Dual Tone Multiple Frequency (DTMF) Based Automation System Using Goertzel DFT Estimation

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ABSTRACT: ***To control processes of his / her choosing, the human mind also needs knowledge of interest. Most methods of remote control systems have been developed in the age of technologically advanced electronic systems, these methods have the problems including the need for special hardware and software to operate the machine. In recent years, Automation Systems based on intelligent networks have been built in manufacturing, commercial and residential sectors. The concept of remotely controlling the devices can be introduced using various wireless technologies such as ZigBee, GSM / GPRS, Bluetooth, but these technologies require software creation, dedicated computers, and network setup schemes. Then implementation is time-consuming and they also make the program expensive. This paper introduces a more responsible, cost-effective Mobile Operated Automated System based on DTMF (Dual Tone Multiple Frequency) theory. It uses Mobile as the receiver end control system and existing Telephone Network infrastructure. The noise in the method is also reduced using Goertzel DFT estimation, and its full analysis is provided.***

KEYWORDS: ***Automated System, Mobile, DTMF (Dual Tone Multiple frequency), Goertzel DFT, noise reduction.***

INTRODUCTION

The branch of a robotics is the basis root of developments in today's technology from which it is brought our thoughts into working condition. To make a more sophisticated device, a mixture of various technologies can be linked together, and so it is done in this study. This bot being easily adaptable is and will be the most critical feature of development in the current and future world. This bot's approval for our society derives from the easy-to-reach technology implied on it. As far as this bot is concerned, it is essentially a farming robot that can be used by users according to their requirements with timely modifications due to the ability of bot to infer logic and its abstraction capacity[1].

With the advent of technology and the implementation in the industrial and commercial environment of network-enabled automation system, devices can be operated and managed from remote location. It can be done by the introduction of networks, along with support for different wireless technologies such as ZigBee [2], Bluetooth, and UWB [3] etc. Automated systems have been rapidly growing and potentially evolving because it makes it easier for the consumer to arrange the appliances and devices according to their convenience.

These systems deal with setting up a network that connects peripheral computers, smart chip-bearing appliances and sub-systems. It promises cautious real-time control of electrically controlled devices from remote location. But these implementations again require communication through radio links or wired communication. Each has its own limitations, be it wired or radio link communication, such as complex wire installation, maintenance, range restrictions, low data rate, high cost, software arrangements etc.

This paper have suggested a framework that provides equivalent operations of remote location control equipment, but using the concept of mobile DTMF. Installed at a site, this mobile controlled switching unit is capable of controlling mains, powered loads and devices with the help of commands received over a phone. Any telephone or cellular (DTMF) collection may be used to send commands to the switching unit [4]. A broad range of applications is feasible in different fields such as household, commercial, office, educational, telephone answering machine, interactive voice response system (IVRS) applications etc. The main advantage of this system is that it makes use of telephone infrastructure already established, and no additional investment is required [5].

Many systems such as low cost GSM / GPRS based wireless home protection system have been proposed in this area. The device is a wireless home network that includes a GSM / GPRS gateway and three types of wireless security sensor nodes including door security nodes, infrared monitoring nodes and fire alarm nodes. But as it is based on GSM, in a situation of low network coverage the program falls short. The paper which proposes home automated systems based on Bluetooth technology enabling control of devices is presented in paper. But the downside here is that Bluetooth technology usually provides a short range of 50 meters. A device is also implemented using the wireless personal area network ZigBee which facilitates the intrusiveness of the respective installation. The wireless network specified in implements new home application with a high bandwidth using 802.11 technology. Yet this very costly device again reduces consumer viability. All these papers suggesting automated systems have some drawbacks as deployed nodes can cause network congestion, entire infrastructure has to be built from the initial level, which is time-consuming and in nature complex.

Our proposed program uses DTMF technology that can be applied in a range of applications such as agricultural, manufacturing, and domestic household applications. Cell network coverage is greater than Local Area Network (LANs) coverage, and users can take advantage of mobile phones to coordinate the system. The presented device is more important than the infrared remote controller, because the protected range is greater and it allows remote monitoring. It also surpasses any other wireless communication method, since it provides a solution that allows low cost and simpler accessibility. The key advantages of this program are set out below:

- No cap on distance (range).
- Switching immediately, without hesitation.
- Less needed hardware components.
- Cost efficient call charges are low.
- Less power consumption compared with other installations.
- Existing telephone network infrastructure also can be abused.
- Switching unit is compatible with telephone collection of any kind.
- User is able to access and connect desired load no.

This paper is structured as follows; Section II outlines the DTMF working theory and the Goertzel DFT calculation for minimizing system noise. Section III describes the proposed system and illustrates the system's advantages. Section IV includes the implementation of the circuit for each device operationally and supports the application of Goertzel DFT with its complete review.

PRINCIPLE AND GOERTZEL DFT ESTIMATION OF DTMF WORKING

Dual-tone multi-frequency signaling (DTMF) is used for telecommunication signaling over analog telephone lines, in the voice-frequency band. The frequencies used in the process of transmitting information are classified into: Low Band Frequencies and High Band Frequencies. The variant of DTMF that is used in push-button telephones for tone dialing is known as Touch-Tone. The DTMF device uses 8 separate, pair-transmitted frequency signals and are represented as sine wave tones. They represent 16 unique numbers, symbols and letters. In our device, each character (frequency pair signal) when pressed and transmitted over the network acts as a control command guiding a load at the receiver end. A 12 key-pad is used, with a central arrangement of 3x4 matrix. The keys for digits 0-9 symbols, * and # are arranged in 4 row keypads and 3 rectangular matrix columns shown in Table I.

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

Table I: Frequency/Key Matrix for DTMF Keypad.

When the user presses the key corresponding to a digit to send commands to control a load, the tones are produced that are identical to its row and column. The technique of producing two different tones which are not harmonically connected to each other removes voices which are unintentionally generated as a valid pair. Such tones can be decoded in our system using the DTMF decoder IC as well as the Goertzel DFT algorithm. Use the algorithm makes noise interference with the signal easier to reduce. Since the analog signal is converted to digital pulse, noise is reduced. The optical tone detection can be accomplished by calculating the energy present in the received signal, according to Goertzel estimation. Each symbol can be divided by simply taking the maximum energy portion into the lower and upper frequency groups shown in figure 1. And can be converted to analog signal for further processing again at the receiver.

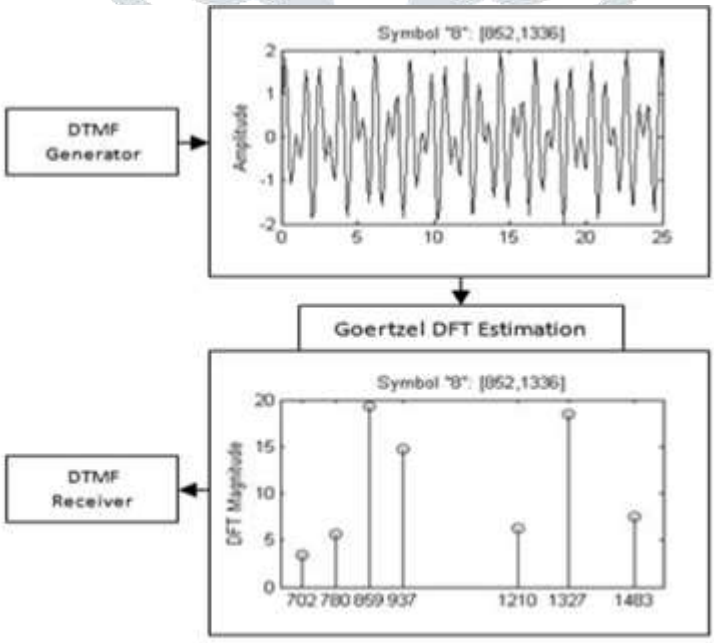

Fig. 1: Goertzel DFT Estimation of Tones Generated

PROPOSED SYSTEM

The proposed system consists of two main sections: the User side (DTMF facilitated cell phone) and the Application End Controller Unit (AECU) side of the receiver as shown in Fig. 2 which is used where the devices and loads must be monitored and controlled. One should note that the system operates in two distinct modes [6].

Implementation of DTMF decoder MT8870D-1, Implementation of Goertzel Algorithm Therefore, two programmed ICs are used to evaluate the operation of the machine in the respective mode. The principal benefit of implementing the Goertzel DFT algorithm is that it removes the DTMF decoder IC requirement. During a time of operation only one mode can be involved [7].

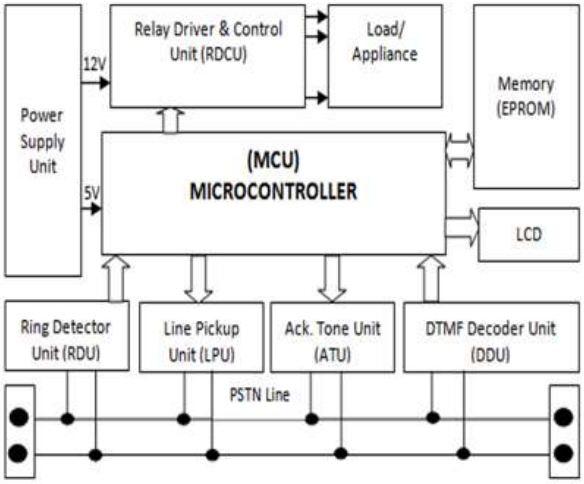

Fig. 2: Block Diagram of Application End Controller Unit

The AECU is attached to the telephone apparatus in parallel and does not disrupt telephone use in any way. Once the user dials the number from anywhere in the world using the cellphone, he can turn on / off any of the 8 relays remotely. The Aurdino board with ATmega328 [8] micro controller (MCU) on the telephone ring senses interface and an automatic phone pick-up becomes available. It then gives the user the options for managing the loads. The consumer will pick the load and thus control the relay switching. This device uses the popular MT 8870 DTMF Decoder IC along with the system implemented by Aurdino MCU (for 1st mode of operation) and the Goertzel algorithm (for 2nd mode of operation). The system is so programmed that the receiver automatically sends an acknowledgment tone to the caller after six rings that a six-digit password number must be entered. The program authenticates the user after entering a correct password and it is only then that the user can enter the load control commands. But if the password is incorrectly entered four times in a row, an alarm sound is produced and the receiver gets disconnected. This role thus prevents any attempts by hackers to successively enter large numbers of codes.

IMPLEMENTATION AND ANALYSIS OF SYSTEM

The entire system is proposed based on the concept of existing telephone infrastructure and thus enables remote control of loads allowing the user to turn them ON / OFF according to the requirement. The smartphone allowed DTMF, and the PSTN phone serves as a means of contact between the user and the device. When it initializes the program. A LCD which indicates that the device is waiting in the form of a call (ring) for user input. When the user calls the machine the signal below is recorded. In nature the calculated values are approximately + 35V/-35V analog.

Ring Detector Unit (RDU)

The signal is transmitted to the circuit through bridge rectifier when the device is called up. The Ring Detector Circuit (RDU) function is to detect the occurrence of any incoming ring and to automatically pick up the call, enabling the user to provide an acknowledgment so that further commands can be received. MCT2E Opto coupler is used, as the signal polarity can be made significant for a longer period of time due to the bridge rectifier. The ring signal is an ac voltage, which passes to the bridge rectifier via the capacitor C2. As this voltage is as high as 60 volts an opto coupler is used before the microcontroller input. C1 guarantees that the opto coupler meets only the ring signal, and not the dc offsets [9].

The machine counts the number of rings after each ring, and decreases the counter by one. The machine waits for 6 rings to automatically pick up the call, and then defends its core intent to automatically pick up the incoming call. The security protocols programmed in it ensure that only authorized users gain access to the network after the call is connected and the device is turned on. The framework is thus built with a security password itself in the initial phase to protect and authenticate legitimate user access

DTMF Decoder Unit

DTMF Decoding mode1: Instead of the Goertzel algorithm, when the implement the DTMF decoder IC, device is said to be running in Mode1. In this mode DDU decoder IC decodes the commands entered by the user to control the loads. The framework is implemented with a full DTMF receiver, the MT8870D-1 [6]. It uses the technique of digital counting to detect and decode all 16 DTMF tonepairs to a 4-bit string. The frequency decoder accepts the user order and decodes the input data stream that the Aurdino is processing further. DTMF Decoding mode-2: The device is said to be run in mode-2 when the AECU is run bypassing the DTMF decoder IC with the implementation of the Goertzel DFT algorithm. Unlike our method, only system was implemented by the Goertzel algorithm. In mode-2 the commands entered by the user to monitor the loads are decoded by MCU according to the received Goertzel DFT signal. Find the portion of the maximum energy in the lower and upper frequency groups as the desired one.

Acknowledgment Tone Unit

If the loads are handled effectively, the user earns an acknowledgment. An ATU circuit is planned and implemented with the intention of intimating the user. By sending desired commands more devices can be handled further. Upon completion of the execution, the machine auto hangs the line to end the operation. As the Aurdino drives Q1, it is turned on and off at a frequency of 325 Hz and introduces an additional alternating current of 2 mA. That causes a tone for the caller to hear. This sound is used to acck. User when the commands are completed or when there are any errors in the order. This also makes auto line pick-up simpler, because the signal transmission to the telephone line is through two transistors. The device is built in such a way that Q1 generates a line current of about 20mA which corresponds to the receiver being raised.

Relay Driver and Control Unit

The Relay Driver and Control Unit (RDCU) comprises eight identical switched relay positions to handle the loads, input power and data positions to drive the relays via 10 Pin SIP connector. The BC547 NPN transistor Q1 functions as a relay driver. The circuit diodes protect the transistors against the back-emf that happens when the relay is turned off and the magnetic field collapses [10].

CONCLUSION

The introduced system primarily operates the public switched telephone network (PSTN), which involves remote control of devices using DTMF-based tone system. It allows complete duplex communication between user and Application End Controller without interrupting standard PSTN Line communication. This can be achieved as the device is conceived and connected to the line using parallel communication. The agreed range for exchanging the signals is also not limited, as it uses the widespread PSTN infrastructure already deployed.

Overall this paper introduces a safe load / device control strategy using DTMF theory that is cost-effective over other wireless technologies. This approach has been applied using 2 G mobile communications network, and because there is no need to install a whole new infrastructure, but leverage the existing telephone network, the program is highly qualified. Two device operating modes viz mode1: are defined with DTMF decoder IC and mode2: with Goertzel DFT algorithm to decode the received encoded signals.

It is then proven that the noise influencing DTMF signals was effectively suppressed by applying the Goertzel DFT algorithm. All of these factors make this system a safer way to transmit control signals and receive alerts from a remote location.

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