDRD|=((1<<PD0);
uint8_t cmd;
app_1 = EEPROM_read(0);
          if(app_1==0)
          {
          PORTD|=(1<<PD0);
          }
          else
          {
          PORTD&=(~(1<<PD0));
          }

while(1)
{
switch(cmd)
{
case A_0:
app_1=~app_1;
if(app_1==0)
{
PORTD|=(1<<PD0);
EEPROM_write(0,app_1);
}
else
{
PORTD&=(~(1<<PD0));
EEPROM_write(0,app_1);
}
break;
}
}
```

Fig. 4. Algorithm for home appliances control system.

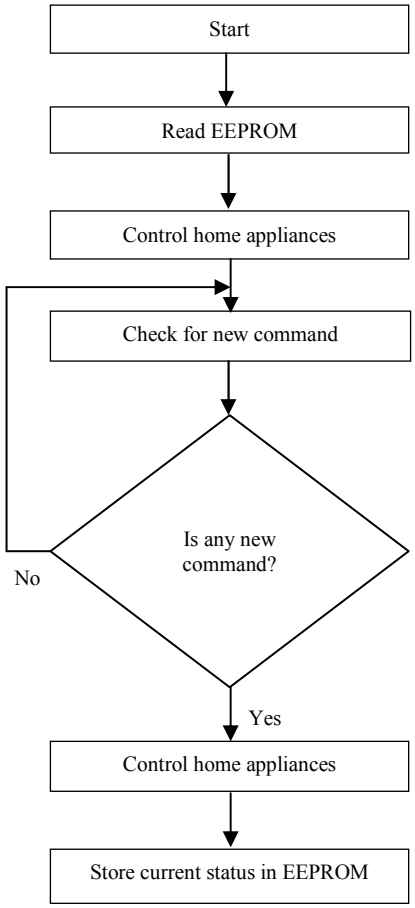

Fig. 5. Flow chart of the developed system.

The flow chart for the mobile controlled home appliances is shown in Fig. 5. The complete circuit diagram is shown in Fig. 6. In Fig. 6, the decoder circuit and relay driving circuit are not shown because the decoder circuit is shown in Fig. 3 and the relay driving circuit is shown in Fig. 2.

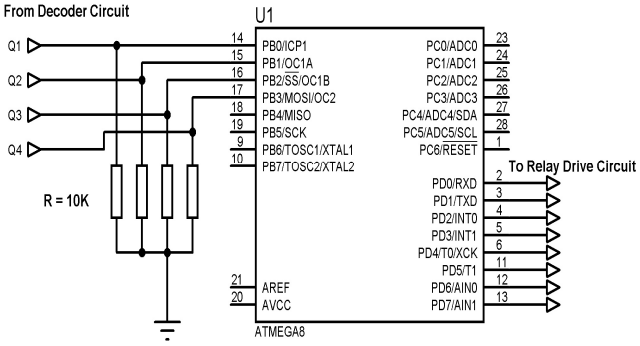

Fig. 6. Complete circuit diagram of the proposed system.

IV. System Evaluation

The proposed system can be used practically because of its flexibility, cost effectiveness and greater security. Due to simplicity of the design, use of less components makes the proposed home appliances control system less costly than other same types of system. Only the mobile phone is the costly parts of the proposed system. A mobile phone of very simple configuration can be used for this purpose. Now a days simple mobile phone is very cheap (available within US$15) in Bangladesh. Due to low cost of mobile phone the proposed control system is cost effective. This system requires only one mobile phone which locates at home, the other mobile phone can be the personal mobile phone of the user. So within US$20 the proposed control system can be implemented.

The proposed system also eliminates security threats completely by assigning a specific phone number to the mobile phone to operate which acts as a receiver and located at home. Now a days mobile phones have call blocking facilities, so one can assign a specific phone number as he wants and can block all other incoming phone calls. By assigning a specific phone number to the receiver mobile phone prevents establishing a phone call except himself. As call establishing is mandatory, so no one can be harmful for the proposed control system.

Another fact is, the proposed system can be used for some other purposes like main switch control of industries. If fire hazard occurs, this control system can be used to turn off the main switch automatically and immediately. It can reduce fire hazard subsequently.

The proposed control system has some drawbacks. The main disadvantage is cellular phone call establishing is mandatory for the proposed control system, so the proposed control system can only be used within cellular coverage area, another disadvantage is that every time, when one wants to control home appliances it is necessary to make a call to the mobile phone that resides at home, there may be a time delay to establish a phone call and for each call charge is applicable.

V. Conclusion

In this paper a low cost DTMF based mobile phone controlled home appliances system was developed. The developed system uses DTMF tone as control signal. The DTMF tone is received by the mobile phone that resides at home. The received DTMF tone is further decoded to digital values using DTMF decoder. A microcontroller based control algorithm was developed according to the output logic of the decoder for the purpose of controlling home appliances from a remote place. The proposed system is not fixed for home appliances control, it can be used anywhere for the purpose of controlling any types of electronic devices remotely. The developed system requires two mobile phones of any configuration for remote communication. Within cellular network coverage the home appliances can be controlled from anywhere, anytime. Again the proposed system does not suffer from security threats because mobile phones have call blocking facilities, so the user can block all incoming calls except specified one.

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