

Wireless Home Automation System with Acoustic Controlling

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Abstract—The proposed paper presents the design and implementation of a wireless home automation system with acoustic controlling. In this system, one voice recognition module has been added to the wireless network. The automation process will be done using recognition of voice commands and the Radio Frequency technology. The voice commands in this system are person independent. The proposed system has transmitting and receiving sections. Initially, the voice command is stored in the memory of voice module using the functions keys arranged. The input voice fed is processed in the voice recognition system where the feature of the voice command is extracted and matched with the pre-loaded voice commands. The module recognizes the voice and sends control messages to the microcontroller. The receiving microcontroller then processes the received data and switches the respective appliances via connected driver circuits.

Index terms: Driver Circuit, Micro Controller, RF, Voice Recognition Module and Zigbee.

I. INTRODUCTION

Home automation is one of the major growing industries that can change the way people live. Some of these home automation systems target those seeking luxury and sophisticated home automation platforms; others target those with special needs like the elderly and the disabled. The aim of the reported Wireless Home Automation System is to provide those with special needs with a system that can respond to voice commands and control the on/off status of electrical devices, such as lamps, fans, television etc,. The system should be reasonably cheap, easy to configure, and easy to run. The perfect user interface still does not exist at present and to build a good interface requires knowledge of both sociology and technology fields. According to major companies that are involved in speech recognition researches, voice will be the primary interface between humans and machines in the near future. Researchers have investigated the possibility of using voice activation in cars to enable hands free controlling. Recently, a Hidden Markov Model

(HMM) based speech recognition system was implemented in to enable voice activated wheelchair controlling. The performance of the speech recognition in home environments depends on the implementation of the speech recognition system interfaced with the smart chip called microcontroller with proper programming. The main contribution of this paper is proposal, implementation and evaluation of a microcontroller based voice activated wireless home automation system for assessing the feasibility of using voice as the unified control method in real wireless home environments.

II. RELATED WORK

A. *Hidden Markov Model (HMM)-Based Speech Recognition*

The reason why HMMs are popular is because they can be trained automatically and are simple and computationally feasible to use. HMMs to represent complete words can be easily constructed (using the pronunciation dictionary) from phone HMMs and word sequence probabilities added and complete network searched for best path corresponding to the optimal word sequence. HMMs are simple networks that can generate speech (sequences of cepstral vectors) using a number of states for each model and modeling the short-term spectra associated with each state with, usually, mixtures of multivariate Gaussian distributions (the state output distributions). The parameters of the model are the state transition probabilities and the means, variances and mixture weights that characterize the state output distributions. Each word, or each phoneme, will have a different output distribution; a HMM for a sequence of words or phonemes is made by concatenating the individual trained HMM for the separate words and phonemes. Current HMM-based large vocabulary speech recognition systems are often trained on hundreds of hours of acoustic data. The word sequence and a pronunciation dictionary and the HMM training process can automatically determine word and phone boundary information during training. This means that it is relatively straightforward to use large training corpora. It is the

major advantage of HMM which will extremely reduce the time and complexity of recognition process for training large vocabulary.

B. Speech Recognition using HM2007

The heart of the project is the HM2007 speech recognition integrated circuit. The chip provides the options of recognizing either forty 0.96 second words vocabulary or twenty 1.92 second words vocabulary. For memory the circuit uses an 8K X 8 static RAM. The chip has two operational modes; manual mode and CPU mode. The CPU mode is designed to allow the chip to work under a host computer. This is an attractive approach to speech recognition for computers because the speech recognition chip operates as a co-processor to the main CPU. The job of listening and recognition doesn't occupy any of the computer's CPU time. When the HM2007 recognizes a command it can signal an interrupt to the host CPU and then relay the command code.

The HM2007 chip can be cascaded to provide a larger word recognition library. Speech recognition is classified into two categories, speaker dependent and speaker independent. Speaker dependent systems are trained by the individual who will be using the system. These systems are capable of achieving a high command count and better than 95% accuracy for word recognition. The drawback to this approach is that the system only responds accurately only to the individual who trained the system. This is the most common approach employed in software for personal computers. Speaker independent is a system trained to respond to a word regardless of who speaks. Therefore the system must respond to a large variety of speech patterns, inflections and enunciation's of the target word. The command word count is usually lower than the speaker dependent however high accuracy can still be maintain within processing limits. Industrial requirements more often need speaker independent voice systems, such as the AT&T system used in the telephone systems.

C. Controlling Circuit

The Controlling circuit comprises of two sections: Transmitting section with 8052 microcontroller and Receiving section with ARM9. Wireless module is connected to each one of the port of 8052 microcontroller and ARM9.

1) ARM9: (Mini2440 / S3C2440 ARM9 Board):

The S3C2440A is developed with ARM920T core, 0.13um CMOS standard cells and a memory complier. Its low power, simple, elegant and fully static design is particularly suitable for cost- and

power-sensitive applications. It adopts a new bus architecture known as Advanced Micro controller Bus Architecture (AMBA). The reason why ARM9 is preferred in this system is to accommodate advance functionalities of viewing the appliances on display which are operating and can be connected to an high speed internet through which the appliances can also be operated.

2) 8052 Microcontroller:

The 80C52 is a high-performance static 80C51 design fabricated with high-density CMOS technology with operation from 2.7 V to 5.5 V. The 8x52 contain a 128 x8 RAM and 256x8 RAM respectively, 32 I/O lines, three 16-bit counter/timers, a six-source, four-priority level nested interrupt structure, serial I/O port for either multi-processor communications, I/O expansion or full duplex UART, on-chip oscillator and clock circuits. In addition, the device is a low power static design which offers a wide range of operating frequencies down to zero.

3) Wireless (Zigbee) module:

Zigbee protocol is the communication protocol that is used in this system for wireless communication. Zigbee offers 250 kbps as maximum baud rate, however, 115200 bps was used for sending and receiving as this was the highest speed that the UART of the microcontroller could be programmed to operate at.

III. SYSTEM IMPLEMENTATION & RESULTS



Figure1. Block Diagram of Wireless Home Automation System with Acoustic Controlling.

A. System Functionality

At first the required voice commands are stored in the 8 bit CMOS static RAM using function keys available on the voice recognition board. The commands can be stored as per user flexibility like "Device-1 ON" which acts as a sample voice. Then, the actual voice is fed into the HM2007 module after amplification by an audio power amplifier LM380. Whatever the voice received by the speech processor

that is stored in the 74HC573 memory chip. The parameters of received voice are matched with the pre-existed voice in the voice processor memory. The 7-segment LED display driver IC is driven by the chip 74HC573 which allows the user to connect to the microcontroller input output ports. 7-segment LED display is driven by IC CD4511B. Whenever the module recognizes the actual voice, control messages or signals are sent to the microcontroller at Transmitter Section. It must be noted that the voice processor cannot produce sufficient current to drive the controller directly. The output from the DTMF decoder must be compatible with the microcontroller because the microcontroller can take 5V as input voltage and can give 5V as output voltage which can overcome by signal conditioning circuit. The transmitting microcontroller then processes the received data and sends its control signal to the receiving controller where the respective code will execute to switch ON/OFF using the driving relays.

Algorithm

Step 1: Initialize all the module processes.

Step 2: Store sample voice commands required in the HM2007 speech processor memory using function keys.

Step3: Provide the input voice command corresponding to the appliance control which is already stored in HM2007 Memory.

Step 4: When the input matches with sample voice stored, then send control signal to the transmitting controller. Else display error value on 7-segment display of HM2007 speech processor.

Step 5: Received control signal from speech processor is now modulated with Zigbee transmitter and send to receiving section Zigbee receiver.

Step 6: Received modulated signal from transmitting section is now demodulated to original control signal and is fed to receiving controller.

Step 7: If the control signal ID is matched with the pre-existing appliance ID then the controller drives corresponding appliance to switch ON/OFF by executing the code written.

Step8: Stop the process when no voice input received by speech processor.



Figure2: Transmitting Section with HM2007 and 8052 microcontroller

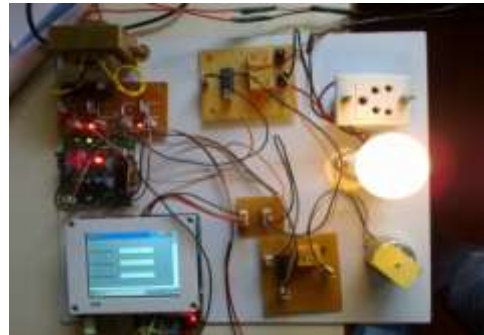


Figure3: Receiving Section with ARM9 and Home Appliances

Firstly a certain user's voice is recorded by a recorder (the tone, the speed and the content are all same), then the record is compared with the real voice for certain times within different distance. After some experiments by recorder the time of passage of uncertain users is zero in the results. The experiment result is very ideal for family users. When speakers are apart from the microphone farther the identification ratio descends obviously. The reason is that the ratio of the energy of useful voice signals and noise signals descends gradually; distortion appears when characteristic distilling and lastly leads to inaccessibility requests in module match.

IV. CONCLUSION

The response with different values of the input frequency shows a good and accurate rise time, fall time, duty cycle and pulse width. The system has practical coverage up to few meters. Confirmative voice with specific voice pitch and frequency is desired by the speech recognizer used in this system to produce better recognition results. The system controls extended and multiple home appliances by using speech recognition technology.

V. FUTURE SCOPE

The current system limits its application in noise free environment. Future studies should aim at making it insensitive to noise by introducing proper noise filter into it. By making advanced and partial modifications, this project can be used in acoustic control of vehicle's braking systems thus reducing risk of accidents. It can be applied in various applications such as voice activated wheel chairs, robotic control appliances, aerospace etc.

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