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A Secured Dual Tone Multi Frequency based Smart Elevator Control System

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Abstract
This paper presents design and simulation of Smart Elevator Control System (SECS) with Security based on Dual Tone Multi Frequency. Dual Tone Multi Frequency corresponding to a particular key on cell phone is decoded into a 4 bit code and is used to control the elevator system. In the conventional system security is the major concern and the system can be misused. In this research paper a novel SECS is presented which is highly secured, economical than the conventional system. The SECS is operated using a cell phone and one can control the whole system using mobile after entering the predefined correct password . The simulation of the SECS has been done Proteus Professional v8.01 software package and the system verification has been done on Xilinx v 10.1 software package.

Keywords: *Dual Tone Multi Frequency, Microcontroller, Liquid Crystal Display, Decoder, Motor, Elevator, Password*

1. Introduction

With the development of advanced technology everything is getting sophisticated and more intelligible. Modern lifestyle needs cutting edge technology and smart electronic systems are introduced daily[1-2]. Microcontrollers are playing a very important role in the development of the smart systems as brain is given to the system. Most of the latest technologies have microcontrollers embedded in them for carrying out autonomous operations and taking smart decisions. A microcontroller is basically a single chip microprocessor suited for control and automation of machines and processes. Today, microcontrollers are used in every domain for carrying out automated tasks in a more accurate manner[3]. All the modern day devices such as air conditioners, power tools, toys, office machines employ microcontrollers for its operation[4]. The block diagram of microcontroller system is shown in Figure.1.

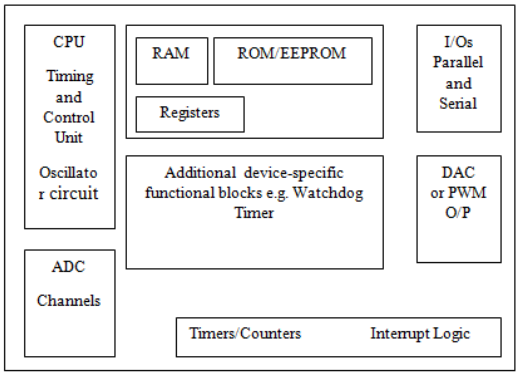

Fig.1 Microcontroller System

Microcontrollers consist of Central Processing Unit (CPU) ,timers and counters, interrupts, memory, input/output ports, analog to digital converters (ADC) on a single chip[5]. This single chip integrated circuit design reduces the size of control board and power consumption is low. This paper presents a Dual Tone Multi Frequency(DTMF) based SECS with security which can be controlled through a cell phone. DTMF is a generic communication term for touch tone[6-8]. In DTMF, a particular frequency which consists of two separate tones is assigned to each key so that it can be identified by the electronic circuit. DTMF is a method of Multi Frequency Shift Keying (MSFK) data transmission technique[9-11]. The overlapping of two sinusoidal waves as defined by DTMF standards is given as:

$$x(t)=A\cos(w_L t)+B\cos(w_H t+\Phi)$$

where w_L and w_H are the low and high frequencies of the sine waves being used. A and B represents the the amplitude of the signals and Φ is the initial phase shift.

Table.1 shows the low and high frequency corresponding to each key.

Table 1 : DTMF Frequency

	1209 Hz	*1336 Hz*	*1477 Hz*	*1633 Hz*
697 Hz	1	2	3	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C
941 Hz	*	0	#	D

The low and high frequency corresponding to each button is shown in the above table. The DTMF tones are decoded by a decoder which gives a 4-bit code as output. This output is taken as input by the microcontroller to control the elevator system.

2. Block Diagram

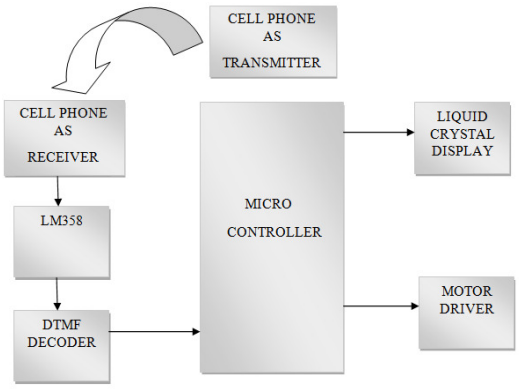

Fig.2. Hardware Block Diagram

Figure.2 shows the hardware block diagram of the SECS .The system consists of :

1. **Cell phone**- In SECS, a transmitter and receiver cell phones are used. Whenever any key is pressed on the transmitter cell phone , a tone of specific frequency corresponding to that key is generated and gets received on receiver cell phone and after amplification the decoder decodes the tone into a 4-bit code which is received by microcontroller.
2. **LM358**- LM358 is a dual operational amplifier which is used to amplify the DTMF tone generated in the cell phone. The LM358 opamp is used in transducer amplifiers and dc gain blocks.It is a 8 pin DIP which operates from a single power supply and has low standby power dissipation.
3. **DTMF Decoder**- The decoder used for decoding DTMF signal is HT8870. It decodes the DTMF signal generated by pressing a key on the cell phone into a 4-bit code which is taken by the microcontroller.
4. **Liquid Crystal Display**- The LCD is a dot matrix liquid crystal display that displays alphanumeric characters and symbols. 16X2 LCD digital display has been used in the system to show the password details and the floor information.
5. **Motor Driver**- Motor driver IC is used to control motors through a microcontroller. L293D IC is used as a motor driver IC . It provides different logic to control the direction of the motor.It is assembled in a 16 lead plastic package which has 4 center pins connected together. L293D is used in the elevator system to control the motor direction according to the floors.

The smart elevator system uses a password based security which must be correctly entered to operate the elevator. The elevator can only be operated and accessed after entering the correct password. One cell phone in the sytem acts as the receiver and a user can operate the elevator with the other cell phone which acts as transmitter. The elevator system with security presented in this paper is designed for nine floors but it can be extended to the desired number of floors. No sensor has been used to determine the location of the floor but the floor location is determined by software coding technique. By pressing any key from 1 to 9 in the transmitter phone ,corresponding floor can be selected after passing the security check. In this way a more secured access is granted to the officials in prohibited research areas just by operating the elevator through a cell phone. For the sake of security ,timeout has been added in the SECS. After elevator has reached to the destination floor ,the system will get reset after one minute if not used. The user needs to re-enter the password to operate the elevator.This system is highly suitable for hitech buildings and prohibited research areas where security is a major concern.

3. Power supply

The microcontroller uses a +5V power supply w.r.t ground. The Figure.3 shows the power supply schematic:

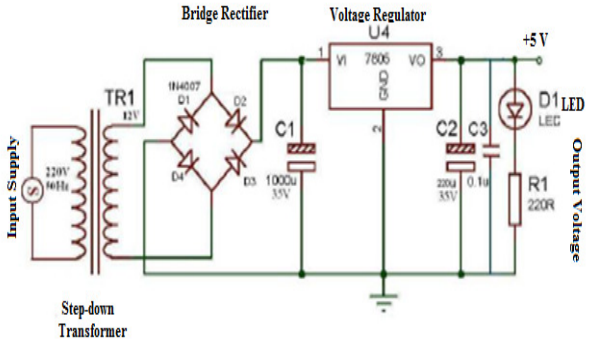

Fig.3. Power Supply Schematic

The microcontroller works on five volts power supply which must be purely dc. The circuit consists of step down transformer which converts 230 V AC to 12 V AC.The output 12V AC is given to the bridge rectifier which coverts it into 12V dc. 7805 voltage regulator is used which converts 12V to 5V dc and the output is then given to the microcontroller.

4. Circuit Simulation

The simulation of the circuit has been done on Proteus Professional v 8.0 software package.16 X 2 LCD has been used and is connected to PORT D of the microcontroller.PIC16F877A microcontroller based on modified harvard architscture has been used.The simulation of the circuit is shown below in Figure.4.

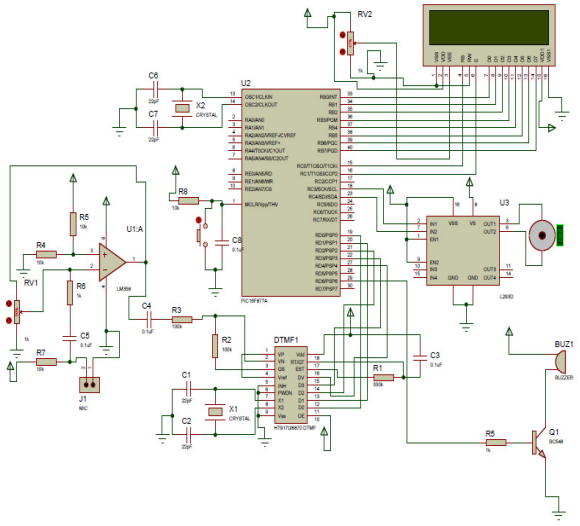

Fig.4.Circuit Simulation

The above circuit shows the simulation of smart elevator system with security. DTMF decoder and an operational amplifier LM358 has been used to carry out the functioning of the system. The elevator system is controlled by transmitter cell phone ,the DTMF tone generated by pressing a key on the transmitter mobile gets received on receiver cell phone and this tone is decoded into a 4-bit code by DTMF decoder . This code is then taken as input by the microcontroller and used to operate the elevator system.

To show the operation of a DTMF operated elevator more accurately, a key pad has been used which simulates the keypad of the transmitter mobile and by pressing the key the decoded DTMF signal operates the elevator. Figure.5 shows the circuit simulation with the keypad to emulate the DTMF operation.

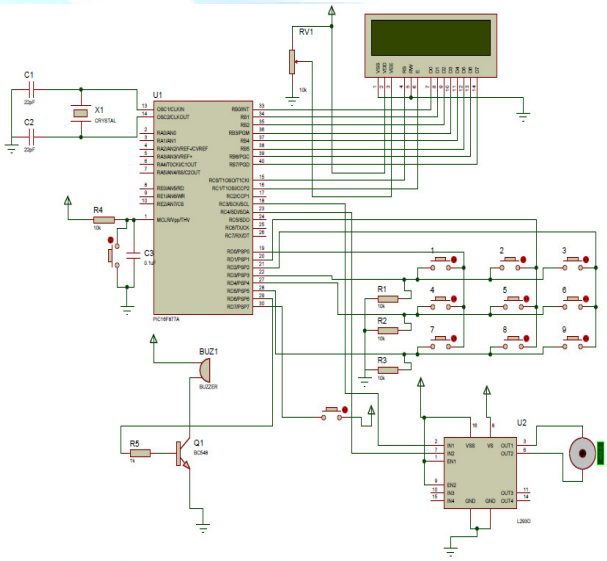

Fig.5. Circuit Simulation with Keypad

The keypad is used to enter the password for starting the elevator operation and entering the floor information. The buzzer sounds a beep on entering wrong password and locks the elevator sytem if the wrong attempts exceed three to make system more secure. The SECS can be restarted by entering a master password which is also predefined. Table.2 shows the 4-bit output code generated corresponding to a low and high DTMF frequency of each key .

Table 2 : Decoded Output

The above table shows the decoded logic by a DTMF decoder corresponding to press of key on the cell phone.

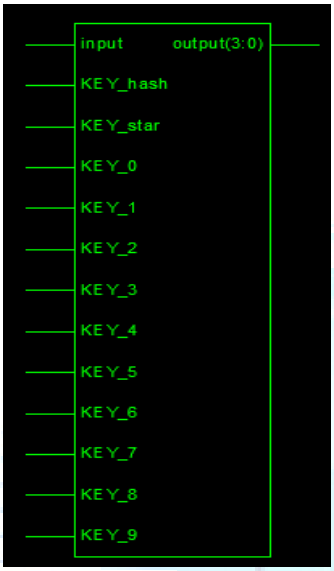

Fig.6. RTL of the system

Register-transfer level (**RTL**) is the abstraction of a design in which the modelling of synchronous digital circuits is done in terms of the flow of digital signals between hardware registers and the logical operations performed on those signals. The RTL of the system is shown in Figure.6.

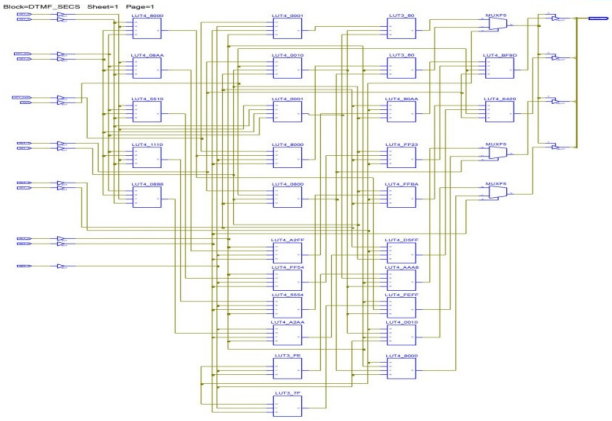

Fig.7. Technology Diagram

The Figure.7 shows technology diagram of the SECS in which the implementation of DTMF decoded logic is done by realising different gates and multipexers . By pressing any key on the transmitter cellphone a 4-bit logic code is generated by the decoder as output which is taken as input by the microcontroller.

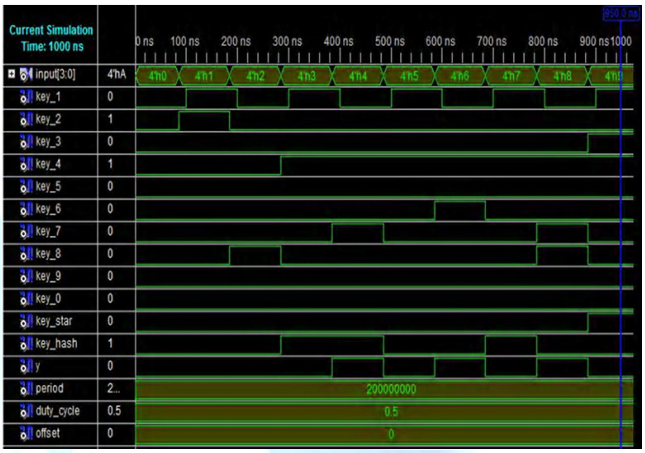

Fig.8.Testbench Waveform

5. Results

The simulation of the system has been done on the Proteus professional software v 8.0 and SECS with security is running in good agreement.The validation of the system has been done through Xilinx software and the testbench waveform has been shown in Figure.8. The DTMF tone generated is decoded to a 4 bit code by the decoder and the system is operated accordingly. Realisation of the decoded output has been done through various gates and is shown in Figure.7. After entering the correct password ,the SECS can be controlled and a particular floor is reached.

6. Conclusion and Future Scope

The design developed in the paper is appropriate according to modern day technology. This design of SECS with security can be used in the prohibited areas where security is a major concern.One can operate the elevator with his cellphone after passing the security check by dialing the correct password. The system proposed here is suited with the modern tehnology. This study can be extended in terms

Button	*Low DTMF Frequency (Hz)*	*High DTMF Frequency (Hz)*	*Decoded Output*			
			A	*B*	*C*	*D*
1	*697*	*1209*	*0*	*0*	*0*	*1*
2	*697*	*1336*	*0*	*0*	*1*	*0*
3	*697*	*1477*	*0*	*0*	*1*	*1*
4	*770*	*1209*	*0*	*1*	*0*	*0*
5	*770*	*1336*	*0*	*1*	*0*	*1*
6	*770*	*1477*	*0*	*1*	*1*	*0*
7	*852*	*1209*	*0*	*1*	*1*	*1*
8	*852*	*1336*	*1*	*0*	*0*	*0*
9	*852*	*1477*	*1*	*0*	*0*	*1*
0	*941*	*1336*	*1*	*0*	*1*	*0*
*	*941*	*1209*	*1*	*0*	*1*	*1*
#	*941*	*1477*	*1*	*1*	*0*	*0*

of area and power at layout and characteristic level with the help of advanced VLSI applications.

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