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Raspberry Pi (Model B) Based Interactive Home Automation System

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Abstract: The process of automation is becoming more popular because of its numerous applications. Home automation is something that deals with the control of domestic appliances. The main aim of this paper is to develop an advanced method of home automation with the application of Raspberry Pi through voice. Python is used as the main programming language which is default, provided by Raspberry Pi. The voice is recognized by using DTW algorithm.

Keywords: *Raspberry Pi, Voice, Home Automation, Python, DTW Algorithm.*

I. INTRODUCTION

Home automation is the automation of home, by controlling the appliances in the home by using controllers. It may include centralized control of appliances, security locks of gates and doors and other systems. The system integrates electrical devices in a house with each other. Through the integration of information technologies with the home environment, systems and appliances can communicate in an integrated manner which results in convenience, energy efficiency, and safety benefits. Automation is, characterized into two types. They are, Scheduled events and Non-scheduled events. In scheduled events the programming may include time-related commands, such as having your lights turn on or off at specific times each day. In non-scheduled events, such as turning on the lights in the home according to the user command.

II. VOICE RECOGNITION SYSTEM

The first step used in the voice recognition is the user to speak a word or phrase into a microphone. The microphone detects the voice signal which is in the form of analog. Then the analog signal is digitized by using an "analog-to-digital (A/D) converter", and then stored in memory.

To determine the "meaning" of this voice input, the processor attempts to match the input with a digitized voice sample, or template that has a known meaning. This technique is a close analogy to the traditional command inputs from a keyboard. The program contains the input template, and attempts to match this template with the actual input using a simple conditional statement

Each person's voice is different; the program cannot possibly contain a template for each potential user, so the program must first be "trained" with a new user's voice input before that user's voice can be recognized by the program. During a training session, the program displays a printed word or phrase. The user speaks that word or phrase several times into a microphone. The program computes a statistical average of the multiple samples of the same word and stores the averaged sample as a template in a program data structure.

This approach to voice recognition, the program has a "vocabulary" that is limited to the words or phrases used in the training session, and its user base is also limited to those users who have trained the program. This type of system is known as "speaker dependent". It can have vocabularies on the order of a few hundred words and short phrases, and recognition accuracy can be about 98 percent.

A more general form of voice recognition is available through feature analysis and this technique usually leads to "speaker-independent" voice recognition. Instead of trying to find an exact or near-exact match between the actual voice input and a previously stored voice template, this method first processes the voice input using "Fourier transforms" or "linear predictive coding (LPC)", then attempts to find characteristic similarities between the expected inputs and the actual digitized voice input. Figure 2 shows the working of voice recognizer.

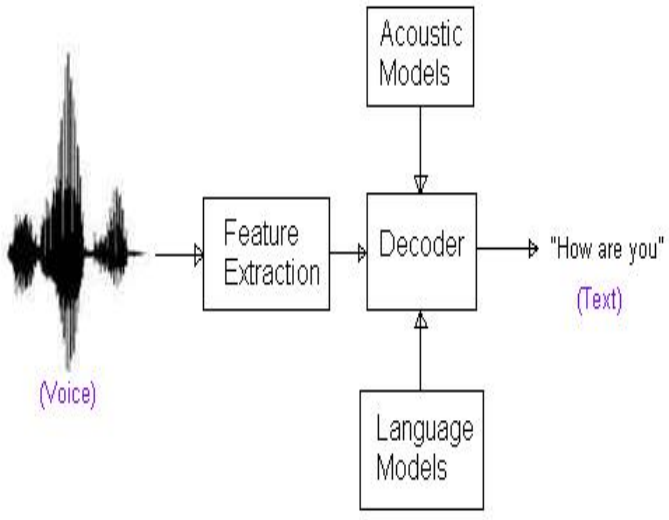

Figure 2: Voice Recognition

III. DTW ALGORITHM

Dynamic time warping (DTW) is a time series alignment algorithm developed originally for speech recognition. It aims at aligning two sequences of feature

vectors by warping the time axis iteratively until an optimal match (according to a suitable metrics) between the two sequences is found.

A = a1, a2, . . , ai, . . , an.
B = b1, b2, . . , bi, . . , bn.

The two sequences can be arranged on the sides of a grid, with one on the top and the other up the left hand side. Both sequences start on the bottom left of the grid.

Inside each cell a distance measure can be placed, comparing the corresponding elements of the two sequences. To find the best match or alignment between these two sequences one need to find a path through the grid which minimizes the total distance between them. The procedure for computing this overall distance involves finding all possible routes through the grid and for each one computes the overall distance. The overall distance is the minimum of the sum of the distances between the individual elements on the path divided by the sum of the weighting function. The weighting function is used to normalize for the path length. It is apparent that for any considerably long sequences the number of possible paths through the grid will be very large. The major optimizations or constraints of the DTW algorithm arise from the observations on the nature of acceptable paths through the grid.

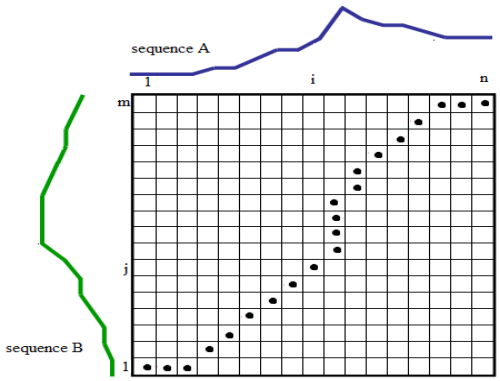

Figure 3: Representation of Optimal Match between Two Sequences

IV. RASPBERRY PI

Raspberry Pi is available in the following models, namely Model A, Model B and Model B+. Model A has 256Mb RAM, one USB port and no network connection. Model B has 5 12Mb RAM, 2 USB ports and an Ethernet port. It has a Broadcom BCM2835 system on a chip which includes an ARMl176JZF -S 700 MHz processor, Video Core IV GPU, and an SD card. The GPU is capable of Blu-ray quality playback, using H.264 at 40MBits/s. It has a fast 3D core accessed using the supplied OpenGL ES2.0 and Open VG libraries. The chip specifically provides HDMI and there is no VGA support. Model B+ is similar Model B but it has more GPIO ports than Model B.

The GPIO header has grown to 40 pins when compared to the 26 pin as in Model B. Model B+ has 4 USB 2.0 ports compared to 2 ports in the later. It also has better hot plug and over current behavior. The old friction-fit SD card socket has been replaced with a much nicer push-push micro SD version. By replacing linear regulators with switching ones the power consumption is reduced between 0.5W and 1W.The Raspberry Pi primarily uses Linux-kernel based operating systems and it is non volatile memory. Figure 4 shows the diagram of Raspberry Pi. The foundation has provided Debian and Arch Linux ARM distributions Here is used Python as the main programming language, with the support for BBC BASIC, C and Perl. Python was chosen as the main programming language, as it is easy to learn and a programming language that is suitable for real world applications. With the addition of NumPy, SciPy, Matplotlib, IPython, and PyLab.

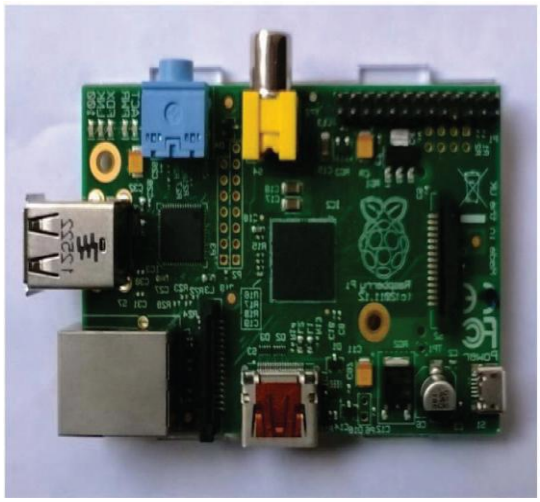

Figure 4: Raspberry Pi Board

Python can be used more effectively for the analysis of experimental data or control system purposes. Figure 5 shows the diagrammatic layout of Raspberry Pi.

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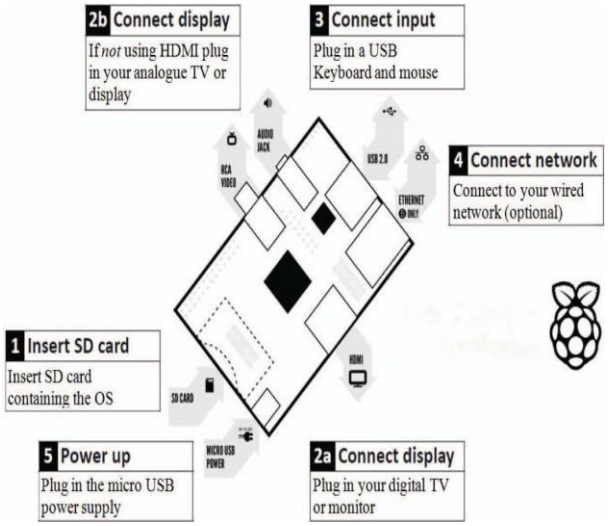

Figure 5: Layout of Raspberry Pi

V. PROPOSED SYSTEM

Raspberry Pi has been chosen as the processing unit for the system because of its user friendly features and economical benefits. The python coded algorithm has been fed into the Raspberry Pi and then it is connected to the microphone.

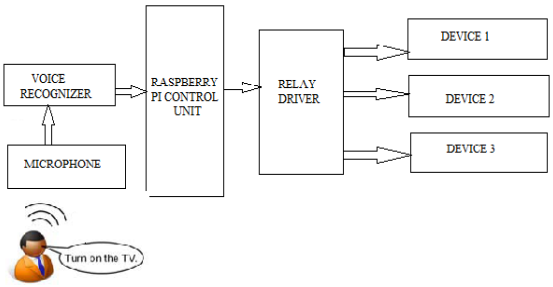

Figure 6: Proposed System Block Diagram

The controller is trained with the speech signal and then the command is stored into the database. The microphone is used to receive the voice command from the user. The Raspberry Pi recognizes the speech signal and controls the appliances according to that command. The Devices to be controlled have been interfaced with Raspberry Pi using relay driver circuit due to different power ratings of devices and Raspberry Pi. The block diagram of proposed method is shown in Figure 6.

VI. FLOW CHART

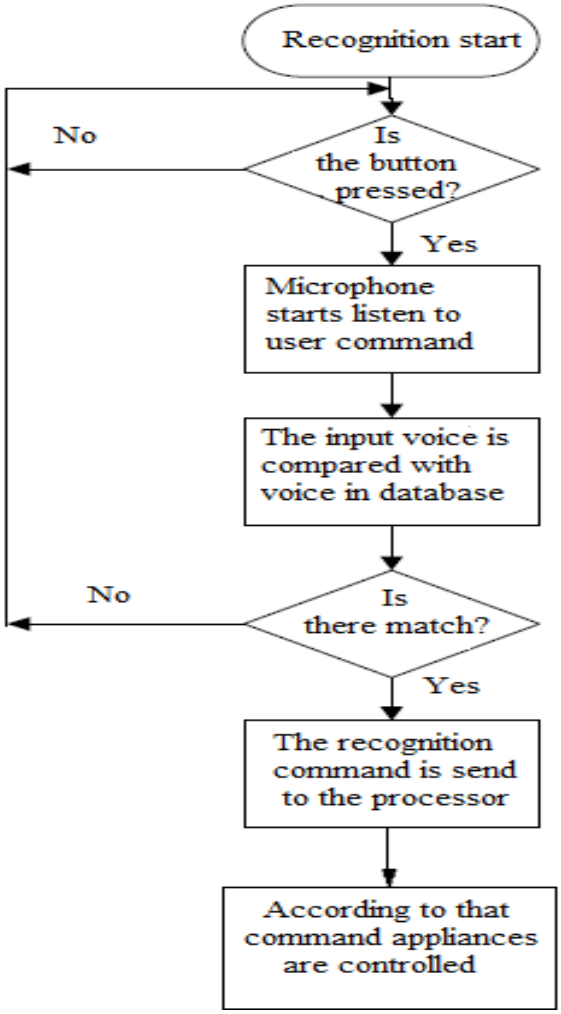

Figure 7: Control Algorithm

The appliances are controlled by using above control algorithm shown in Figure 7.

VII. CONCLUSION

The voice controlled home automation using Raspberry Pi is proposed for the benefit of saving energy, safety to home and boon to elderly and disabled. And also this paper provides a basic application of home automation using Raspberry Pi which can be easily implemented and used efficiently.

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