

## Voice Controlled Intelligent Remote for Consumer Electronics

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**Abstract:** Census has revealed that over 21 million people in India have been suffering from one or other kind of disability. This is about 2.1 percentage of total population. Among the total disabled in the country, 27.9 percentage persons are having functional movement disorder. Hence intelligent remote is proposed and developed to help physically challenged people and patients in the hospitals with limited motor skills in hand. The proposed device take the voice command of physically challenged people and generate equivalent infra red signal for a consumer devices. Low power embedded raspberry pi convert the voice command to text and 8051 based system generates infra red signal as per text command. Thus, the proposed system is implemented and tested in real time.

**Key words:** IR generation • Transmitter • Raspberry pi • MCS8051

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### INTRODUCTION

As per Census, more than 21 million people in India are suffering from different kinds of disability [1]. Physical disability becomes a major obstacle in the lives of physically challenged people and they are not able to perform their day - to-day activities without help of other people [2]. Most of motor impaired users use computers as their communication device [3]. Thus voice based system can be beneficial for such physically challenged people.

The idea of interaction between human and machine led to research in Speech recognition. Automatic speech recognition system involves conversion of speech into text. Speech recognition offers greater freedom to employ the physically handicapped people in several applications like manufacturing processes; medicine and telephone network [4].

Speech recognition technology is used for converting speech signals into a sequence of words or other linguistic units by the use of an algorithm [4]. Out of 87 different speaker, the error word rate of 19% with 20 seconds was found using raspberry pi [5]. Automatic speech recognition has been viewed as successive transformations of acoustic micro structure of speech signal into its implicit phonetic macro- structure. In other words, a speech recognition system is a speech-to-text conversion whereas the output of the system displays text corresponding to the recognized speech.

Languages, on which so far automatic speech recognition systems have been developed, are just a fraction of total around 7300 existing languages. Russian, Portuguese, Chinese, Vietnamese, Japan, Spanish, Filipino, Arabic, English, Bengali, Tamil, Malayalam, Sinhala, Hindi are prominent among them. English is the language for which maximum work for recognition is done [5]. A voice-controlled human-computer interface system has been designed that enables severely handicapped individuals to operate a computer this will be the new generation of interface for disabled [6]. The hands free speech recognition method based on HMM composition which realizes and improves user interface by countering additive noise [7]. Approach to unsupervised speaker adaption task for HMM based speech synthesis models which avoids need for supplementary acoustic models [8].

IR remote control is most popular equipment for home and office appliances such as air conditioner, television. Recent researchers concentrate on the use of IR remote control of devices for controlling different applications. Literature shows work on detection and study of various IR control signals [9]. IR control signal is used to control home appliances and industrial machine parameters [10, 11]. There is a white paper on how IR remote can be used to provide cost efficient solution for controlling many kinds of electronics devices [12]. Interferences between IR remote control systems for electrical home appliances and high frequency electronic ballast lightning is described by this paper [13].

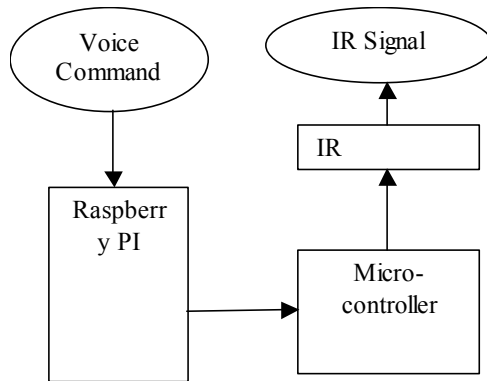


Fig. 1: Block Diagram of Intelligent remote system

The proposed system convert voice command into digital using Raspberry pi and transmitting equivalent IR code using Raspberry pi and ESA MCB 51 microcontroller kit. This proposed intelligent IR generation system will be used to control many devices in home for physically challenged people and for patients in the hospitals.

Rest of paper is organized as follows, the section II explains about speech recognition system and IR code generator. The section III shows complete software description of intelligent remote system. Implementation details and results are mentioned in section IV. Conclusion is given in section V.

**Hadware System Design:** Block diagram in Fig 1, represents complete intelligent remote system which consist of raspberr y pi and 8051 microcontroller. Raspberr y pi takes input from physically challenged people and convert that signal into equivalent text format. This text is saved in raspberr y pi. Python script is used to recognize input command in text form and as per command, raspberr y pi generates control signal for 8051 microcontroller which is used to generate equivalent IR code with the help of IR transmitter connected to one of the GPIO pin of 8051.

**Speech Recognition System:** Speech is the most common communication platform for exchanging information among humans. Speech recognition systems are the efficient alternatives for such devices where typing becomes difficult. The proposed speech recognition system converts speech signals into a sequence of words by algorithm implemented on a computer. Given voice command is analyzed and compared with the predefined command in the grammar file and based on match, text is displayed. More number of commands can be added in grammar file to make library of word for a universal applications.

The key feature of Raspberry pi-2 model b, is 1GB ram. Other features of pi 2 are 4 USB ports, 900MHz quad-core ARM Cortex-A7 CPU, 40 GPIO pins, full HDMI port, Ethernet port, Combined 3.5mm audio jack, Micro SD card slot, Video Core IV 3D graphics core. Because it has an ARMv7 processor, it can run the full range of ARM GNU/Linux distributions, including Snappy Ubuntu Core, as well as Microsoft Windows 10. Speech recognition application computation intensive and requires lot of memory, that is the reason Raspberry Pi-2 model is chosen.

**Generation of IR Signal:** This consists of 8051 microcontroller and RC6 IR transmitter. Microcontroller takes digitized voice command as input from voice command recognition system. Database is created for different commands which consist of IR code in binary form. In response to input voice command, microcontroller will fetch IR code in the binary form and generates IR code with the help of RC6 transmitter.

**RC-6 Protocol:** RC-6 signals are modulated on a 36KHz Infra Red Carrier. The duty cycle of this carrier has to be between 25 percent to 50 percent. Data is modulated using Manchester coding.

**Header Field:** First the Leader Symbol [LS] is transmitted. Its purpose is to adjust the gain of the IR receiving unit. This leader symbol is followed by a Start Bit SB which always has the value of "1". Its purpose is to calibrate the receiver's timing. The field bits are used to calculate mode. Here mode zero is used. Thus all field bits are set to zero. Finally the header is terminated by the trailer bit TR. Bit time of trailer symbol is twice the normal bits. Trailer bit acts as a traditional toggle bit, which will be inverted whenever a key is released. This allows the receiver to distinguish between a new key and a repeated key.

**Control Field:** Control field holds 8 bits which are used as address byte. It indicates that total of 256 different devices can be controlled using mode 0 of RC-6. The MSB is transmitted first.

**Information Field:** The information field holds 8 bits which are used as command byte. This means that each device can have up to 256 different commands. The MSB is transmitted first.

**Signal Free Time:** The Signal Free time is a period in which no data may be transmitted (by any device). It is important for the receiver to detect the signal free

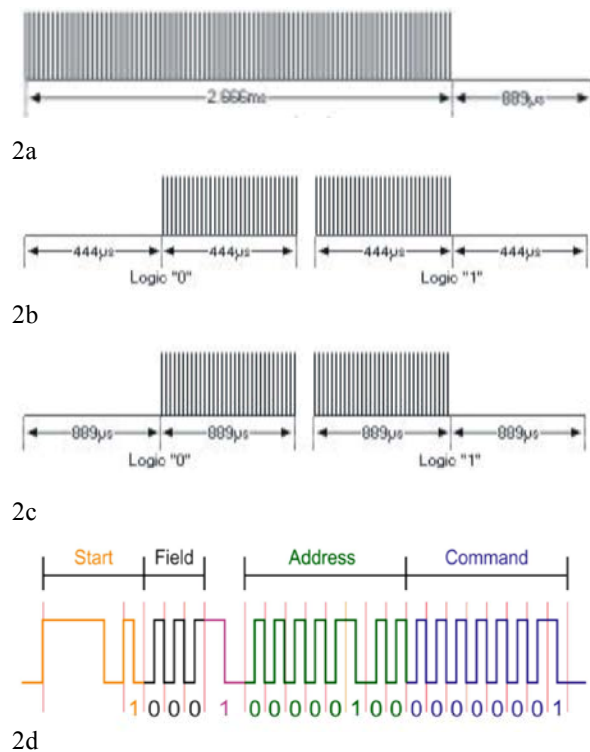


Fig. 2a: Leader bit, 2b: Normal bit, 2c: Toggle bit, 2d: RC6 Frame Format

time at the end of a message to avoid incorrect reception. The signal free time is set to  $6t$ , which is 2.666ms.

Below mentioned diagram shows different bits used in RC6 frame format as shown in Fig 2d. Fig 2a shows width of header bit. Similarly Fig 2c represents width of toggle bit and Fig 2a shows width of normal bit in RC6 frame format. Sample RC6 frame format is shown in Fig 2d.

### Software Description of the System

**Speech Recognition System:** There are lot of open source software's available for implementing speech recognition system. This paper use Sphinx software developed by CMU.

Pocket sphinx is based on Hidden Markov model (HMM) classifier. HMM is the mathematical tool for real time modelling. It creates stochastic models from known utterances and compares the probability that the unknown utterance generated by each model. HMM has several states each state corresponds to one observable event restriction is that when number of observation increases size of module becomes larger. For each state probability distribution is defined that specifies every observation symbol generated in particular state values of states are hidden hence this model is called Hidden



Fig. 3: Speech recognition system hardware implementation

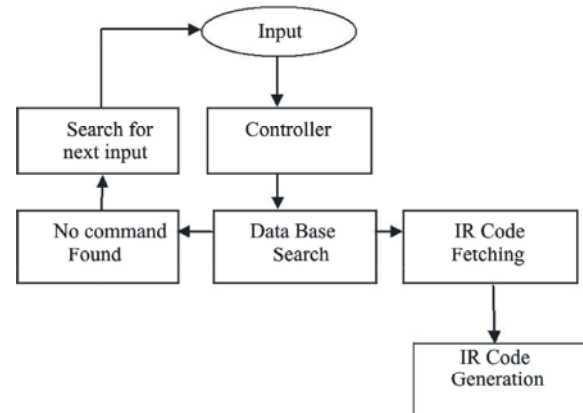


Fig. 4: Internal logic for IR code generation

Markov models. HMM uses Vitterbi algorithm to find the most probable path. Phoneme is the linguistic unit used to construct words. For example, the word "bat" is composed of three phones /b/ /ae/ /t/. There are about 40 such phonemes are required for English. The configuration file allows us to choose the feature extraction method of speech and the data for training. The system connection is shown in Figure 3.

**Generation of IR Signal:** IR code is generated on 8051 microcontroller with the help of assembly language in Keil uVision 4. This flow chart describes how IR code is generated for consumer electronics device.

This proposed system generates IR code for DVD player to make it on or off. Same system can be extended by creating the data base for different IR code to make the remote as universal remote as shown in Figure 4.

**Implementation and Result:** Sphinx base 0.8 and Pocket sphinx 0.8 are installed in raspberry pi which are used to analyzing the input voice commands. The system is

[illegible]

Fig. 5: Voice Command Recognized

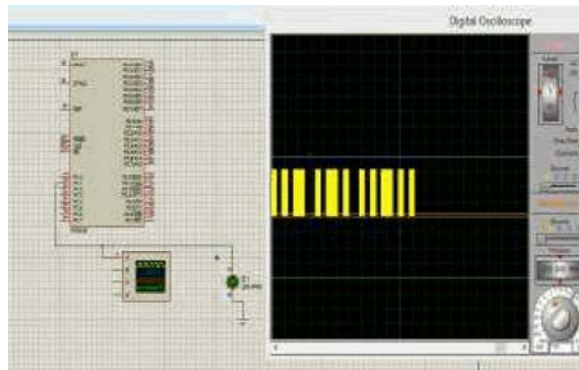


Fig. 6: Simulation of IR code in Proteus



Fig. 7: IR Code Waveform on CRO



Fig. 8: IR Code generation hardware implementation

configured to choose Mel Frequency Cepstral Coefficient (MFCC) as feature extraction method. Grammar file is created with predefined commands which are to be recognized.

**HMM based phoneme model for English is being trained using WSJ data:** During testing, Viterbi decoding is used to compute the most probable match of the word being uttered and the results are displayed in Figure 5. Based on predefined commands in the grammar file if the match is found on voice command, respective text is displaced. Thus voice to text is conversion is done. That text is saved in a text file. Using the transcribed text and trigger for IR generation is given through GPIO pins.

IR code generation logic is implemented in 8051 microcontroller for DVD player as shown in Figure 6. IR code is not visible to human eyes. However we can observe the blinking of IR transmitter led with the help of camera. It is also possible to get complete IR code on CRO as shown in Figure 6. This logic is implemented and verified on Proteus before using it in hardware.

## CONCLUSION

Proposed work is initiated keeping in mind the needs and comforts of physically challenged people and patients in the hospitals with limited motor skills in hand. Most of products seen in the market are focused for the larger strata of the society. Technology is no longer different. The traditional remote controls with push down buttons are nearly impossible to use for people suffering with diseases inhibiting motor functions. A voice controlled smart remote however, solves that issue.

This proposed system is used to control Philips DVD player and can be extended to one step ahead to make it as universal for making the home automation which would help physically challenged people

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