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Raspberry pi based voice operated Robot

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1. ABSTRACT:
Speech is the most important way of communication for people. Using the speech as the interface for processes became more important with the improvements of artificial intelligence. In this project, it is implemented to control a robot with speech comment. Speech commends were taken to the computer by the microphone, the features were extracted with The Mel Frequency Spectral Coefficients algorithms and they were recognized by the help of Artificial Neural Networks. Finally, the comments have converted the form in which the robot can recognize and move accordingly. Our proposed system aim at a robotic vehicle operated by human speech commands. The system operates with the use of an android device which transmits voice commands to raspberry pi to achieve this functionality. The transmitter consists of the android phone Bluetooth device. The voice commands recognized by the module are transmitted through the Bluetooth transmitter. These commands are detected by the robotic vehicle in order to move it in left, right, backward and front directions. The Bluetooth receiver mounted on raspberry pi is used to recognize the transmitted commands and decode them. The controller then drives the vehicle motors to move it accordingly. This is done with the use of a driver IC used to control the motor movements. The Bluetooth technology used to transmit and receive data allows for remotely operating the system within a good range. Voice operated robot is used for one moving object is developed such that it is moved as per commands are given by the voice recognition module and that command is received by robot and robot is matched the given command with stored program and then set the command as per voice using wireless communication.

Keywords: Android Smartphone, Bluetooth module, robot, Raspberry Pi Kit, dc motor.

2. Introduction

Speech is the most used way of communication for people. We born with the skills of speaking, learn it easily during our early childhood and mostly communicate with each Other with speech throughout our lives. By the developments of communication technologies in the last era, the speech starts to be an important interface for many systems. Instead of using complex different interfaces, speech is easier to communicate with computers. In this project, it is aimed to control a robot with speech commands. The robot is able to Recognize spoken commands to move correctly. To give a direction to the robot, first, the voice command is sent to the computer using a microphone. The computer recognizes the command by speech recognition system. And then computer converts the voice command to direct command that predefined and recognizable by the robot. When the robot gets the direction command, it moves according to the spoken command.

3. Literature Review

1. Speech Recognition by Wireless Robot

In this presented system, voice recognition system is used as the user interface to operate the system..Firstly, We have to give voice commands via android smart phone which will be with us only. These commands are processes in the smart phones s/w and according to signals are then sent to Bluetooth modem which is connected wirelessly to the Raspberry Pi board. A motorized miniature model of the robot is made.

2. Voice Controlled Intelligent Wheelchair using Raspberry Pi:- Acoustic Controlled Robotic Vehicle

ROM, RAM, parallel I/O, serial I/O, Counters and clock circuits. Microprocessors are intended to be general-purpose digital computers whereas microcontrollers are intended to be special-purpose digital Controller. The microprocessor contains a CPU, memory-addressing circuits and Interrupt handling circuits. Microcontrollers have these features as well as timers, parallel and serial I/O, and internal RAM and ROM.

Microcontroller models vary in data size from 4 to 32 bits. Four-bit units are produced in huge volumes for very simple applications; and8-bit units are the most versatile. 16 and 32-bit units are used in high-speed control and signal processing applications. Many models feature programmable pins that allow external memory to be added to the loss of I/O capability.

3. Speech Recognition by Wireless Robot

Speech is an ideal method for robotic control and communication. The speech recognition circuit we will outline, functions independently from the robot's main intelligence [central processing unit (CPU)]. This is a good thing because it doesn't take any of the robot's main CPU processing power for word recognition. The CPU must merely poll the speech circuit's recognition lines occasionally to check if a command has been issued to the robot. We can even improve upon this by connecting the recognition line to one of the robot's CPU interrupt lines. By doing this, a recognized word would cause an interrupt, letting the CPU know a recognized word had been spoken. The advantage of using an interrupt is that polling the circuit's recognition line occasionally would no longer be necessary, further reducing any CPU overhead.

4. Voice Activated Programmable Multipurpose Robot

Controlling the machines and environment with speech makes human life easier and more comfortable. This project is a simple implementation of this approach. A robot is controlled by voice commands. Voice command is taken through a microphone, processed in the computer and sent to the robot and finally, the robot acts accordingly.

Speech is the most used way of communication for people. We born with the skills of speaking learn it easily during our early childhood and mostly communicate with each other with speech throughout our lives. By the developments of communication technologies in the last era, the speech starts to be an important interface for many systems. Instead of using complex different interfaces, speech is easier to communicate with computers.

4. Proposed Methode

The proposed method of voice-operated robot is controlling the robot through android smart phone wirelessly. Definition of speech recognition can be stated as speech recognition is the method of converting the speech signal i.e. spoken word to a sequence of the word by use of an algorithm which is implemented as a program.

System Description:

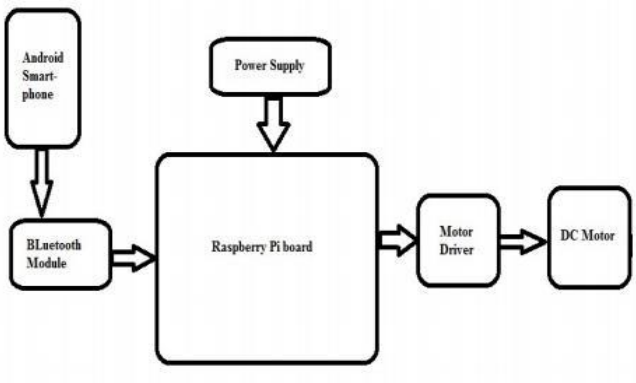

Fig 1. Voice operated robot diagram

Voice operated robot including the control system is shown in fig. Here the construction of speech recognized robot is done for wireless operation.

The main building blocks:

- Power Supply
- Android Smart phone
- Bluetooth modem
- Raspberry Pi
- DC motors with driver

In this work the main modules are as follow:

1) Android phone: here we are used to receiving voice command from the mobile phone(using software voice to text converter)and is connected wirelessly to Bluetooth module.
2) Bluetooth Module: This is used for wireless connection between Raspberry pi and Android Smartphone.
3) Raspberry Pi: This is the main component which performs the speech recognition process and controls all the operations.
4) Motor driver: we are using motor driver IC L293D is drive the DC motors which are connected to the Raspberry Pi via the motor driver IC.
5) DC Motors: DC Motors are used to drive the robot in different directions as per the received voice command.

Detail description of the proposed block diagram and information related to every step is explained below.

4.1 Power Supply:

This section deals with the power requirements of the robot for DC motors. The power supply is a basic need to design any systems. The Raspberry Pi is powered by +5v micro USB supply and the exact current required is dependent on the connections are given to the Raspberry Pi. In this system, the model B Raspberry Pi is used with typically between 700- 1000mA current. And for this supply, the Power bank with 5v 1A is used, shown in fig.

Fig 2. Power Bank

4.2 Android Smartphone:

Android is an operating system based on the Linux kernel and designed primarily for touch screens mobile devices such as smartphones and tablet computers. Initially developed by Android, Inc., which Google backed financially and later bought in 2005, Android was unveiled in 2007 along with the founding of the Open Handset Alliance a consortium of hardware, software, and telecommunication companies devoted to advancing open standards for mobile devices. The first publicly available smartphone running Android, the HTC Dream, was released on October 22, 2008. The user interface of Android is based on direct manipulation, using touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching and reverse pinching to manipulate on-screen objects. Internal hardware such as accelerometers, gyroscopes, and proximity sensors are used by some applications to respond to additional user actions, for example adjusting the screen from portrait to landscape depending on how the device is oriented. Android allows users to customize their home screens with shortcuts to applications and widgets, which allow users to display live content, such as emails and weather information, directly on the home screen. Applications can further send notifications to the user to inform them of relevant information, such as new emails and text messages. It is the APP which is used in our project to control or command the robot. Android Meets Robots: Voice. Recognition Uses android mobiles internal voice recognition to pass voice commands to your robot Pairs with Bluetooth Serial Modules and sends in the recognized voice as a string.

For example, if you say Hello the android phone will return a sting *Hello# to your Bluetooth module *and # indicate the start and stop bits Can Be used with any microcontroller which can handle strings.

Examples Platforms: Arduino, ARM, PICAXE, MSP430, 8051 based and many other processors and controllers.

4.3 Bluetooth Module HC-05:

The Bluetooth serial module named even number is compatible with each other; The salve module is also compatible with each other. In another word, the function of HC-04 and HC-06, HC-03, and HC-05 are mutually compatible with each other. HC-04 and HC-06 are the former versions that user can't reset the work mode (master or slave). The command set of HC-03 and HC-05 are more flexible than HC-04 and HC-06s. Generally, the Bluetooth of HC-03/HC-05 is recommended for the user. HC-05 is the latest wireless Bluetooth serial cable. This can be powered from 3.3V up to 6Vfor better attachment. It is qualified Bluetooth V2.0+EDR

(Enhanced Data Rate) 3Mbps Modulation with complete 2.4 GHz radio transceiver and baseband. Features: Typical -80dBm sensitivity. Up to +4dBm RF transmits power. Low power operation 1.8 to 3.6V I/O. Integrated antenna. Default Baud rate: 38400 and supported Baud rate 9600, 19200, 38400, 57600, 1152000, 230400, 460800. Use CTS and RTS to control data stream. When master and slave are paired, red and blue LED blinks 1time/2s in an interval. Auto connects to the last device on power as default. Permits pairing device to connect as default. Therefore it is connected to wireless communication.

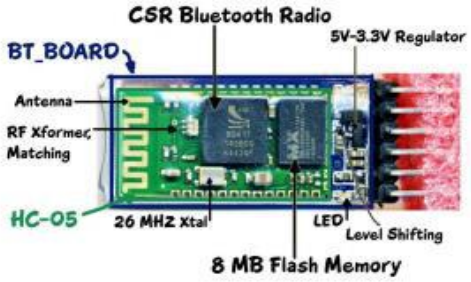

Fig 3. Bluetooth Module

Fig 4. Bluetooth Module HC-05 chip

4.4 Raspberry Pi:

The Raspberry Pi is a series of credit card sized single-board computers developed by the Raspberry Pi Foundation. It features a Broadcom system on a chip which consists of ARM-compatible CPU and on-chip Graphics Processing Unit GPU and memory ranges from 256 MB to 1GB RAM. Secure Digital SD cards are used to store the operating system and program memory in either the SDHC or MicroSDHC sizes. The board has 1 to 4 USB slots, HDMI and composite video output, and a 3.5 mm phone jack for audio. It also has Ethernet. Wi-Fi and Bluetooth port. Raspberry foundation provides Debian and Arch Linux ARM distribution for download and python is main programming language where C, C++, PHP, Java and more also available. Speech synthesis is done by using the raspberry pi. Hardware: This diagram shown in fig. 4 is of model A, A+, B, B+. Model A, A+ and Zero lack the Ethernet and USB hub components. The Raspberry Pi 2 uses Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache.

Fig5: Raspberry Pi Board

Software:

The Raspberry Pi uses Linux-kernel based operating systems. The primary supported operating system is Raspbian and the current release of Ubuntu supports the Raspberry Pi 2. The install manager for the Raspberry Pi is NOOBS. The operating system includes with NOOBS are: Arch Linux ARM, OpenELEC, OSMC and the Kodi open source digital media center, Pidora, RISC OS is the operating system of the first ARM-based computer.

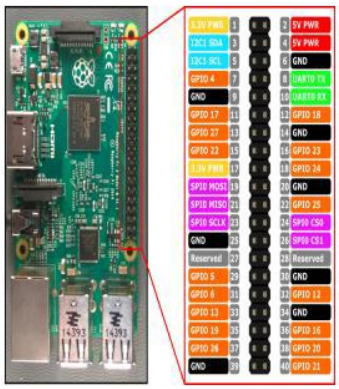

Fig 5. Raspberry Pi Pins

4.5 Motor Driver IC L293D:

This allows DC Motor to drive in either direction. L293D is a 16 pin IC which can control a set of 2 DC motors simultaneously in any direction. It works on the concept of H bridge that allows the voltage to be flown in either direction. Therefore H bridge IC is ideal for driving DC Motor. There are two enable pins on l293d. Pin 1 and Pin 9 are there to drive the motor so they should be high to drive the Motor. To drive the left H bridge motor the enable pin 1 should be high and for to drive the right H bridge motor pin 9 should be high. If anyone pin from 1 or 9 goes to low the motor will suspend the working. It's like a switch. Pin 2,7,15,10 are the 4 input pins. The motors are rotated on the basis of inputs provided across the input pins as LOGIC 0 or LOGIC 1.

Features: Wide Supply-Voltage Range: 4.5 V to 36 V
Separate Input-Logic Supply
Internal ESD Protection
Thermal Shutdown
High-Noise-Immunity Inputs
Functionally Similar to SGS L293 and SGS L293D
Output Current 1 A Per Channel (600 mA for L293D)

Fig 6: L293D Driver circuit

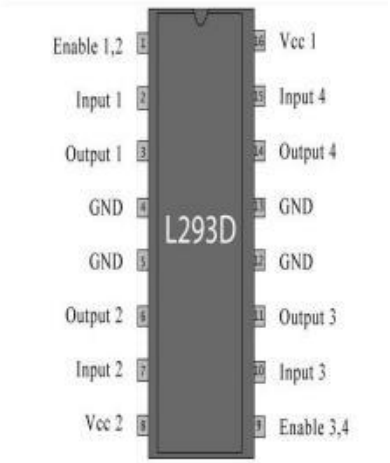

Fig 7: IC L293D

Fig 8. DC Motor

Methodologies and Working

4.1.1 Methodology:

The voice-operated robot is to use the speech conversion technology to interpret the voice commands. This smart Voice operated robot will play an important role in the future society.

4.1.2 Working:

In this presented system, voice recognition system is used as the user interface to operate the system. Firstly, we have to give voice commands via android smart phone which will be with us only. These commands are processes in the smart phones s/w and according to signals are then sent to Bluetooth modem which is connected wirelessly to the Raspberry Pi board. A motorized miniature model of the robot is made. The robot is operated by 2 DC motors. The Raspberry Pi operates these DC motors via IC L293D and controls the robot accordingly. The voice commands are Forward, Left, Right, stop.

AMR VOICE Application

When the command is given through the smartphone, The APP AMR (Androids Meets Robot) Voice should be ON with working internet connection and is paired with the Bluetooth modem HC-05 so due to this the commands will be sent to the Bluetooth modem wirelessly. The APP AMR uses smartphones internal voice recognition to pass voice command to the robotic system. It sends the recognized voice as a string e.g if a person says Right the android phone will return a string Right to the BT module where the and shows the start and stop bits.

2.2 Speech Recognition:

The method to enable recognition of spoken word into the text. It is known as automatic speech recognition or speech to text recognition. Speech recognition is a bit complex process as it involves the mixture of extremely complex linguistic, mathematics and computing itself. Language keeps the people far above than any other creatures. Just with help of bit letters we can build the words and can express them.

When the word is spoken the voices generate the little sound packets called phones which corresponds to the letter or group of a letter in the words. Phonemes are the blocks that are of sound that all words are built from e.g. when the word said as Stop it produces the phones s, t, a, a, p. Phonemes are the ideal bits of sound. Real bits analyzed are always with the phonemes. The basic principle of identifying the speech by recognizing its components is a good way but using the language in an account is a better way. That is Language model is used here in this recognition system.

Circuit Diagram:

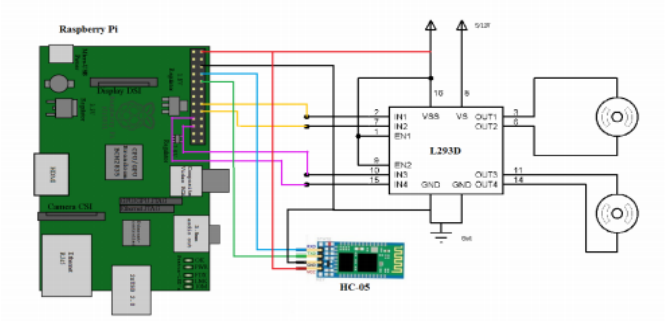

Fig 9. Circuit Diagram

5. Results

5.1 Introduction:

The experimental analysis is performed in this chapter. In order to recognize the voice-operated robot's working, the accurate preprocessing operations are performed. The designed hardware prototype model is as shown in fig. below:

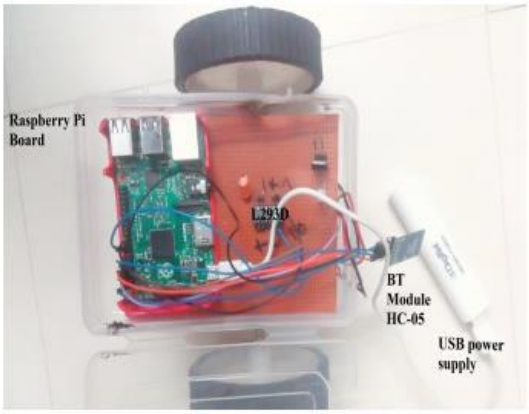

Fig 10.Hardware model

Procedure to Run:

- Power on the Raspberry Pi Board.
- Make sure that the phone is having working internet connection.
- Run the APP AMR Voice. 22
- Pair with Bluetooth module HC-05.
- Give the voice commands on the Phone.
- AMR Voice APP will display the said command.
- Within 2sec the robot will follow the direction given by the user: Right, Left, Forward, Stop.

5.2 Result:

The speech recognition is achieved by the use of Raspberry Pi board with the Bluetooth wireless interface of the smartphone. And the output is generated by the system which has accuracy about 95% i.e. after 1-2 sec. the voice command is followed by the robotic system and the system moves RIGHT, LEFT, FORWARD according to commands and STOPS.

Data given	Number of test	Number of correct test	Percentage of accuracy
Right	10	9	90%
Left	10	9	90%
Forward	10	10	100%
Stop	10	10	100%

Table 1. For Percentage accuracy

Conclusion:

This Speech-to-Text conversion system is implemented by using HMM. After that, the test spoken word is addressed by a forward algorithm of HMM. It can be clearly seen that the average recognition rate of 95% achieved. The motor drive and control system of the prototype speech operated robot has been tested. The proposed Raspberry Pi based voice operated robot brings more convenience and ease for the disabled people. This hi-tech technology can also improve the safety of users who use an ordinary joystick-controlled powered robot.

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