TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
PULCHOWK CAMPUS

HOME APPLIANCES CONTROL AND SECURITY USING PSTN

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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a project report entitled "Home Appliances Control and Security using PSTN" submitted by Basant Raj Gharti Magar (066/BEX/408), Pawan Subedi (066/BEX/426), Sulav Malla (066/BEX/443) and Suyash Chand (066/BEX/446) in partial fulfilment of the requirements for the Bachelor's degree in Electronics & Communication Engineering.

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ABSTRACT

The project entitled "Home Appliances Control and Security using PSTN" is capable of controlling home appliances remotely and also providing home security using Public Switched Telephone Network (PSTN). The system is able to receive a call from its user, ask the user for security verification and finally, on verification, enable the user to control home appliances. Moreover, the system is able to obtain the status of different sensors in the house (temperature sensor and IR sensor) and based on the status, relay the user in case of any security-lapse. The system has used Dual Tone Multiple Frequency (DTMF) signaling for its operation. The final system is an embedded system so that it can be used directly in any house just by creating a slight modification to the presently existing home-circuitry. The important aspect of the system is that it enables its features in user-friendly and cost-effective ways.

KEYWORDS: Remote device control, Home Security, PSTN, DTMF.

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LIST OF SYMBOLS AND ABBREVIATIONS

D	Diode
Q	Transistor
AGC	Automatic Gain Controller
DTMF	Dual Tone Multi- Frequency
EEPROM	Electrically Erasable Programmable Read Only Memory
IC	Integrated Circuit
IR	InfraRed
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LSB	Least Significant Bit
MSB	Most Significant Bit
Op-amp	Operational Amplifier
PC	Personal Computer
PCB	Printed Circuit Board
PSTN	Public Switched Telephone Network
PWM	Pulse Width Modulation
SD	Secure Digital
STD	Subscriber Trunk Dialing
SPDT	Single Pole Double Throw

1. INTRODUCTION

1.1. Background

The development of technology has given the world with many new devices that perform various critical applications and help people. In this scenario, devices that provide a mechanism to control the appliances in houses remotely and provide home security have also been invented. These devices have not actually been able to meet the requirement of Nepali citizens, yet. The systems developed for the world's scenario do not fit into Nepali market. These systems are either too complex to implement or are too costly. The system capable of providing these requirements at low cost and with least complexity is Nepali market's requirement.

In the present context of our country, we are facing the problem of load shedding every day. In this scenario, there is no doubt that the devices in houses could be left in ON state, unwillingly. This obviously results undesired consequences. Thus the need to know the state of appliances and control them remotely has always been a necessity. Moreover, the situation where the appliances have to be controlled remotely might be created even in absence of load shedding.

Similarly, intrusions in the houses are quite common in the present days. Various incidents of theft are recorded each day. Thus a system that can inform people about such incidents in their houses when they are away could certainly help reduce such cases of trespassing.

Moreover, houses catching fire in absence of people in them is yet another common problem in the present context. Many houses are burnt to ashes because the owner remains uninformed about an incident of fire in his house. Thus, a system that is able to detect start of fire and inform about it to the owner is also another important requirement in the present time.

1.2. Objectives

- To get knowledge on use of electronic devices and circuits.
- To use the present available PSTN and extend its application, making it more flexible.
- To remotely control home appliances from anywhere around the world.

- To help solve problem of energy wastage and decrease the problems due to load shedding.
- To help people experience home automation in time-saving and cost-effective ways.

1.3. Scope of the Project

The system that has been designed is able to enhance the application of already-present PSTN. The system will enable the user to control the desired home appliances remotely from any part of the world. The user will simply require an access to a telecommunication network (landline or mobile). They can remotely log into the system using a security key and control the devices at will. Since the project utilizes the already present PSTN, the system will be able to provide home automation in cost effective ways.

The system covers yet another important topic of home security using the PSTN. The system is able to make a call to a preset mobile number and inform about the security problems in the user's house. For this, temperature sensor to detect the fire in the house and IR sensor to detect the trespassers have been employed.

The importance of the system is pronounced for the reason that any kind of user can utilize the system once it is installed to their houses, i.e. prior knowledge about electronics is not necessary for the users. The best part of the project is that the system can be easily installed, just by creating some extension to the presently available home circuits.

1.4. Proposed Works

The time schedule of the project was divided into two parts, as a part of our project proposal. The first part included the time period from topic selection to the mid-term defense. The second part included time period from the mid-term defense to the final presentation. As per the proposal, topic selection, study of the feasibility of the project, study of the project, proposal presentation, simulation of some task and some part of the final work were planned to be completed till the midterm defense. Similarly, the areas like design of the wav-player for the audio feedback, design of ring detector and pickup circuit and DTMF decoder and encoder circuits were planned to be done after the midterm defense. Similarly, task relating to sensor and security, assembly of all the parts, testing and fabrication and also report preparation were also planned as the task to be carried in the second phase.

1.5. Methodology

Our system is a microcontroller-based embedded system. All the decision making and automation is carried out by the microcontroller, which will be the heart of the system. We have designed a circuit to detect the ring, i.e. know when somebody has called and wants to access our system. Another circuit is present to pick up the phone. There is yet another circuit that detects the security-lapse situation in the house, i.e. case of fire in the house or some trespassing and finally a circuit that makes a call to a pre-stored mobile number of the user.

We had proposed to have audio feedback in our system and thus we have a module to play audio clips, too. This module makes the system more interactive and user friendly. For the purpose of authenticity, our system will require a password to access it. Therefore only authorized user can access and change the status of the devices.

The user will access and control the appliances through the calling telephone's touch-tone keypad. The Dual Tone Multiple Frequency (DTMF) code are decoded by our DTMF decoder circuit and appropriate actions are taken by the microcontroller. Moreover, the system waits for five rings before the call is handled so that the regular calls are distinguished.

The accomplishment of the system in its complete form required various steps to be carried out. At first, the system was broken down into several modules that are described in the sections that follow. Then step by step these modules were developed. During the period of which, ATMEGA8 microcontroller was employed. Each module developed were integrated in various steps so that they could be tested for the operation as accordance to the requirements. The process was continued till each of the modules was developed. Then a generic program for microcontroller was written; the modules were interfaced together and the overall system operation was tested. The modules were interfaced together by designing a general interface circuit and this time ATMEGA32 microcontroller was employed due to availability of higher number of input/ output pins and also its large program memory. Then a complete-system-in-one-PCB was designed.

2. LITERATURE REVIEW

2.1. Telephone Operation

Telephone line consists a pair of wire viz. TIP and RING. The pair of wire is responsible for carrying full duplex audio and the operating current for the telephone. The telephone connected to line is powered from current limited 48V power source, so phone on-hook, should measure around 48V DC. Practically the operating voltages of the telephone system can vary from 24V to 60V depending on the application, although 48V nominal voltage is the most commonly used. Telephone applications often require and use positive grounding in the central office, where positive conductor of the 48V power supply is connected to earth ground. The telecommunication industry began the positive ground convention in the 1940s. Generally when the telephone is on-hook, one telephone line wire is quite near to the ground potential and other one carries -48V. When telephone is put off-hook, the voltage between the wires going to the telephone drops down to the 3 to 9 V range and typically has current of 20-60 mA through the telephone. The typical operating current range is 20-35 mA. Any more than 55 or 60 mA might harm the phone. So the telephone equipment itself does not need any high voltage to operate. Typical telephone DC resistance is around 180 Ω and AC impedance is typically somewhere around 600 Ω. Typically, the telephone central provide from 200 to 400 Ω of series resistance to protect from short circuits and decouple the audio signals.[1]

A telephone uses an electric current to convey sound information from one subscriber to another. When the two of them are talking on the telephone, the telephone company is sending a steady electric current through the closed path telephones. The two telephones are sharing this steady current. But as one talks into his telephone’s microphone, the current that his telephone draws from the telephone company fluctuates up and down. These fluctuations are directly related to the air pressure fluctuations that are the sound of the voice at the microphone. Because the telephones are sharing the total current, any change in the current through a telephone causes a change in the current through another telephone. Thus as one talks, the current through another telephone fluctuates. A speaker in that telephone responds to these current fluctuations by compressing and rarefying the air. The resulting air pressure fluctuations reproduce the sound of the voice. Although the nature of telephones and the circuits connecting them have changed radically in the past few decades, the telephone system still functions in a manner that at least simulates this behavior. The current which powers the telephone is generated from the 48V battery in the central office. The 48V voltage is sent to the telephone line through some resistors and indictors (typically there is 2000 to 4000 ohms in series with the 48V power source). The old ordinary offices had about 400 ohm line relay coils in series with the line.

A telephone is connected to the telephone exchange by a twisted pair of 0.54mm copper wires, known by the phone company as “the loop”. Although copper is a good conductor, it does have resistance. The resistance of No.22 AWG wire is 16.46 Ohm over 1000 Ft at 77 degree Fahrenheit (25 degree Centigrade)[2]. When the telephone is in on-hook stage, the TIP is about 0V while RING is about -48V with respect to ground. In off-hook condition current is drawn, TIP goes negative and RING goes positive. A typical off-hook condition is TIP is about -20V and RING is about -28V. This means that there is about 8V between the wires in normal operation condition.

2.2. DTMF

Dual Tone Multi-Frequency or DTMF is a method for instructing a telephone switching system of the telephone number to be dialed, or to issue commands to switching systems or related telephony equipment.

Pressing a button in DTMF enabled telephone generates a ‘tone’, which is combination of two frequencies, one from lower band and another from upper band. For example, pressing the push button 9 transmits 850 Hz and 1477 Hz. An extended design provides for an additional frequency 1633 Hz in the upper band and could produce 16 distinct signals. When used to dial a telephone number, pressing a single key will produce a pitch consisting of two simultaneous pure tone sinusoidal frequencies. The row in which the key appears determines the low frequency, and the column determines the high frequency. For example, pressing the ‘1’ key will result in a sound composed of both a 697 and 1209 Hz tone.

The tone frequencies are defined by the Precise Tone Plan which is selected such that harmonics and inter-modulation products will not cause an unreliable signal. No frequency is a multiple of another, the difference between any two frequencies does not equal any of the frequencies, and the sum of any two frequencies does not equal any of the frequencies. The frequencies were initially designed with a ratio of 21/19, which is slightly less than a whole tone. The frequencies may not vary more than +/- 1.5% from their nominal frequency, or the switching center will ignore the signal. The high frequencies may be the same volume or louder as the low frequencies when sent across the line. The loudness difference between the high and low frequencies can be as 3 decibels (dB) and is referred to as “twist”. The minimum duration of the tone should be at least 70mS, although in some countries and applications DTMF receivers must be able to reliably detect DTMF tones as short as 45mS.

2.3. Telephone Set

A telephone set is an apparatus that creates an exact likeness of sound waves with an electric current. The essential components of a telephone set are the ringer circuit, on/off hook circuit, equalizer circuit, hybrid circuit, speaker, microphone, and a dialing circuit.

2.3.1. Ringer Circuit

The ringer circuit, which was originally an electromagnetic bell, is placed directly across the tip and ring of the local loop and its sole purpose is to alert the destination party of incoming calls. The tone of the ringer should be loud enough to be heard from a distance. In modern telephones, the bell has been replaced with and electronic oscillator connected to the speaker. Today, ringing signals can be of any imaginary sound.

2.3.2. On/Off Hook Circuit

The on/off hook circuit, sometimes called a switch hook, is nothing more than a simple SPDT switch placed across the tip and ring. The switch is mechanically connected to the telephone handset so that when the telephone is idle (on hook), the switch is open. When the telephone is in use (off hook), the switch is closed, completing an electrical path through the microphone between the tip and ring of the local loop.

2.3.3. Equalizer Circuit

Equalizers are combinations of passive components (resistors, capacitors, and so on) that are used to regulate the amplitude and frequency response of the voice signals. The equalizer helps solve an important transmission problem in telephone set design, namely, the interdependence of the transmitting and receiving efficiencies and the wide range of transmitter currents caused by a variety of local loop cables with different dc resistances.

2.3.4. Speaker

The speaker is the receiver for the telephone. The speaker converts electrical signals received from the local loop to acoustical signals that can be heard and understood by a human being. The speaker is connected to the local loop through the hybrid network. The speaker is typically enclosed in the handset of the telephone along with the microphone.

2.3.5. Microphone

The microphone is the transmitter for the telephone and it converts acoustical signals in the form of sound pressure waves from the caller to electrical signals that are transmitted into the telephone network through the local subscriber loop. The microphone is also connected to the local loop through the hybrid network. Both the microphone and the speaker are transducers, as they convert one form of energy into another form of energy. A microphone converts acoustical energy first to mechanical energy and then to electrical energy, while the speaker performs the exact opposite sequence of conversions.

2.3.6. Hybrid Network

The hybrid network (sometimes called a hybrid coil or duplex coil) in a telephone set is a special balanced transformer used to convert a two-wire circuit (the local loop) into a four-wire circuit (the telephone set) and vice versa, thus enabling full-duplex operation over a two-wire circuit. In essence, the hybrid network separates the transmitted signals from the received signals. Another function of the hybrid network is to allow a small portion of the transmit signal to be returned to the receiver in the form of a side tone.

2.3.7. Dialing circuit

The dialing circuit enables the subscriber to output signals representing digits, and this enables the caller to enter the destination telephone number. The dialing circuit could be a rotary dialer, or most likely an electronic dial-pulsing circuit which sends various combinations of tones representing the called digits.

3. CIRCUITS INVOLVED IN FINAL SYSTEM

3.1. Wav Player

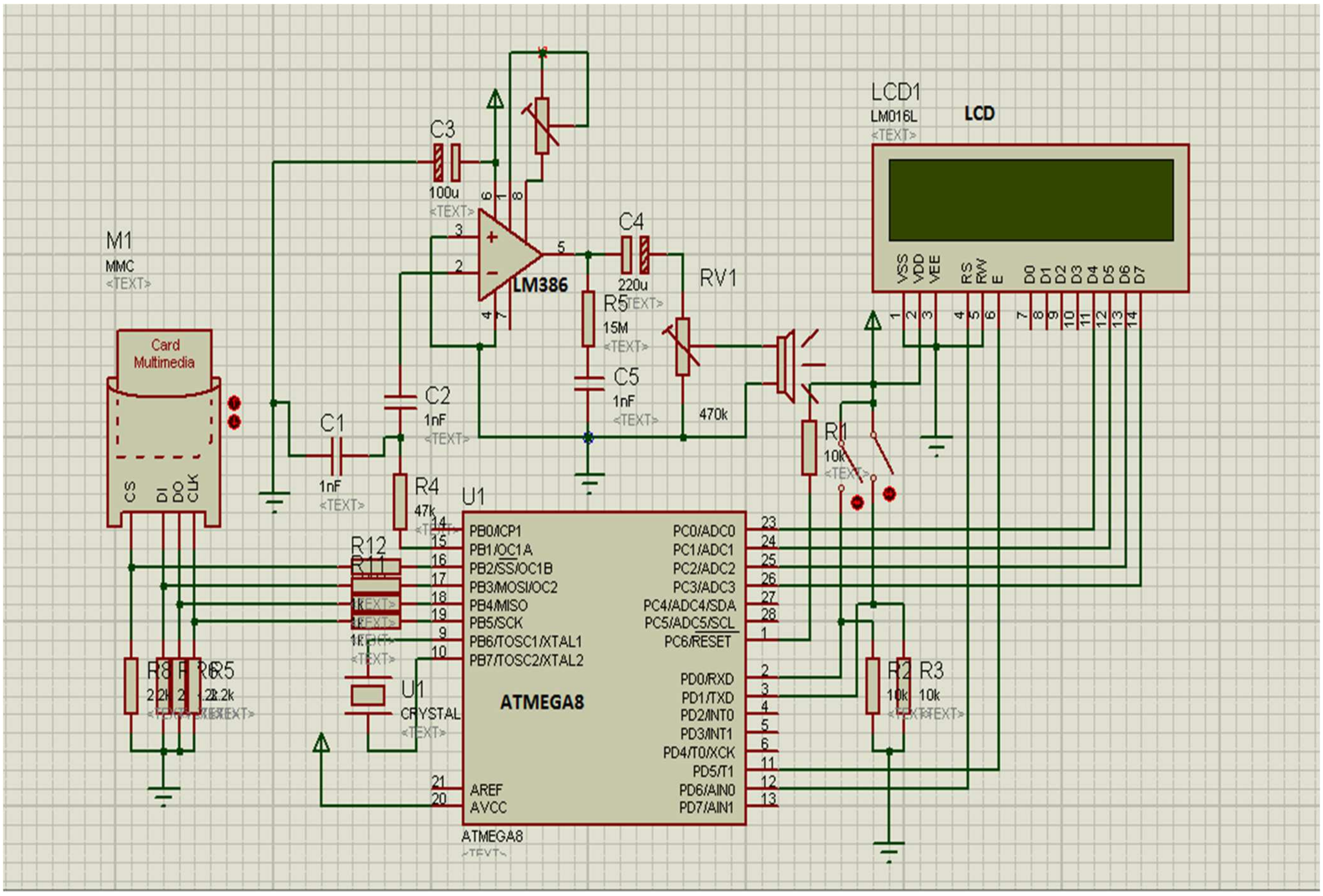

Figure 3.1 Wav player initial circuit

The wav-player, that has been employed to give audio feedbacks to the user of the system, is able to store audio clips in .wav format in a SD-card. A separate module of wav-player has been designed for the purpose. The sound clips are mono format sampled at 44,100 Hz with 8-bits quantization. The sound clips are stored in digital format in the SD-card. We have implemented FAT16 file system making it possible to storing sound clips directly using a PC. Similarly, the audio clips are converted to analog format to play using the PWM of microcontroller. The frequency of the PWM (220.5 KHz) is five times the sampling frequency of audio signal. This PWM signal is followed by simple RC-filtering. The lowpass RC filter has cut-off frequency at 22 KHz and thus only the average value of the PWM is passed through. This is our required audio signal. The output from the filter is then amplified using LM386 low power amplifier. This is illustrated in the following figures (figure 3.2, 3.3, 3.4).

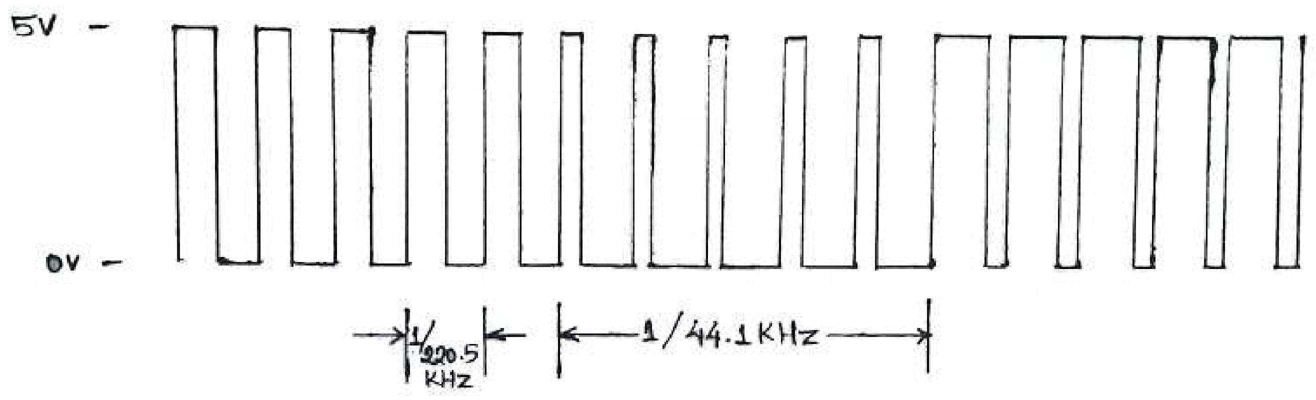

Figure 3.2 PWM audio signal

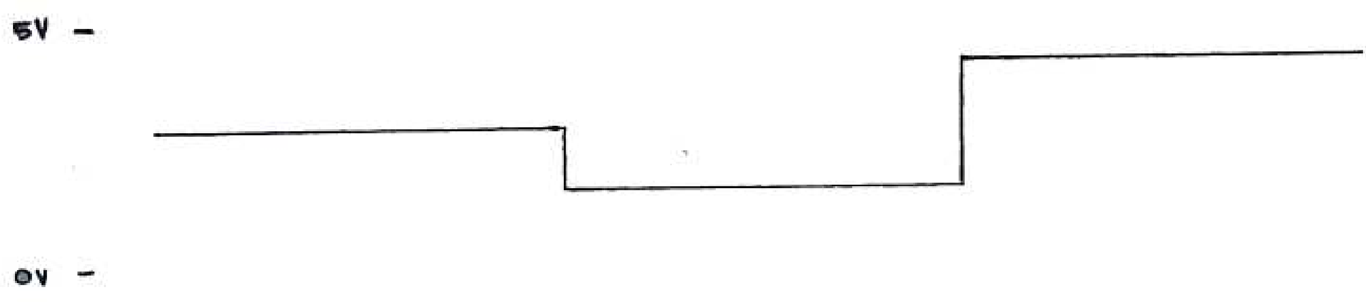

Figure 3.3 Average value of PWM

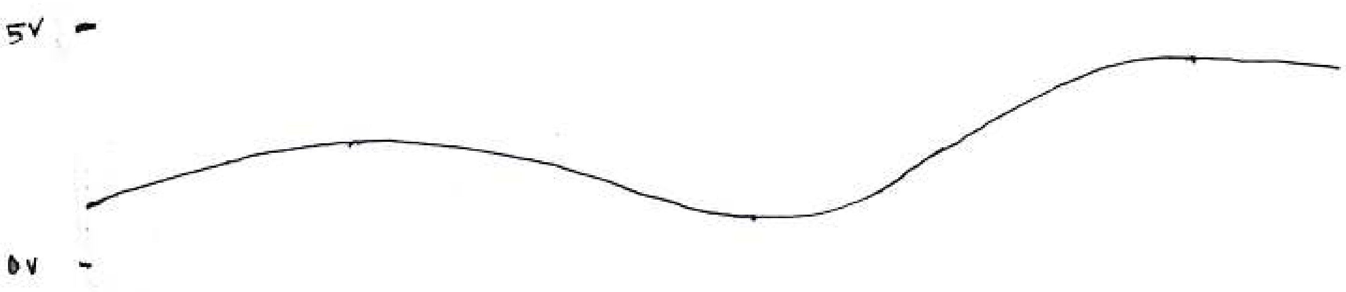

Figure 3.4 Audio output of low pass filter

3.2. Ring Detection Circuit

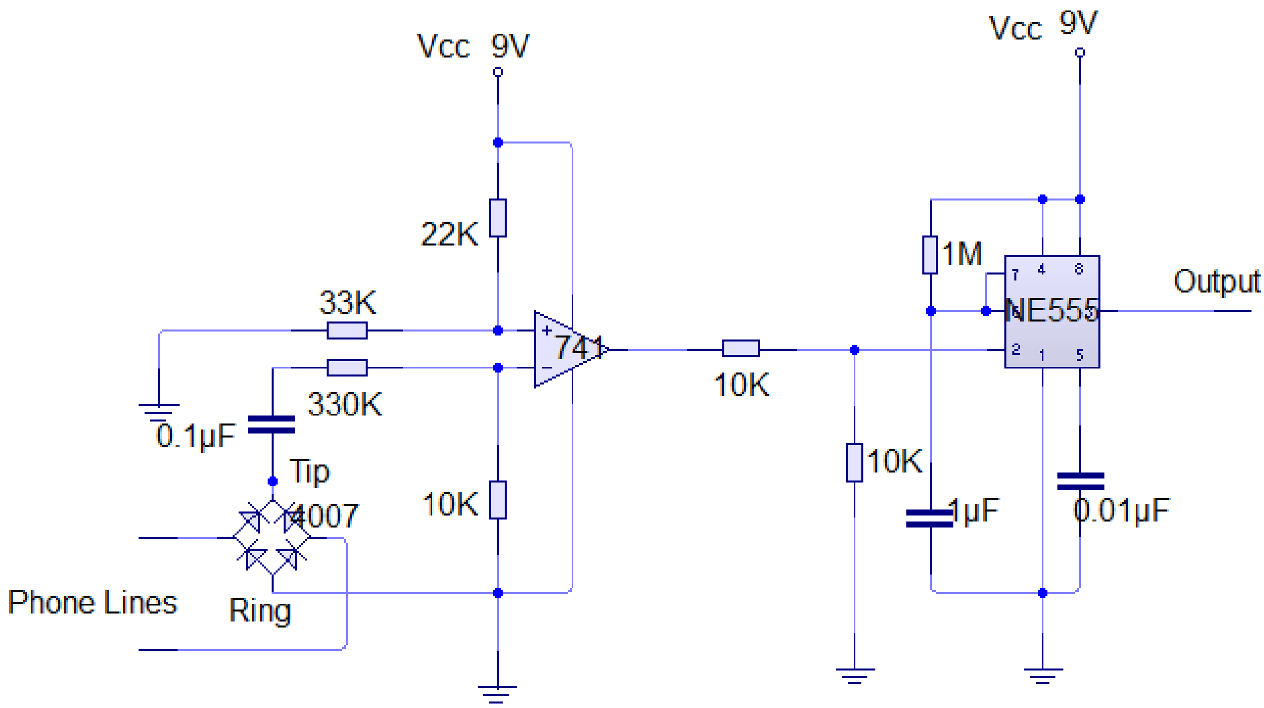

Figure 3.5 Ring detection circuit

The ring detection circuit has been employed to convert the 25 Hz - 90 Volts RMS ac signal sent by the telephone exchange for indication of ring to a logic level that is understood by the microcontroller for processing. A separate module as ring detector circuit has been developed and this unit informs the arrival of ring to the microcontroller and helps counting the number of rings. It consists of a comparator (741 op-amp) for detecting the change in voltage that appears during ringing and non-ringing condition. The comparator triggers the monostable multivibrator (555 Timer) to provide smooth pulse to microcontroller indicating the presence of ring. For the non-inverting input to the comparator the reference voltage is given from the voltage divider with 33 KΩ and 22KΩ resistors in series is 3V. For the inverting input to the comparator the inverting input of comparator is connected via voltage divider with 330 KΩ and 10 KΩ in series with tip. At normal condition i.e. in the absence of ring, the output of the comparator is high. The output of the comparator is fed to the trigger input of the timer circuit. Between two successive rings from exchange, there is a delay of about two seconds and each ring signal consists of two bursts of signals 0.2 seconds apart. Therefore, we need to convert these two bursts of one ring into a single pulse and is accomplished with a 555 timer IC working in monostable mode. When it is triggered by a low going pulse, it generates a pulse whose duration can be controlled by adjusting the values of resistor and capacitor. The time period of a pulse output from the timer operating in monostable is given by: T = 1.1 R C.[3] We have R = 1 MΩ and C = 1 μF. Thus, T = 1.1 second. Hence, the two bursts for a ring signal is converted into a single pulse by the monostable multivibrator. The output of the detector goes high for 1.1 seconds whenever there is a ring in the telephone line. This output is then passed to the microcontroller.

3.3. DTMF Encoder and Decoder

The other module that has been developed is the one that includes both DTMF encoder and DTMF decoder.

3.3.1. DTMF Decoder

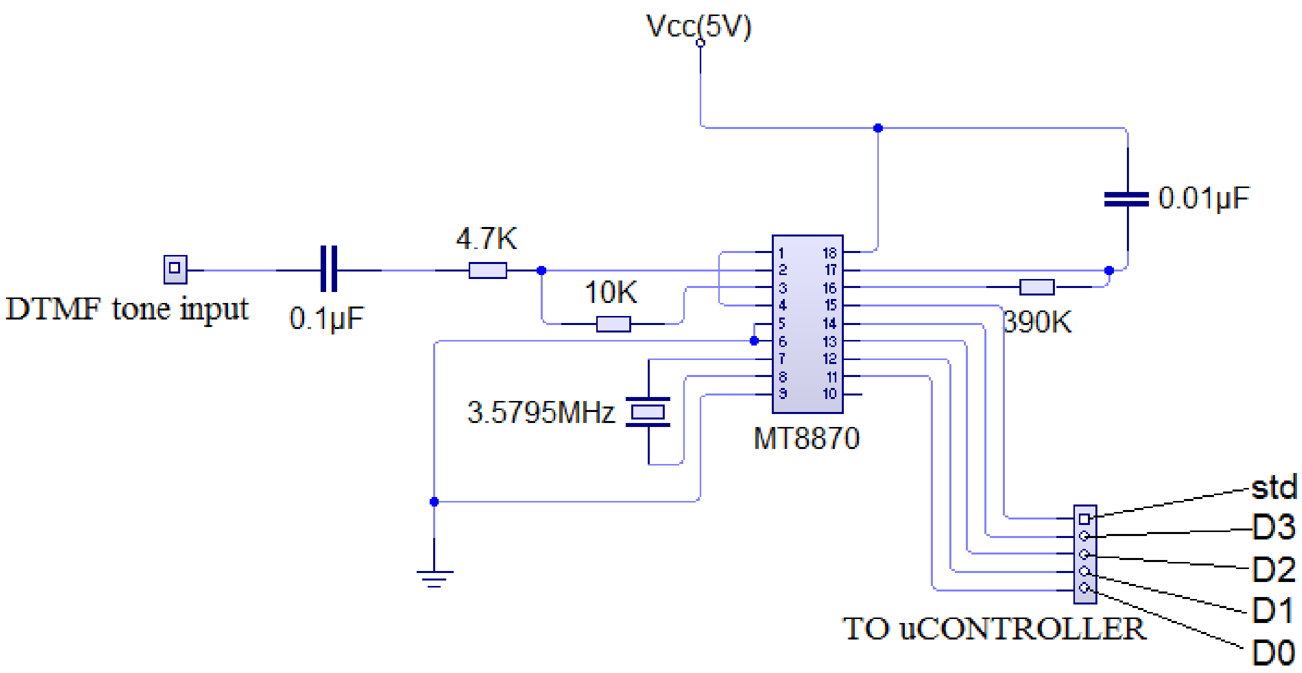

Figure 3.6 DTMF decoder circuit

DTMF decoder circuit is the circuit that has been used in the final circuit to find out the number as per the dual frequency signal sent from the telephone exchange. It consists of a MT8870 IC which is a DTMF decoder, an 18-pin IC that converts analog DTMF signal to 4-bit binary output. This IC converts analog DTMF signal from the telephone into the corresponding 4-bit digital data in its pin 11 (LSB), 12, 13 and 14 (MSB) respectively.[4] Along with this data, another input StD is fed to the interrupt pin of the microcontroller. Pin 11, 12, 13 and 14 are binary coded bits and sent to ports of the microcontroller. When the StD pin is high then only the microcontroller takes the data from the DTMF decoder.

3.3.2. DTMF Encoder

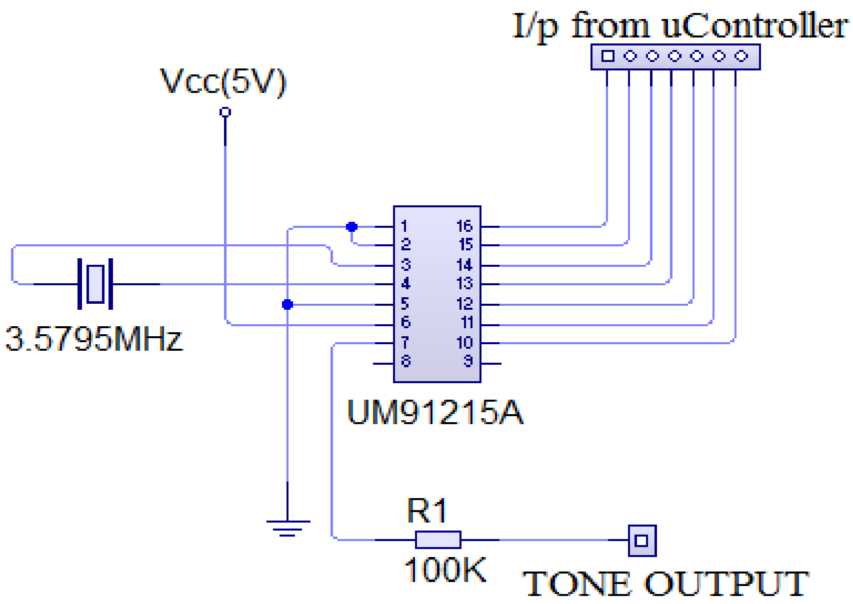

Figure 3.7 DTMF encoder circuit

Similarly, the DTMF encoder unit has been employed in our final circuit to generate a corresponding DTMF combinations to the user's number if any security lapse (fire in the house or intrusion) has occurred in the house. This is a unit that converts the binary coded signals into analog DTMF signals. The UM91215A IC is a 16-pin chip that takes the binary signals from the microcontroller and sends out DTMF tones corresponding to the number to be dialed. The seven output bits from the microcontroller are provided to seven pins numbered 10 to 16 of the DTMF generator IC.[5] The IC then outputs a DTMF tone which is the combination of the two frequencies (upper and lower band). Thus generated DTMF tones are amplified using audio amplifier (LM386) and transmitted through phone line.

3.4. Hook On-Off Circuit

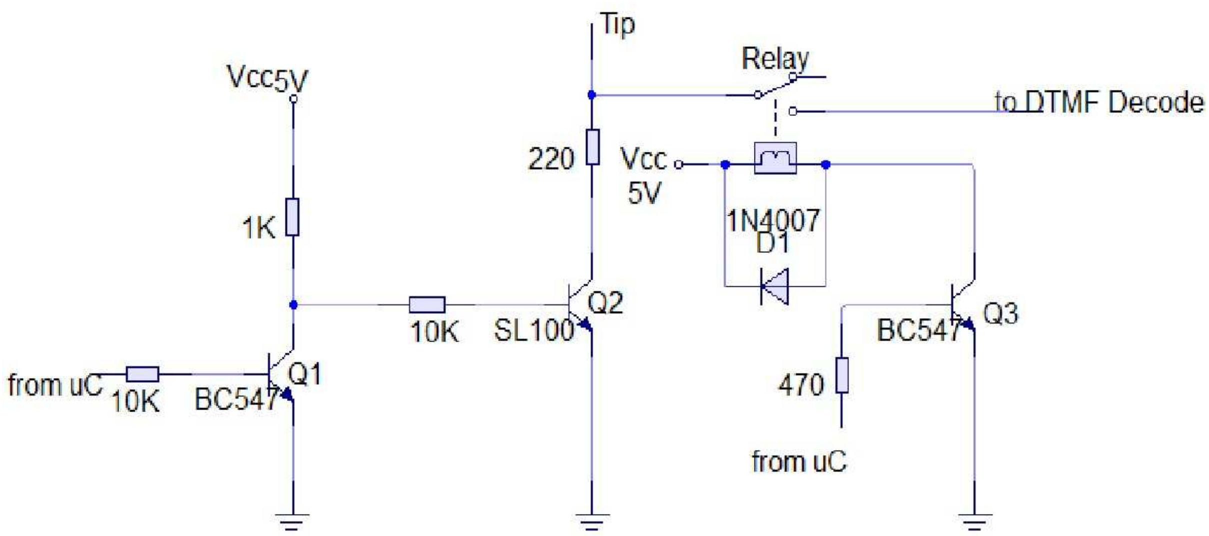

Figure 3.8 Hook on-off circuit

The hook on-off circuit (figure 3.5) module consists of transistors, diodes and resistors, basically. The transistor Q2 is used as switch and is switched by transistor Q1. The input from microcontroller to Q1 is generally high so that Q2 in cut-off mode i.e. OFF state. Whenever situation to hook-off (pick up) the phone arises, the microcontroller provides a low (i.e. no signal is applied) to Q1 and thus resulting Q2 in saturation mode i.e. ON state then resulting the Tip and Ring are connected via 220 Ω and starts the current flow through Q2 , which in fact is the hook-off situation for our phone line. On an ordinary two-wire telephone line, off-hook status is communicated to the telephone exchange by a resistance short across the pair (tip and ring).[6] The microcontroller also provides a high signal to transistor Q3 after providing a low to the input of Q1 with a delay of 500mS. With this, Q3 is in ON, a circuit from Vcc to ground completes through Relay and thus path from Tip to DTMF decoder is also shorted.
The diode D1 is employed in the circuit so that back Emf produced at the coil of relay, just after Q3 is off, won’t affect the circuit.
Once the operation for hook off is completed (i.e. call is aborted), the microcontroller provides a high at input to Q1 and hook-on is created.

3.5. Temperature Sensor Circuit

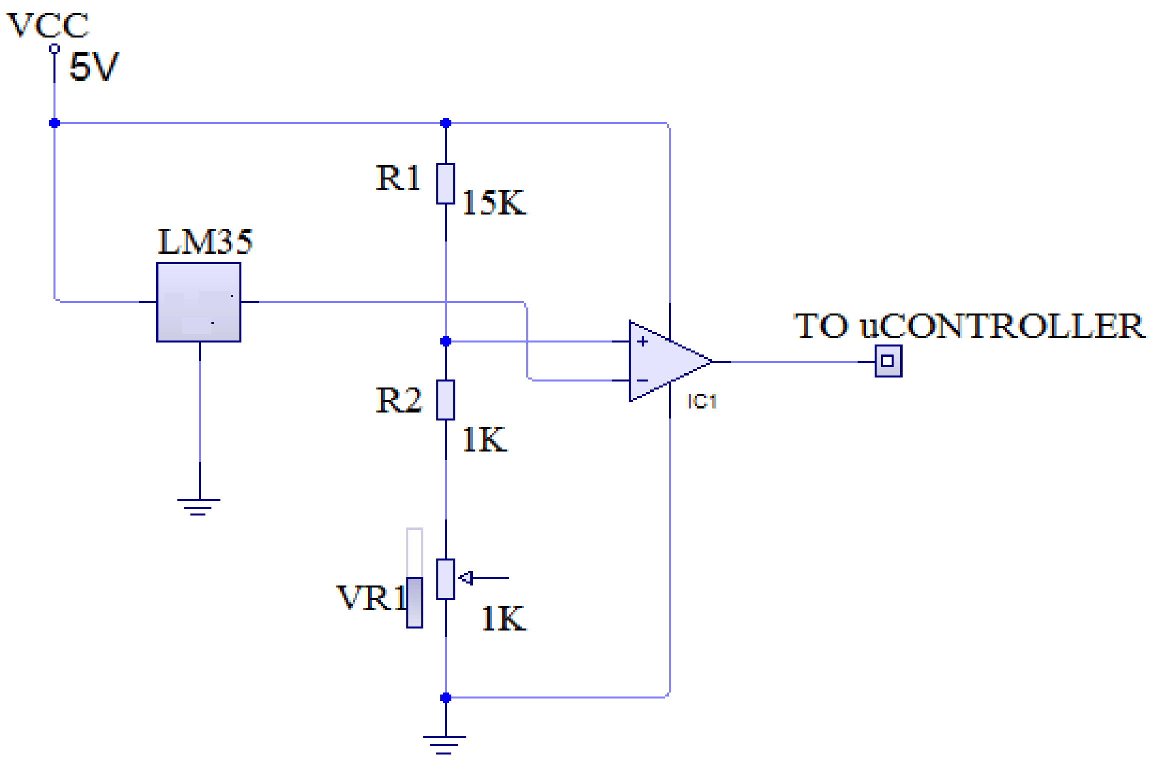

Figure 3.9 Temperature sensor circuit

LM35 is chosen as the temperature sensor for testing whether there is a fire in the house. The output of this IC is compared with a reference voltage which corresponds to normal temperature (which can be selected to be between 30^{o}C to 60^{o}C with the application of preset in the circuit) to find whether the temperature of the room has gone above due to the fire. The linear relationship between the voltage and the temperature (in degree Celsius) presented by this sensor and its wide operating range (-55°C to 150°C) are the luring factors for choosing this sensor. Since, the output-input relation of sensor LM35 is 10mV/°C, [7] the reference voltage given to the comparator is set in between 300 mV to 600 mV using voltage divider circuit.

3.6. IR Sensor Circuit

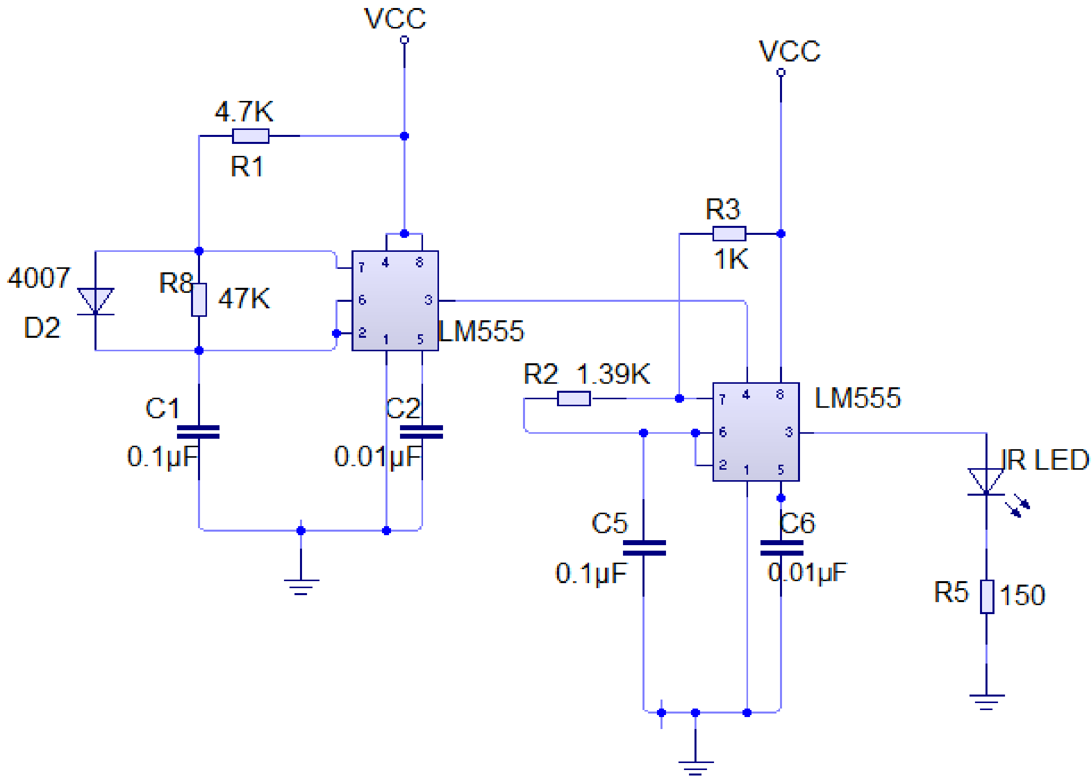

Figure 3.10 IR transmitter circuit

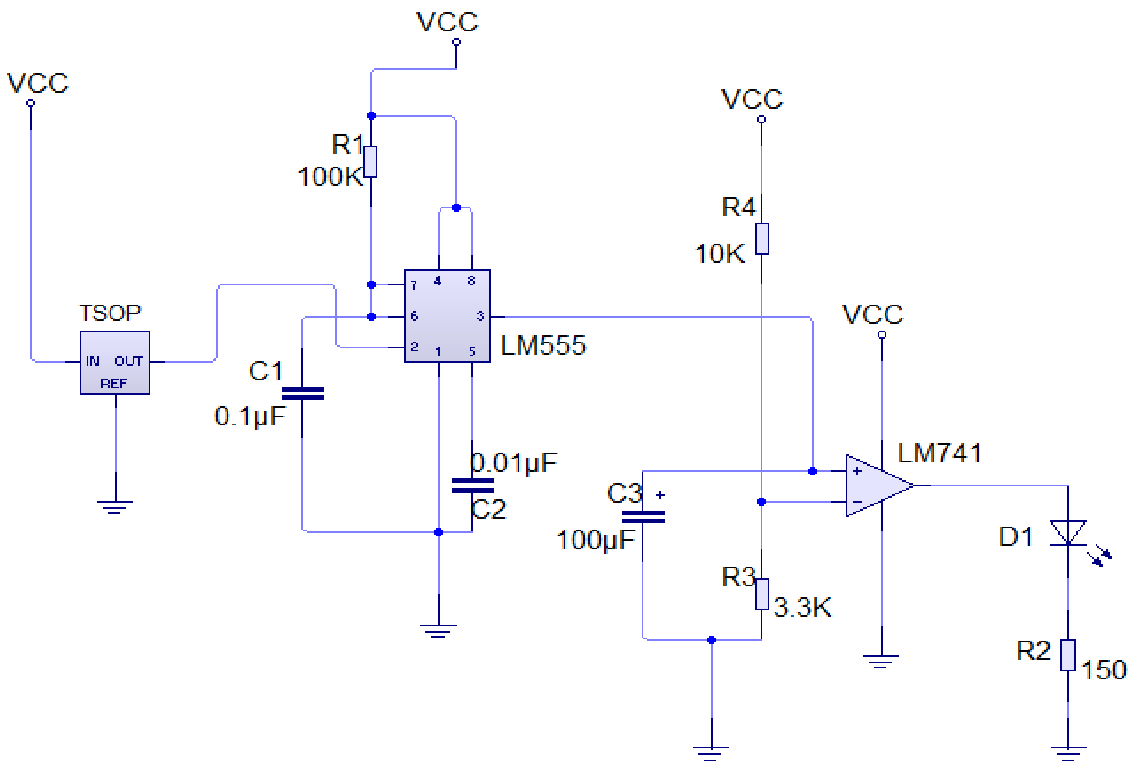

Figure 3.11 IR receiver circuit

Detection of intrusion inside the house is carried out using IR sensor. The total circuit for intrusion detection consists of two parts viz. IR transmitter and IR receiver (Figure 3.6 and Figure 3.7). The transmitter contains an IR LED whose signal is decoded by the receiver placed at certain distance from it. Intrusion is detected whenever there is a blockage in this line of sight path of transmitter and receiver.

IR receiver is designed using TSOP1738 IC. The major reason for using this IC is that the circuit of TSOP1738 is designed in that way that unexpected output pulses due to noise or disturbance signals are avoided which obviously is a requirement so that exact intrusion could be detected. The signal for the TSOP1738 for reception has to modulate a 38 KHz signal [8] and thus transmitter is designed as such. The transmitter circuit has two 555 timers operating in astable mode. The first 555 timer generates the transmitting signal (figure 3.12) continuously. The exact value of resistor and capacitor are chosen to generate this signal (formula in appendix for LM555 section). The signal as in figure is generated rather than a continuous ON signal because the TSOP1738 receiver IC has an AGC in it that decreases its gain applied on the received signal when a constant signal is available to it. Thus to make the receiver IC maintain its gain at high level a signal that remains OFF for longer time than the ON time is generated. Similarly, second 555 timer is employed to generate the 38KHz signal which is modulated by the signal generated by the first 555 timer.

The output from the second 555 timer is fed to IR LED, output infrared light of which is actually detected by the TSOP receiver.

The output signal after TSOP receives the infrared signal from the transmitter LED is shown in figure 3.13. It is just a mirror replica of the signal generated by the first 555 timer of the transmitter. This signal is provided to a 555 timer as in figure. The output from this 555 timer at receiver is shown in figure 3.14. This signal is passed to a comparator after filtering with a capacitor. The output of this comparator is generally high (when the TSOP receiver can see the signal from IR LED) and goes low when the TSOP receiver can’t obtain any signal from the transmitter i.e. whenever there is an intrusion.

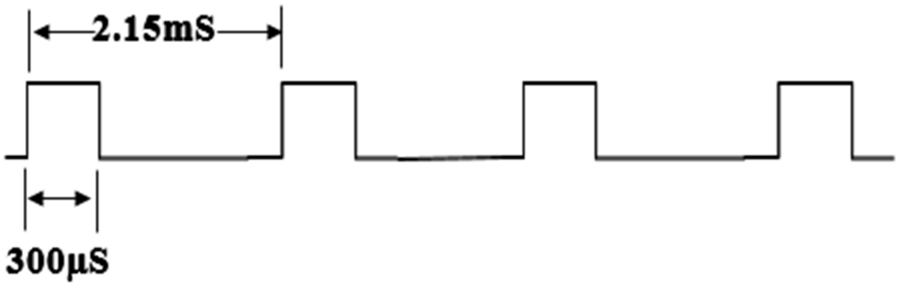

Figure 3.12 IR sensor transmitting signal

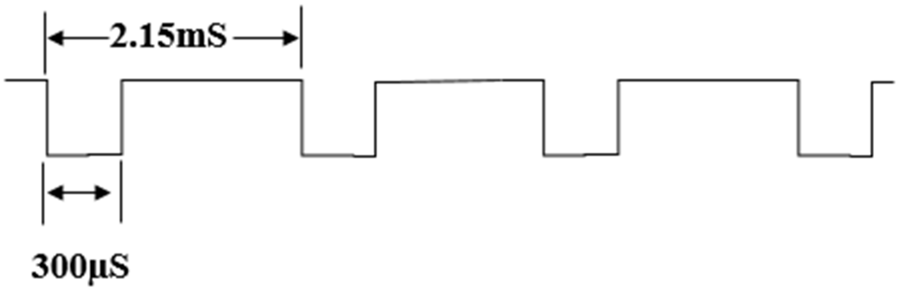

Figure 3.13 IR sensor TSOP received signal

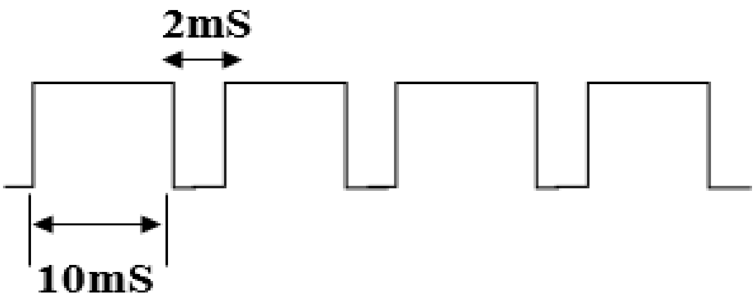

Figure 3.14 The 555 timer output at IR receiver

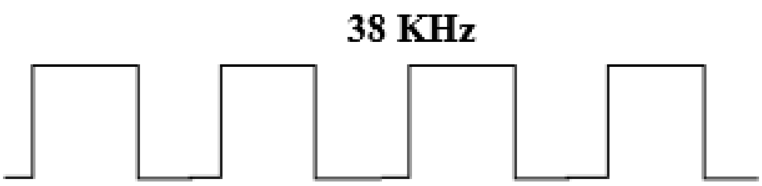

Figure 3.15 38 KHz signal

3.7. AC Appliances Circuit

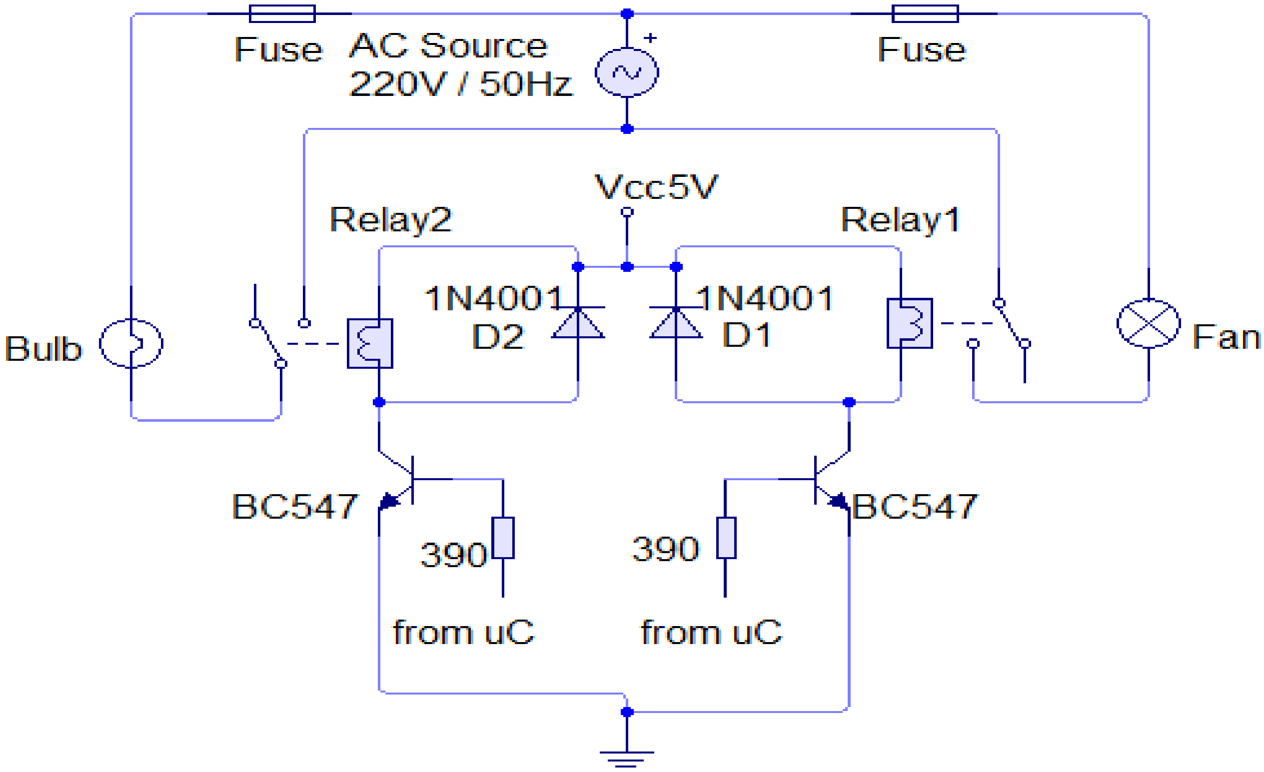

Figure 3.16 AC appliances control circuit

This is the circuit that connects the real AC devices to be controlled to the microcontroller's pins. Whenever, the state of bulb has to be changed from OFF to ON, microcontroller provides a high logic to the base of the transistor. As a result transistor is in ON state and thus the circuit from Vcc to ground through relay2 gets completed. And when current flows through relay, the switch connected to its magnetic coil gets closed causing the circuit through the bulb to complete and thus resulting the Bulb to glow. Similar is the operation with fan.

4. SYSTEM OPERATION

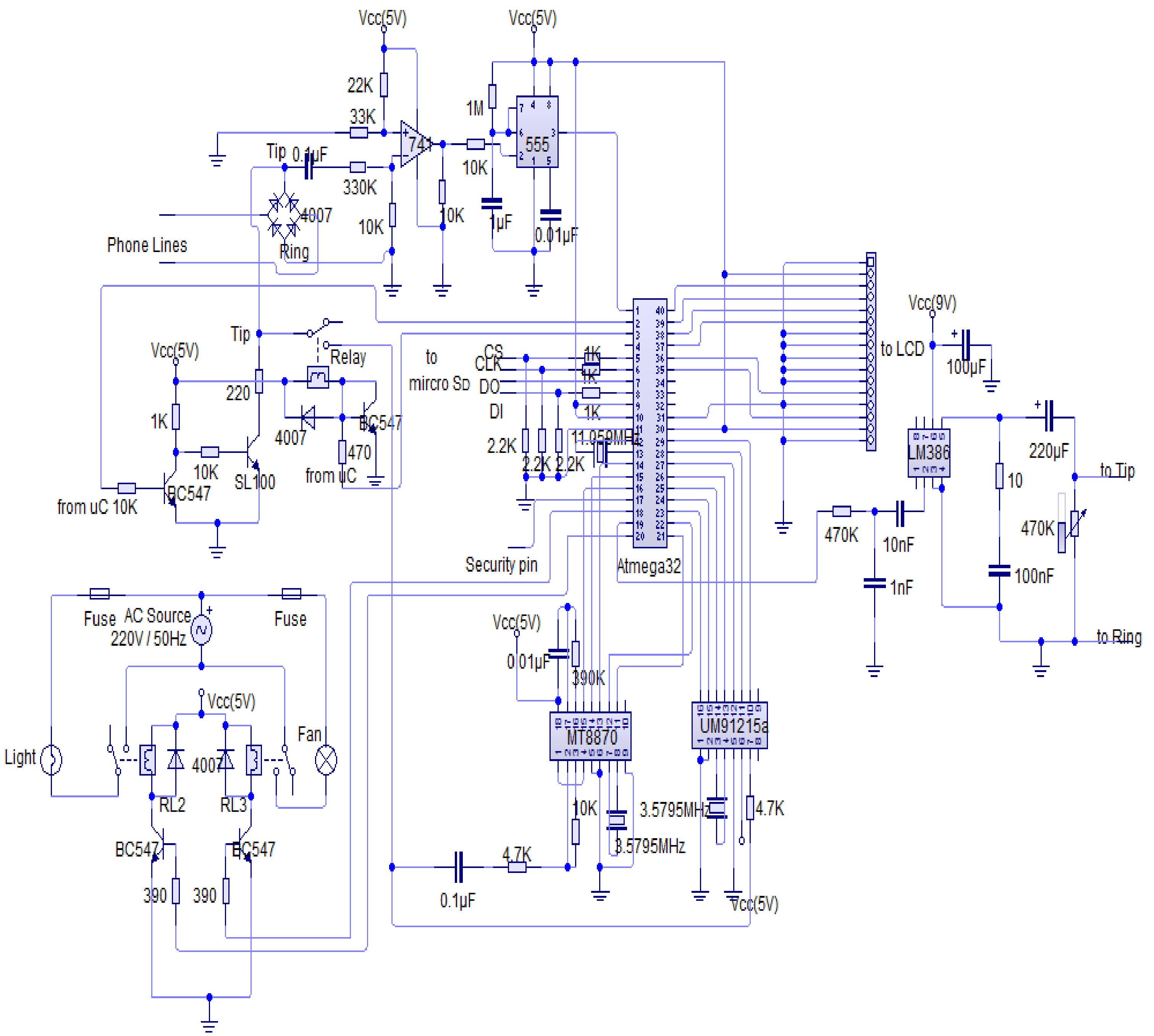

Figure 4.1 Total System circuit

System operation can be divided broadly into two areas viz. appliances control and security. For the part of appliances control, once the system is connected with the regular PSTN line, the user has to make a call to his/her landline number. Once the threshold of five rings are crossed, the count of which is taken care by ring detector circuit, the call is now passed onto the system. The first audio clip stored in SD card that welcomes the user to the system and asks for security verification is played to the user's calling device, through the telephone line. With the audio clip played, the user enters his security verification code, the information of which is processed by the DTMF decoder circuit. The microcontroller checks the security code and compares it with the code that is stored in EEPROM of the microcontroller. If a wrong security code is entered by the user, the system allows the user to enter the code again. Once a valid code is entered, the information of which is provide to the user through the respective audio clip stored in the SD card, the user is asked whether he/she wishes to know the status of the devices or to change their state from ON to OFF or vice versa or even to change the password for the system. He is asked to press different keys for completion of his task. Again the exact key that the user presses is decoded by the DTMF decoder and microcontroller performs the tasks accordingly. The user is then asked whether he wishes to continue with the system for another round of operation or to quit out of the system. If the user wishes to hang-up, the intention of which he obviously provides by pressing respective key, the hook on-off circuit plays its part to hang-up the phone.

Similarly, for the part of security, which involves the system to call the user in case of fire or intrusion in his/her house, the detection of security lapse is carried out by the sensors in the house. The temperature sensor, LM35, senses the rise in temperature above certain normal value and sends an interrupt to the microcontroller. The microcontroller directs DTMF encoder to dial the mobile number stored previously and once the call is established, the information on the possibility of fire in the house is provided to the user by playing the respective audio clip stored in the SD card. Similarly, the intrusion in the house is detected through the IR sensor. The information of which is again provided to the user by dialing his number and playing the respective audio clip.

4.1. System Block Diagram

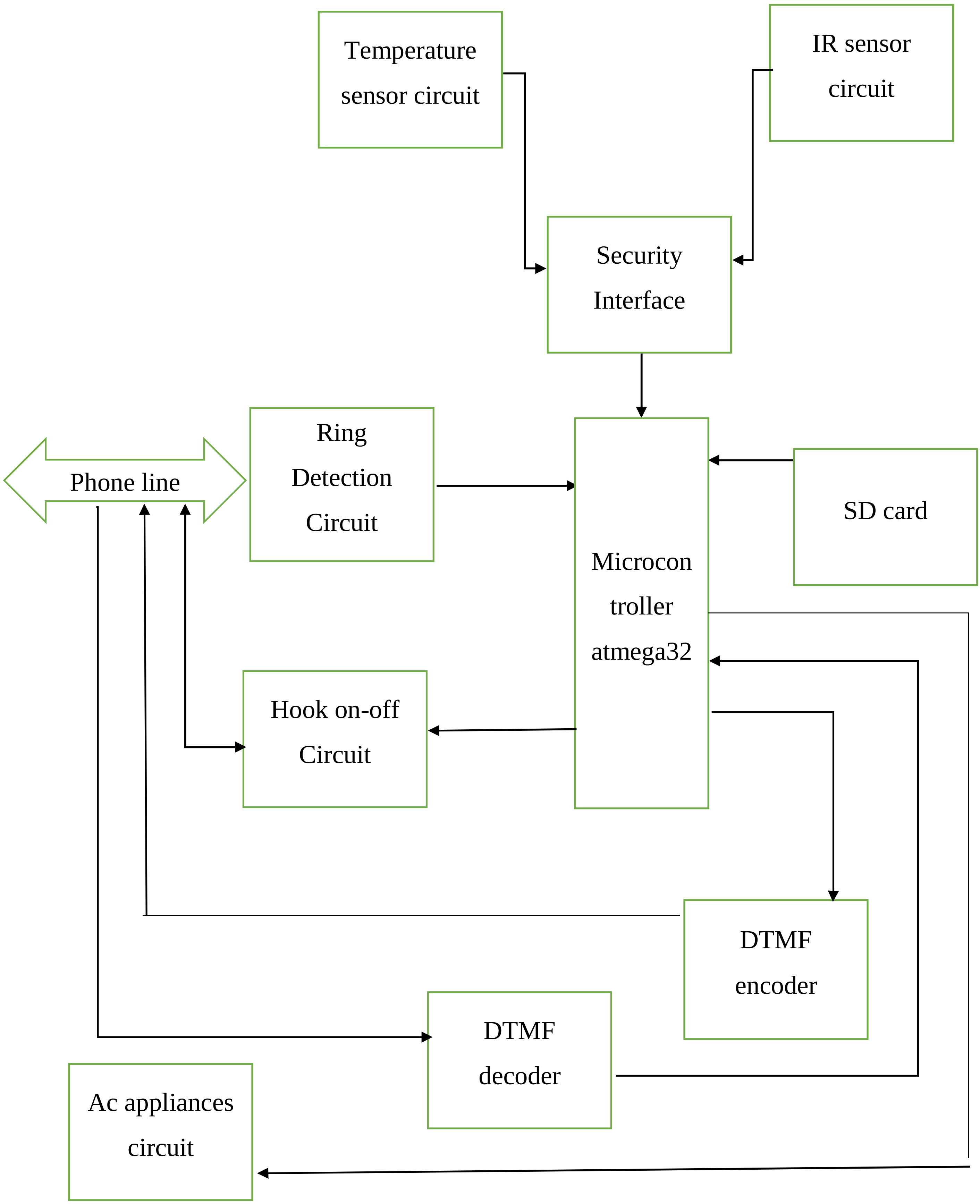

Figure 4.2 System block diagram

4.2. System Flow chart

The operation of the total system can be divided into two parts viz. device control part and home security part. The flowchart for these two parts are presented herewith.

4.2.1 Main System flowchart

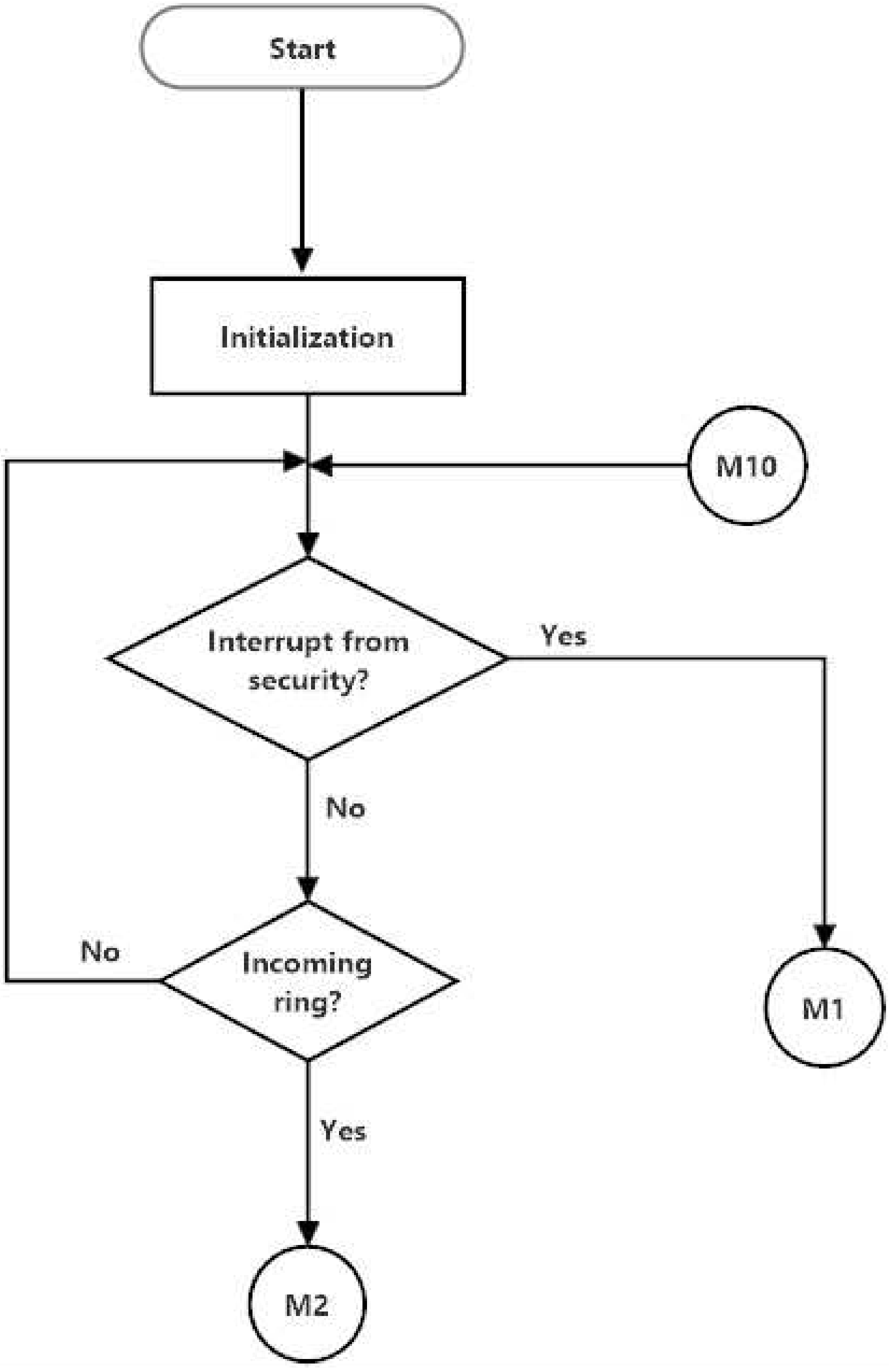

Figure 4.3 Main system flowchart

4.2.2. Flowchart for Device Control

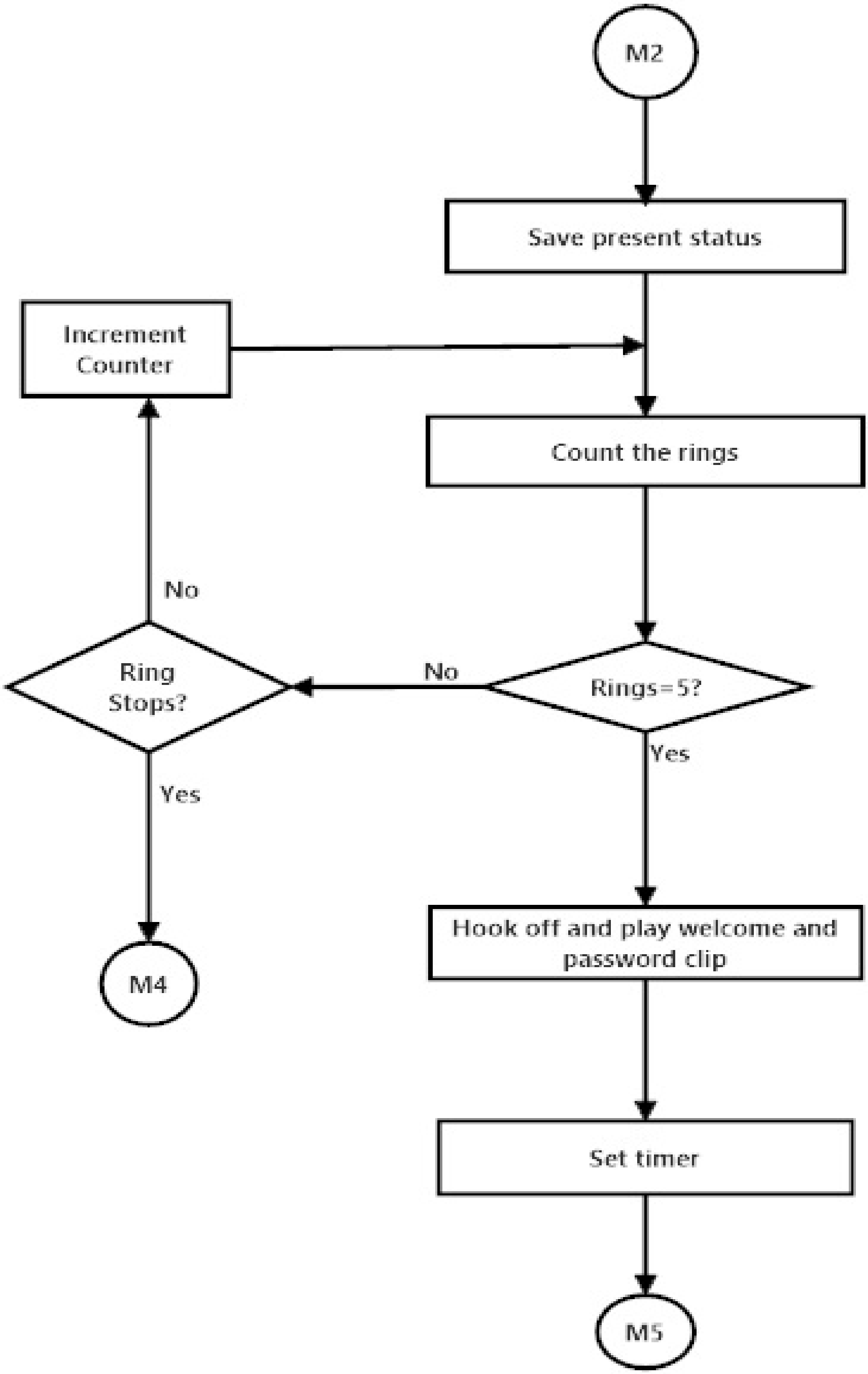

Figure 4.4 Device control flowchart

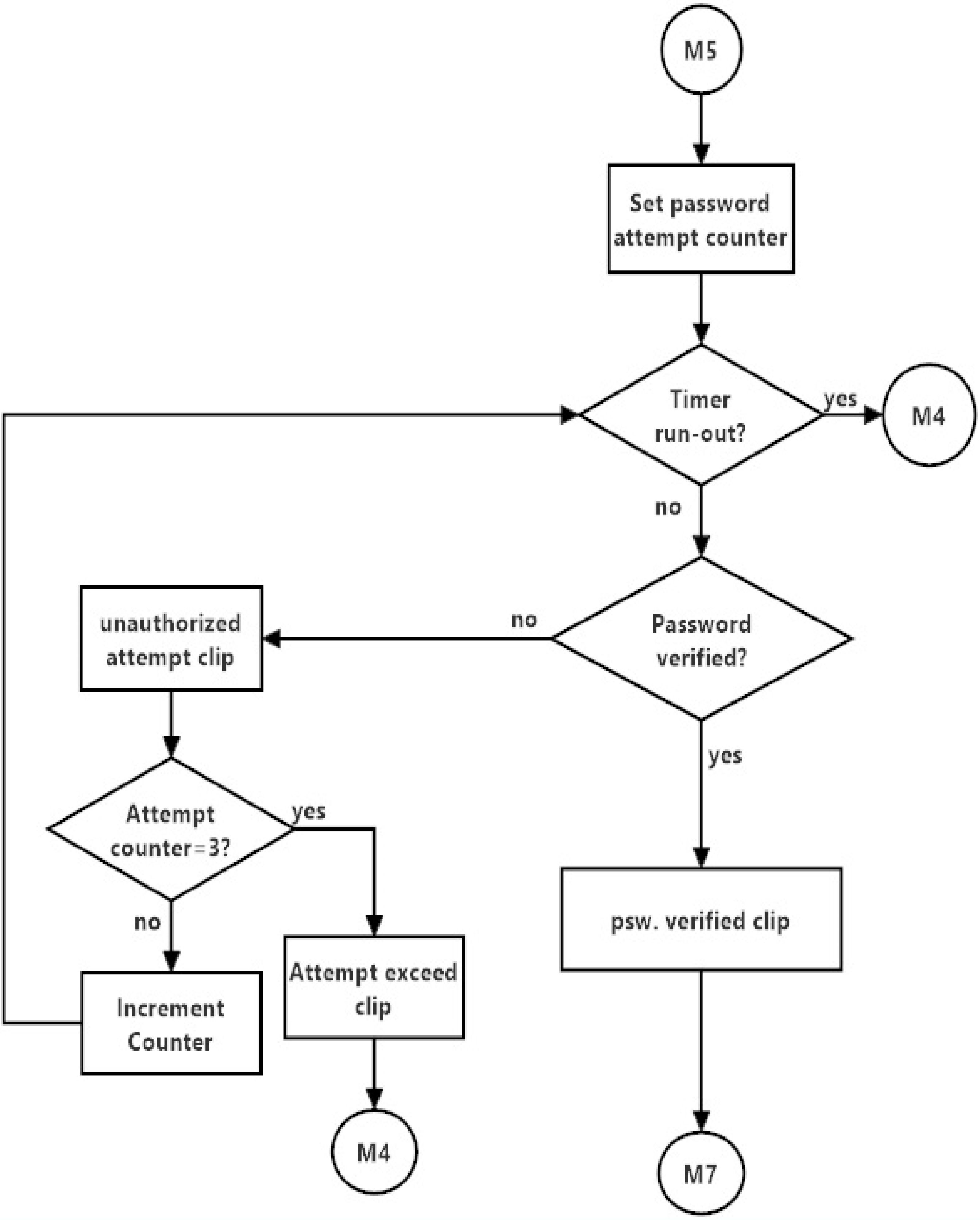

Figure 4.5 Device control flowchart continued

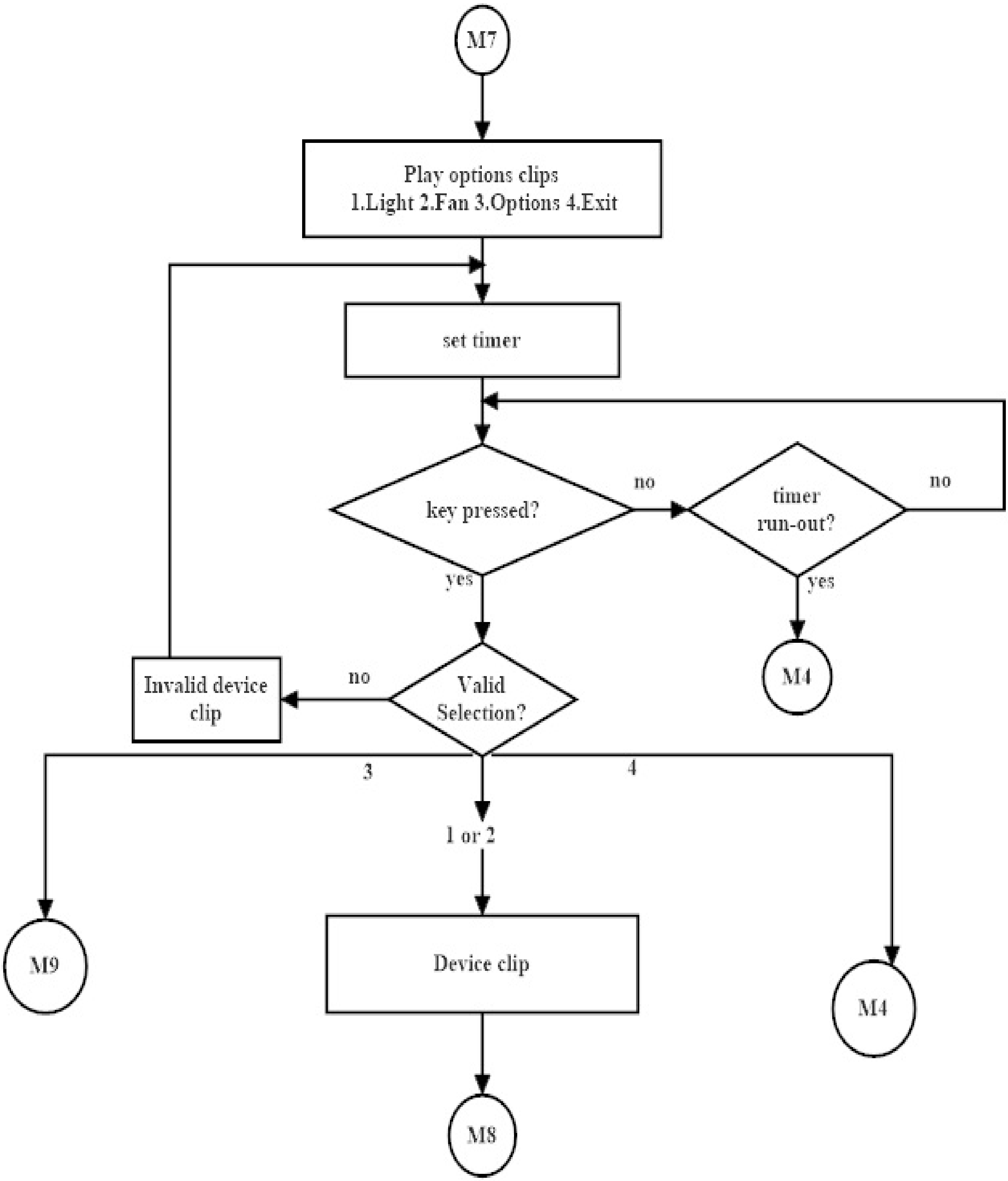

Figure 4.6 Device control flowchart continued

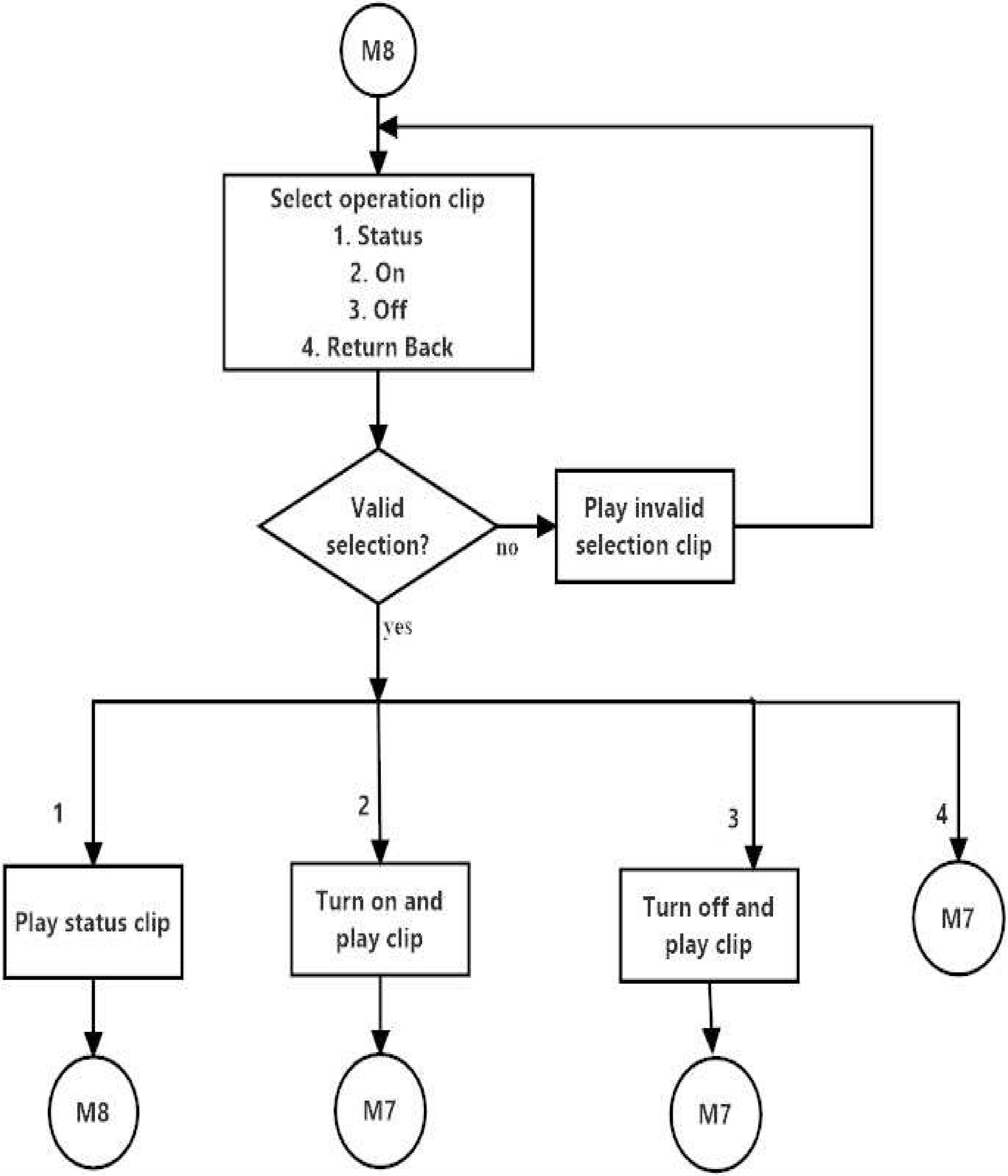

Figure 4.7 Device control flowchart continued

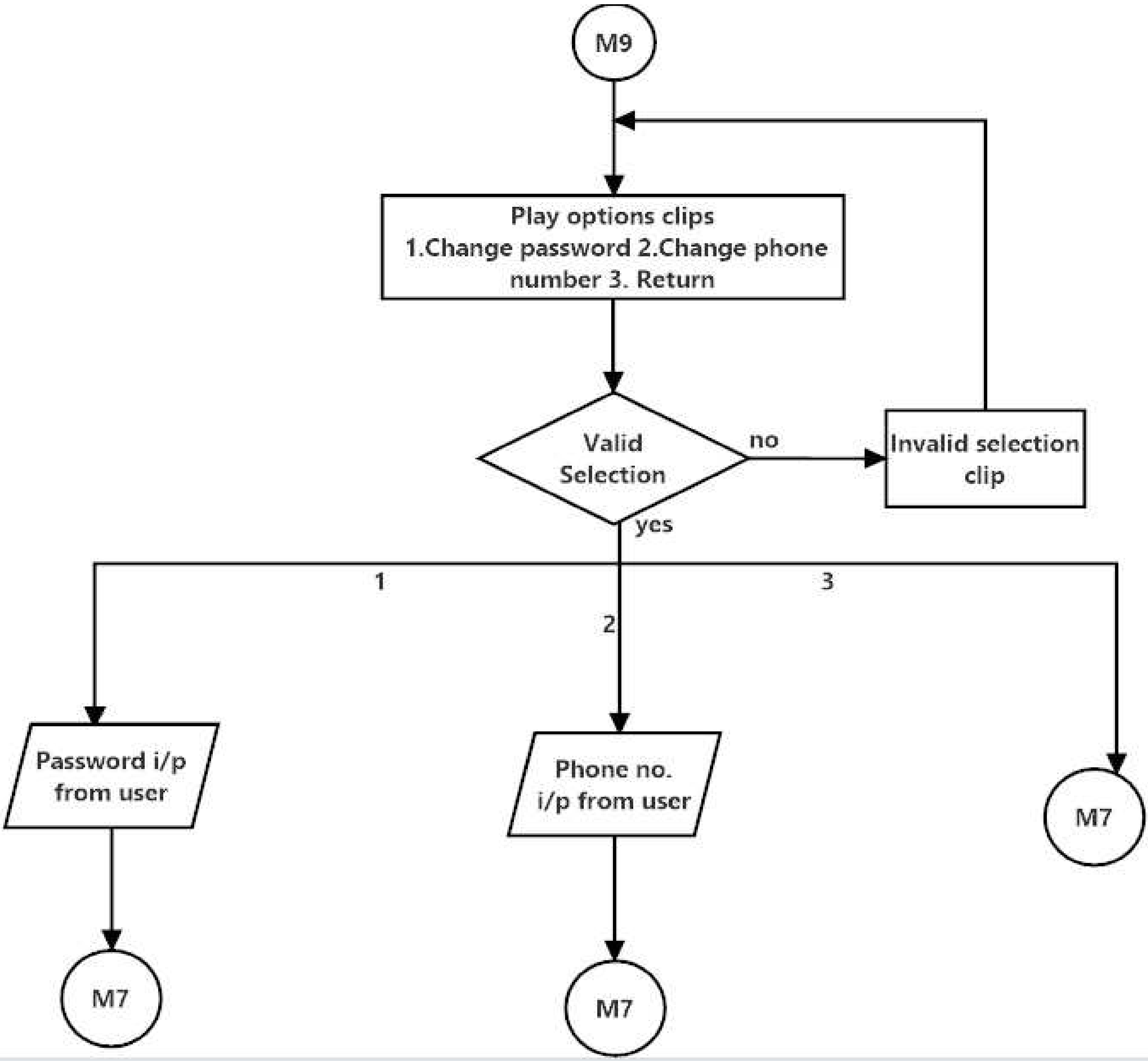

Figure 4.8 Device Control flowchart continued

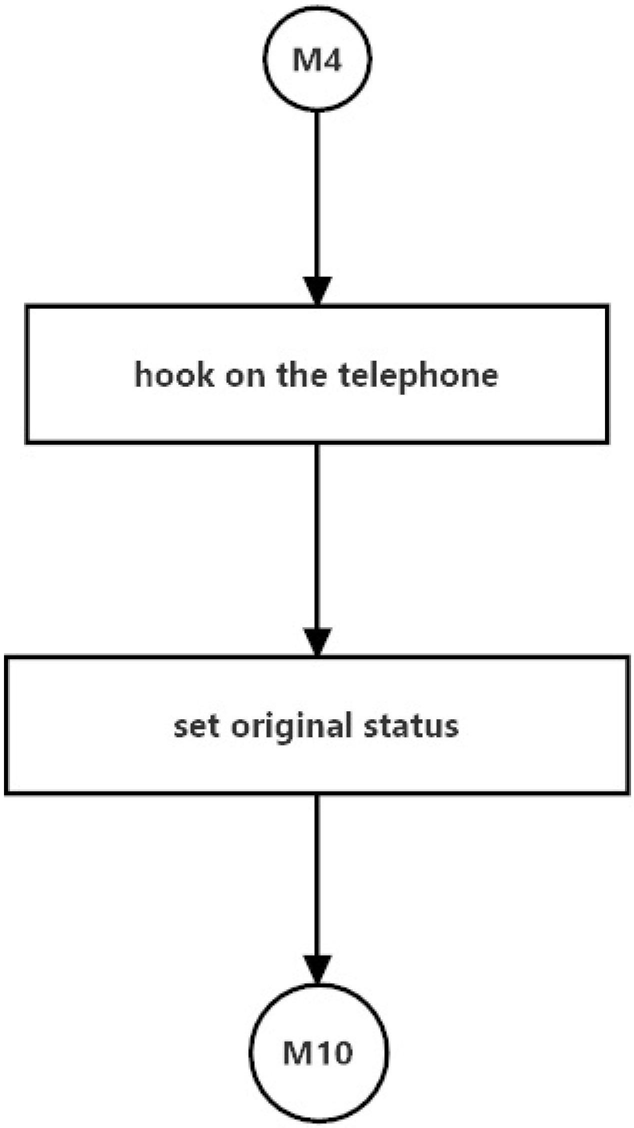

Figure 4.9 Device control flowchart continued

4.2.3. Flowchart for Home Security

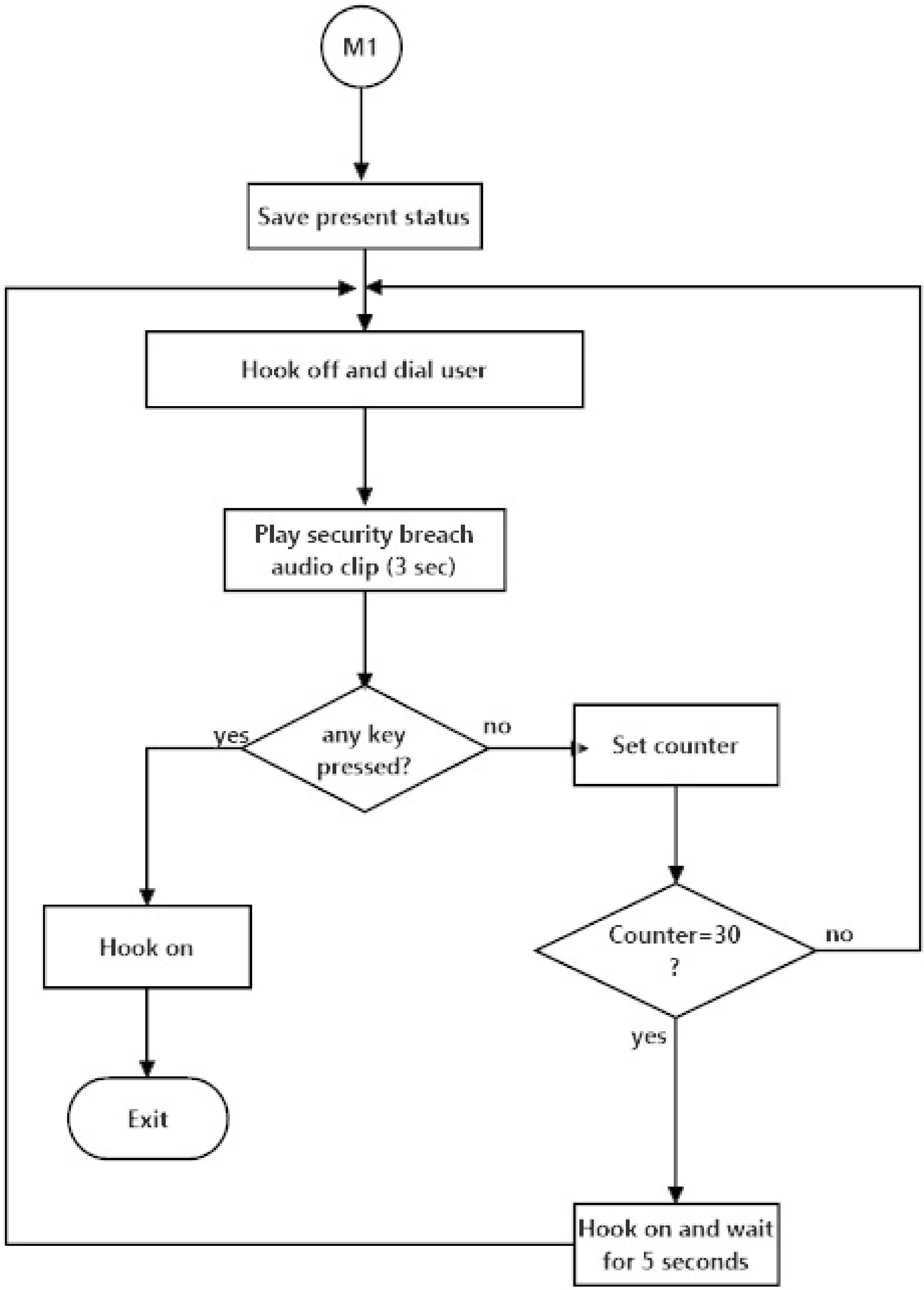

Figure 4.10 Home security flowchart

5. HARDWARE/SOFTWARE ELEMENTS

The system utilizes already installed PSTN, as already mentioned and thus final system will have various devices related to PSTN. The phase during the completion of the project however has been requiring various software and hardware for the system's testing and monitoring. The list of hardware and software that are being used during the process of project development are listed herewith.

5.1. Software Tools

5.1.1. Proteus

This is software which has been utilized for simulation of different circuits to be designed for the completion of project.

5.1.2. PCB Wizard

This is software that has been utilized to generate different circuit layout required in the project.

5.1.3. WinAVR (with open source plug-in)

This is software for writing the C-codes for the microcontroller and compiling them and finally converting them to the .hex format understood by the microcontroller.

5.1.4. HxDx

This is a hex editor. It has been used to analyze the files and disks at byte level.

5.1.5. AVR Burn-O-Mat

It has been used to burn programs into the microcontroller.

5.1.6. Livewire

Livewire has been employed to design circuit diagrams used in the reports.

5.1.7. IVONA Reader

This software has been used to generate sound clips used in the system using its text to speech feature.

5.2. Hardware Tools

5.2.1. AVR Microcontroller (ATmega8, ATmega32)

This is a device that forms the heart of our project. They have been used for generating various controls to different devices used in our system.

5.2.2. DTMF decoder (MT8870)

This is a device that generates the digital output for the digit that travels through the analog phone-line based on the frequency in the two lines.

5.2.3. LCD

This is a device that has been used to display.

5.2.4. DTMF Encoder (UM91215A)

This device generates the DTMF signals according to appropriate digital input.

5.2.5. SD Card

This module is used for storing the sounds for making the system interactive.

5.2.6. Other Discrete Components (transistors, resistors, capacitors, relays)

Various discrete components like transistors, resistors, capacitors, relays etc. are employed in different circuits that make up the total system.

6. LIST OF EQUIPMENTS

The hardware and software that are enrolled directly into the project are already listed. Alongside these hardware and software, we have been using various other equipment for running various tests to obtain the final result of our project. List of such equipment is presented herewith.

- Oscilloscope
- Function generator
- AVR programmer
- Telephone sets
- Telephone wires
- Various household appliances with switches.
- Various sensors (Temperature, IR)

7. RESULTS AND PROBLEMS FACED

7.1. Results

A complete system that can control home appliances and also provide home security has been developed. The system operates as expected. It is able to receive call from the user and control home appliances as per his/her direction. Moreover, the system is able to detect a condition of security lapse and inform the user about it.

Figure 7.1 Main control board

7.2. Problems Faced

Various problems were encountered during the development of the system in its complete form. One of the important problem was for testing of the circuits developed. The system required phone connection for testing at various stage of its development and which was not easily available to us. Moreover, various devices that were required were not easily available in the market and it aided to the problem. We were unable to accomplish the tasks at planned time due to this reason.

8. CONCLUSION AND FURTHUR WORKS

8.1. Conclusion

The project was really important in providing the knowledge on electronic devices and circuits. It helped us to know about exact applications of our theoretical knowledge. In true sense, our study of electronics and communication engineering was broadened. We were able to know the applications of various ICs, microcontroller, software tools and also the techniques to develop a PCB. The intensity of work that had to be carried out to complete a system was also made clear by the means of this project.

Moreover, the project was also useful in delivering a final product. We were able to extend the application of present available PSTN. A system capable of providing means to control household appliances and inform its user about the security issues in his house was developed in cost-effective and easy-to-use manner, using the PSTN. The final product of this project can be easily employed in any house, just by simple modification to the home circuitry presently available.

8.2. Further Works

The complete system is able to deliver its proposed task. In spite of this, various improvements and additions can be implemented into the system for its better performance. At first, for security part, when the system makes call to the user's mobile phone, the system assumes the user to be available all the time and when the call is established, after certain number of rings, the system plays the audio clip informing the user about the security lapse. The problem could be solved using call progress tone detection. The system could at first test for presence of 'dial tone' or absence of 'busy tone' before dialing the stored number. Moreover, the system could also test whether the call has been picked up by the user or not through the detection of voice or absence of 'ring-back tone'. Some task in form of simulation were actually carried out for this requirement of the system but the actual hardware development could not be carried out due to insufficient time and unavailability of phone line most of the times. Thus, this task has been placed under further work's title.

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