Voice Recognition Based Wireless Room Automation System

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***Abstract*—In this 21st century, there has been a remarkable change in the field of Room Automation due to the introduction of improved voice recognition & wireless technologies. These systems are supposed to be implemented in the existing infrastructure of any home without any kind of changes in the existing connections. This system is most suitable for elderly and physically challenged person those who have difficulty in moving around from place to place. The voice recognizing feature of this system also provides a security aspect to this system. The physically challenged [1] persons would be able to control various home [2] appliances by their mere voice commands according to their need and comfort. The Room Automation system is intended to control lights and other electrical appliances in a room using voice commands. So in this project our aim is to design and implement a voice recognition wireless based room automation system.**

Keywords— data acquisition; embedded systems; FSK modulation demodulation, voice recognition; relay drivers.

I. INTRODUCTION

In recent years there have been various researches and developmental work in the domain of voice recognition [3] and room automation. This system is designed to incorporate both these domains to come up with Voice Recognition Based Wireless Room Automation System. The system mainly comprises of three independent stand-alone embedded systems which can be interfaced with each other through wired or wireless media. The embedded system comprises of a Voice recognition module, encoding and transmission module along with decoding and reception module.

The voice recognition based room automation system uses HM2007L IC [4] to identify the voice speech or commands of a specific user. The command recognized by the device is being checked and verified with that of the stored voice speech database from an individual in order to confirm the user identity. Once the identity is found, the corresponding data is being sent from the microcontroller [5] to the encoder for specific encoding techniques to be applied. The encoded data is transferred to the modulator for generation of FSK [6] signal in order to transmit it via an antenna to a remote or far away receiver. The FSK modulated signal is received by the receiving unit for demodulation and successive decoding purpose so as to obtain the desired voice command of the user. The decoded data obtained from the output of the decoder is again compared with the predefined set of data for further checking of valid transmission. If matching is established, the corresponding relay is either energized or de-energized through a relay driver for turning ON or OFF the desired electrical appliance in accordance with the voice command.

II. OVERVIEW

The voice command, *i.e*. the voice signal is given to the microphone connected to a noise eliminating filter. The extraneous noise is filtered out and the required voice command is converted into an analog signal is fed to the voice recognition module. At first this module is trained by the commands, with which the user wishes to control the system, and they are stored in 8K X 8 SRAM.

Then the voice matching part is done by the HM2007 and the corresponding 8bit data output is fed to the microcontroller [7]. The microcontroller generates the modulating signal that is transmitted via an antenna, after it has been encoded and modulated (FSK Modulation of range 3.8MHz-5.8MHz). This signal is received, demodulated, decoded at the receiver end and is fed to the microcontroller, connected with the relays through relay driver. As the microcontroller of the receiver end reads the decoded bit pattern, it follows a sequence to energise or de-energise a relay.

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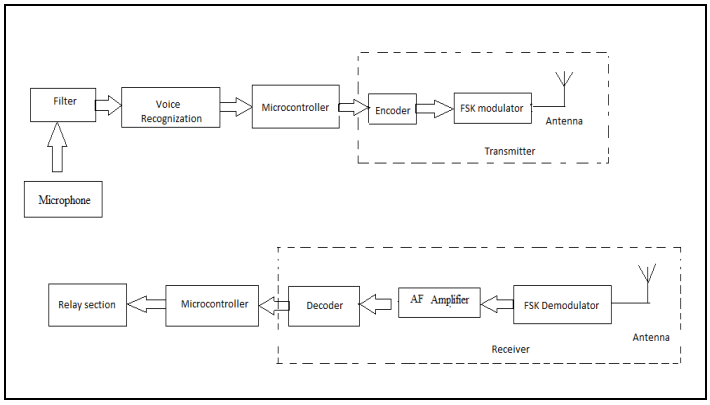


Fig. 1. Block Diagram of Voice Controlled Room Automation System

III. HARDWARE IMPLEMENTATION

This system mainly comprises of three independent stand alone modules. The voice recognition module, the transmitting module and the receiving module. The embedded system is having the microcontroller as central processing unit along with other peripheral devices for encoding, modulation, decoding, demodulation, transmission and reception of the data over a communication link. The microphone connected to the voice recognition module serves the purpose of the sensing unit which senses the voice command of the individual. The reception module is connected to a driver based relay system which is connected to several different electrical appliances which are to be controlled by voice commands.

A. Voice Recognition

HM2007 is a CMOS voice recognition integrated circuit that supports voice analysis, recognition process and system control functions. It is a 40 isolated-word voice recognition system that has external microphone, keyboard, 8K X 8 Static RAM. The speech recognition system is trained with the words, the user want the circuit to recognise. The system can accept voice samples from multiple users, in any language and can identify the user as well as the command by matching it with the trained voice samples. The system will generate an error code (77H) if a user gives any command which he did not train, or that has been trained by some other user.

A microphone is used to take the voice signals as an input. The signal is filtered from the extraneous noise by a noise eliminating filter [7]. Initially the system is trained by storing the voice signal at the user specified location of the 8K X 8 SRAM by the HM2007, and this data will be used by the HM2007 to recognize the voice commands given by the user, during its operation. An 8 bit data corresponding to the location of the voice signal will be generated as the output if the given command matches with the trained command, else an error signal 55H(word too short), 66H(word too long), 77H(no match found) will be generated by the system.

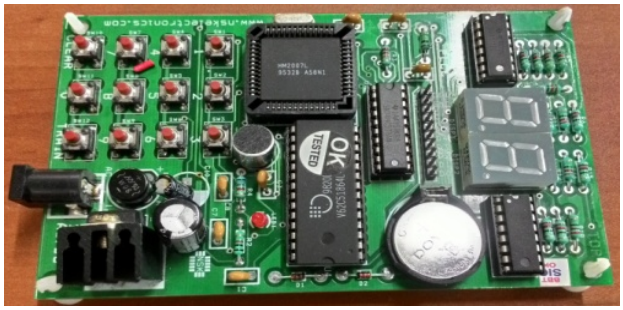


Fig. 2. HM2007 based Voice Recognition Unit

B. Transmitting End

The 8bit data from the voice recognition system is fed to the microcontroller. The microcontroller generates the signal to be transmitted (4bit at a time). This signal is encoded with the receiver address for secure communication (the address of the encoder should match with the address of the receiver), it is then modulated using FSK modulation technique and transmitted through an antenna.

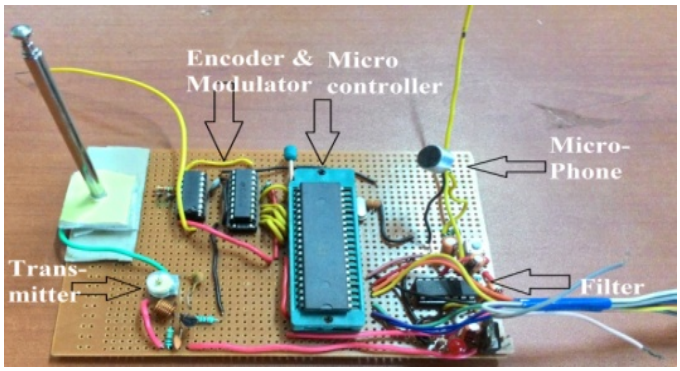


Fig. 3. Transmitting Unit

C. Receiving End

The modulated signal is received at the FSK demodulator. The demodulated output is fed to the decoder. The decoder matches the address bits, from the demodulated signal, with its own address bits and gives this signal in parallel form to the microcontroller, which on receiving the data from the decoder energizes or de-energizes the designated relay, to switch the appliances ON or OFF.

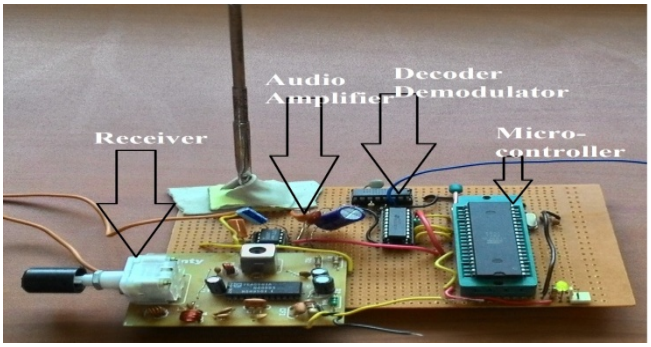


Fig. 4. Receiver Unit

D. Test Circuit

During the testing procedure, the circuit is connected for the testing purpose. A 12V power supply is connected with the HM2007 module. The transmitting and receiving module is also fed with power from the same unit. Two antennas are provided on the transmitter and receiver module for communicating with each other. A relay board consisting of a relay driver along with several relays connected to different electrical appliances. Supply is connected to the relay unit is directly connected with the A.C mains supply.

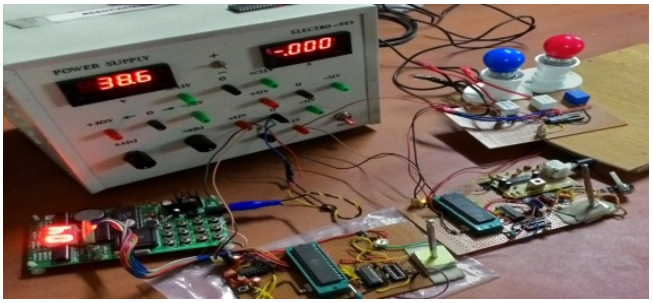


Fig. 5. Complete hardware set up.

IV. Software Implementation

Flowchart for Microcontroller for receiving and transmitting units.

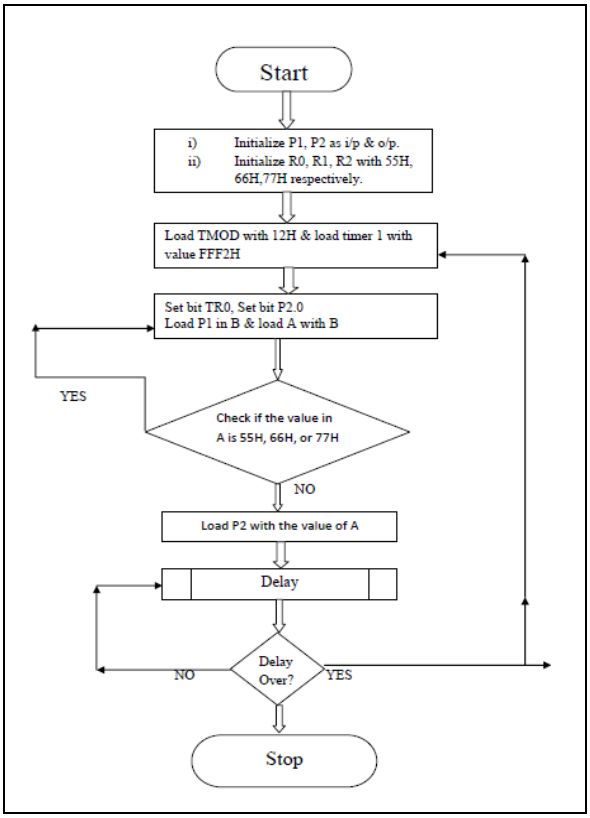


Fig. 6. Flowchart for the transmitter unit.

At the start of the program port P1 and port P2 are initialised as input and output respectively. The registers R0, R1, R2 are initialised with 55H, 66H, and 77H respectively. The TMOD register is initialised to operate the Timer 0 in auto reload mode and Timer 1 in normal mode. The data from port P1 is stored into register B. The data loaded to the accumulator is compared with the values 55H, 66H &77H, if this data matches with any of the above mentioned values then it restarts the program by initialising the timers and there will be no transmission. If this condition is not satisfied then it will send the lower nibble followed by the upper nibble, of the data stored in register B, to the output port P2 with a delay of 100ms between them.

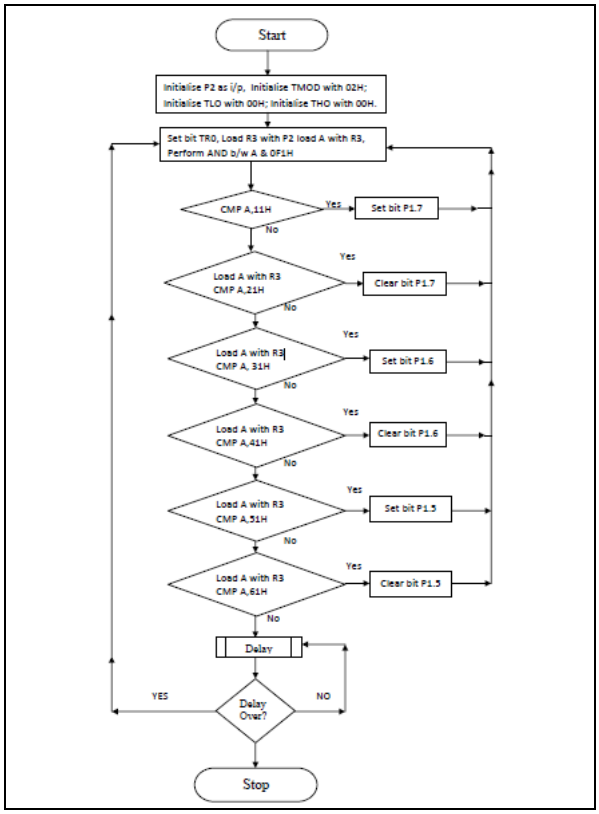


Fig. 7. Flowchart for the Receiver Unit

In the receiving end port P2 is initialised as input, TMOD is initialised to operate in an auto reload mode. Logical AND operation is performed on the received data with 0F1H. The resultant data [2] is compared with the expected values 11H, 21H, 31H, 41H, 51H, and 61H. If the received data matches with 11H then Relay1is excited and the program restarts by re-initialising the TMOD, else the received data is compared with the next expected value and a designated relay is energised or de-energised, this is continued until the received data does not match with 61H. If the data does not match with any of the expected values the received data is discarded and the program is restarted by re initialising the TMOD timer.

V. Result and Discussion

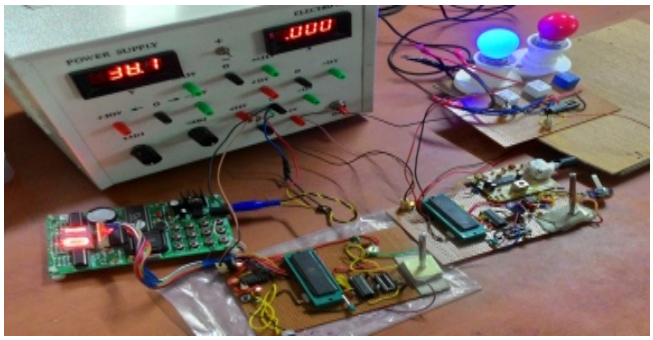


Fig. 8. Test condition 1

In the picture above the voice command “Light1 On”, stored in the SRAM memory location 01 of the HM2007, is given as input. The data 01H generated here is transmitted 4bit at a time, after encoding and modulating it in FSK modulation technique. This data is received in the receiver end which is demodulated, decoded and is fed to the microcontroller here to generate a pattern (i.e. xx1x xxxx) to energize the relay 1. Thus the blue light is switched ON.

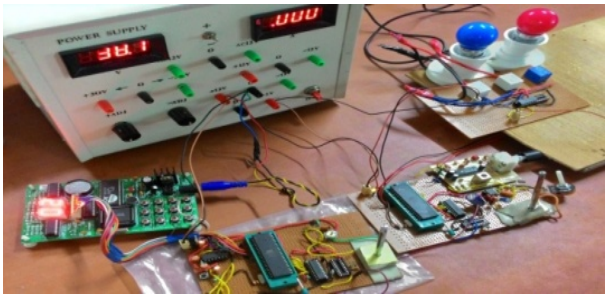


Fig. 9. Test condition 2.

In the picture above the voice command "Light1 Off", stored in the SRAM memory location 02 of the HM2007, is given as input. The data 02H generated here is transmitted 4bit at a time, after encoding and modulating it in FSK modulation technique. This data is received in the receiver end which is demodulated, decoded and is fed to the microcontroller here to generate a pattern (i.e. xx0x xxxx) to de-energize the relay 1. Thus the blue light is switched OFF.

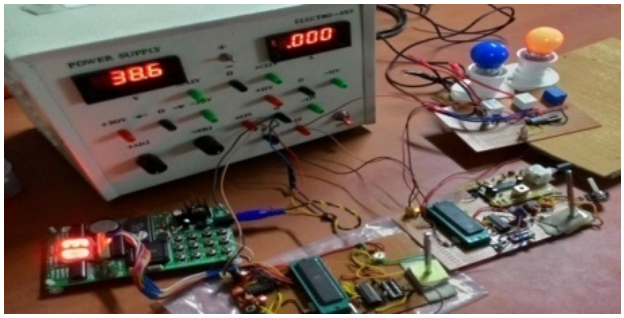


Fig. 10. Test condition 3.

In the picture above the voice command "Light2 On", stored in the SRAM memory location 03 of the HM2007, is given as input. The data 03H generated here is transmitted 4bit at a time, after encoding and modulating it in FSK modulation technique. This data is received in the receiver end which is demodulated, decoded and is fed to the microcontroller here to generate a pattern (i.e. x1xx xxxx) to energize the relay 2. Thus the red light is switched ON.

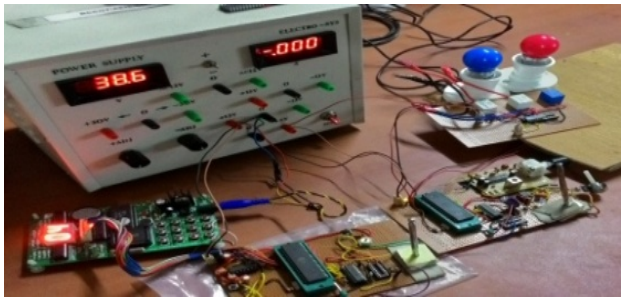


Fig. 11. Test condition 4.

In the picture above the voice command "Light2 Off", stored in the SRAM memory location 04 of the HM2007, is given as input. The data 04H generated here is transmitted 4bit at a time, after encoding and modulating it in FSK modulation technique. This data is received in the receiver end which is demodulated, decoded and is fed to the microcontroller here to generate a pattern (i.e. x0xx xxxx) to de-energize the relay 2. Thus the red light is switched OFF.

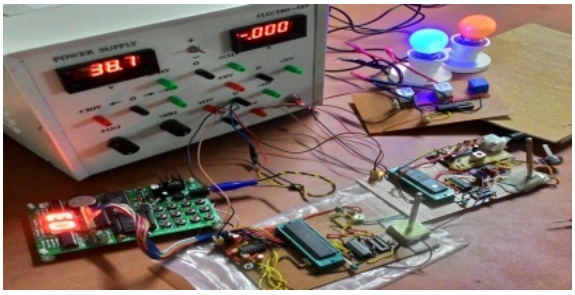


Fig. 12. Test condition 5.

In the Fig. 12 both the lights are switched ON by giving the voice commands "Light1 On" followed by "Light2 On" as input to the voice recognition circuit

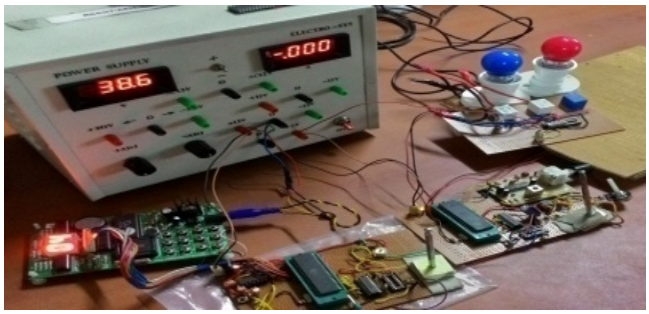


Fig. 13. Test condition 6.

In the picture above both the lights are switched OFF by giving the voice commands "Light1 OFF" followed by "Light2 OFF" as input to the voice recognition circuit.

TABLE I. BIT PATTERN AND CORRESPONDING MEMORY ADDRESS AT TRANSMITTER SIDE

Sl. No	Voice command	Memory Address	Bit Pattern
1	Light 1 ON	01	0000 0001
2	Light 1 OFF	02	0000 0010
3	Light 2 ON	03	0000 0011
4	Light 2 OFF	04	0000 0100
5	Fan ON	05	0000 0101
6	Fan OFF	06	0000 0110

TABLE II. BIT PATTERN AND CORRESPONDING RELAY STATE IN THE RECEIVER SIDE

Sl	Bit Pattern Received	Microcontroller Output	Relay 1	Relay 2	Relay 3
1	0000 0001	xx1x xxxx	ENERGISED	Unchanged	Unchanged
2	0000 0010	xx0x xxxx	DEENERGISED	Unchanged	Unchanged
3	0000 0011	x1xx xxxx	Unchanged	ENERGISED	Unchanged
4	0000 0100	x0xx xxxx	Unchanged	DEENERGISED	Unchanged
5	0000 0101	1xxx xxxx	Unchanged	Unchanged	ENERGISED
6	0000 0110	0xxx xxxx	Unchanged	Unchanged	DEENERGISED

TABLE III. VOICE SAMPLE BY DIFFERENT USERS FOR"LIGHT ON"

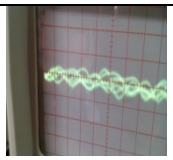
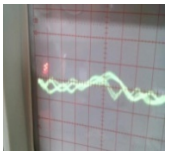
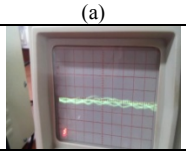
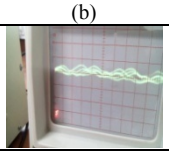
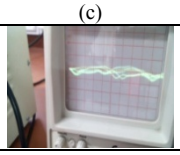
		
(a)	(b)	(c)
		
(d)	(e)	(f)
Voice Sample by different users for "Light On"		

TABLE IV. DIFFERENT VOICE SAMPLES BY THE SAME USER

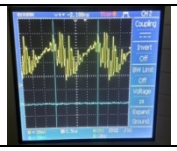
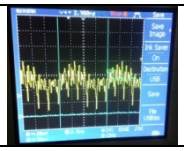
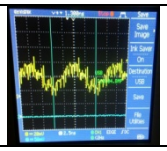
		

Fig. Voice Command "Light"	Fig. Voice Command "On"	Fig. Voice Command "Off"

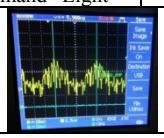
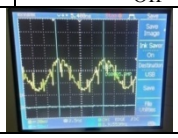

	

Fig. Voice Command "Light On"	Fig. Voice Command "Light Off"	
Different voice samples by the same user		

The Table III and Table IV show the voice samples generated by different users for the command "Light On" and the voice samples for the commands "Light", "On", "Off", "Light ON" and "Light Off" by the single user respectively. The discrete pattern of each of the commands are saved in the SRAM connected with the HM2007 IC, and will be used to compare with the instantaneous voice signals from the user(s) to generate a 8bit code corresponding the outcome of the reorganization process.

CONCLUSION

On the basis of the above training and texting procedures, it is evident that the above Voice Recognition System is an efficient one for users who are unable to move freely in their houses and for disabled persons. This system can also incorporate the aspect of switching ON and OFF the entire process of a house by interfacing it with the MCB board. The system uses an 8bit addressing system to select the desired transmitter and receiver pair. This enables the transmitter side to communicate up to 256 different receiving hubs; each assigned a different address, installed in different rooms by using one single transmitter, by changing the transmitter side address. The system also incorporates a manual override setting that overrides the voice recognition with manual selections from the keyboard acting as a portable controller for the devices associated with the setup. In future, this system can be enhanced by including further security aspects like Biometric and Image Processing Modules in order to restrict any intruder or stranger from entering and operating the household appliances and devices.

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