Voice Controlled Robotic Vehicle

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Abstract: In this paper, a robotic vehicle system for disabled people (controlled either by oral commands or by human computer interface (HCI)) is proposed as a project based on Microcontroller.

A disabled person sitting in a vehicle can control it by giving oral commands. If the person is further unable to control, it can directly be controlled from the base station using oral commands or by using GUI.

Introduction:
In our proposed design, we wish to control the movements of the vehicle using voice commands from the user. These commands will be issued at the base station on a PC connected with a sound card and a Microphone. The commands issued will then be relayed over an RF channel and will be received by the Module-2.

The goal of Voice Controlled Robotic Vehicle (VCRV) is to listen and act on the commands received from the user. Here, the system will require the training from the user (for the accent) after which the device will start understanding the commands issued.

Further the system can also work in Manual Front Panel Control Mode where the switches/ control buttons will be provided in the GUI (Graphical User Interface) and they can be used to control the direction of movements and the other acrobatics.

Designing and Controlling Robot:

2.1 Module-1:
The robot is controlled by two ways, either by the person who is sitting in the vehicle or
from the base station. Considering control from the base station, there will be two modules, one is located within the robot's body and another is worked as operation platform, the two are connected by WLAN. Module-1 is a PC with sound card and microphone is used for speech recognition and signals transfer. Module-2 is used to control the robot to take the corresponding action.

Once the connection is established, voice signals are processed and transferred between Module-1 and Module-2. Speech control robot system includes two parts: speech recognition module and control module. Speech recognition system is used to provide an analysis of the human's voice in order to determine what action the robot needs to take to satisfy operator's request. Control module is used to make the robot understand voice commands and act in the desired mode. The process is shown in Fig.1.

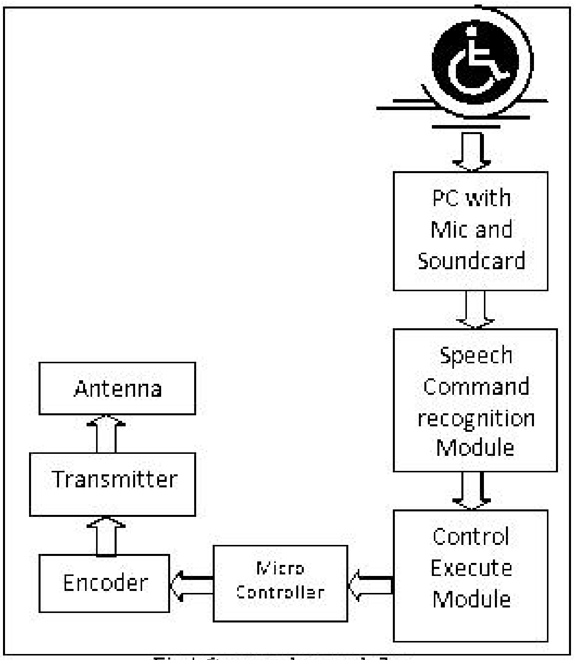

Fig.1 Command control flow

The process of speech commands controlling is complicated. When the operator (either a disabled person in car or a person from base station) speaks to the robot, their voice will be captured by the microphone and passed into soundcard where actual analog to digital conversion takes place. The digital signals from previous step are fed as input to the 'Speech
Command Recognition Module' where oral
commands will be processed into a structure of features. These features may include signal characteristics such as energy or frequency response. The features would be analyzed and compared with the data in database. The database is obtained through signal analysis, that stage can be called "training" of the speech data. The recognized commands will be passed into control module, which is separate from the speech recognition module. The control module will process the commands it receives from the speech recognition module and instruct the robot to take corresponding actions. These actions are sent to the micro-controller which is connected to an encoder transmitter and an antenna. Micro controller sends the corresponding instructions to encoder which encodes address/data bits and transmits the radio signals with the help of the antenna.

There are seven basic commands: go
forward, go backward, turn left, turn right, seat belt tightening/loosening, horn control and stop. All the commands would be given to the control module. Control module checks for the commands and instructs the robot to perform the requested action.

For example, turn left command means the robot will turn left 45 degrees and then go straight. The same extent to the turn right command. Go forward and go backward means it will go straight with a constant velocity. Stop means the robot will halt and waits for further instructions from the user.

2.2 Module-2

Module-2 will be placed on Robot which receives commands sent from Module-1 and

performs the requested actions. Figure 2 shows Module-2 components and connections. Antenna receives the signals which are sent from Module-1 and sends them to the decoder. The decoder connected to the Microcontroller receives serial addresses and data from programmed encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. Microcontroller which is master of all the activities in Midule-2 receives address and data from decoder and activates appropriate devices accordingly.

To achieve proper path it is necessary for a robot to navigate in its environment. The robot should have the ability to avoid obstacle. Ultrasonic sensor is widely applied in obstacle voidance and navigation. Robot emits ultrasonic constantly in the moving process to detecting surroundings environment. The distance between the robot and the nearest obstacle, the angle between the robot and the nearest obstacle is picked up from returned information of ultrasonic sensor. It is possible to use sensor data to detect and avoid obstacles. The data acquired from the sensors can be used for obstacle avoidance and path planning. In order to help for the disabled peoples to tighten seat belts, there will be command that activates seat belt motors to act accordingly. There is also a command for activating horn motors.

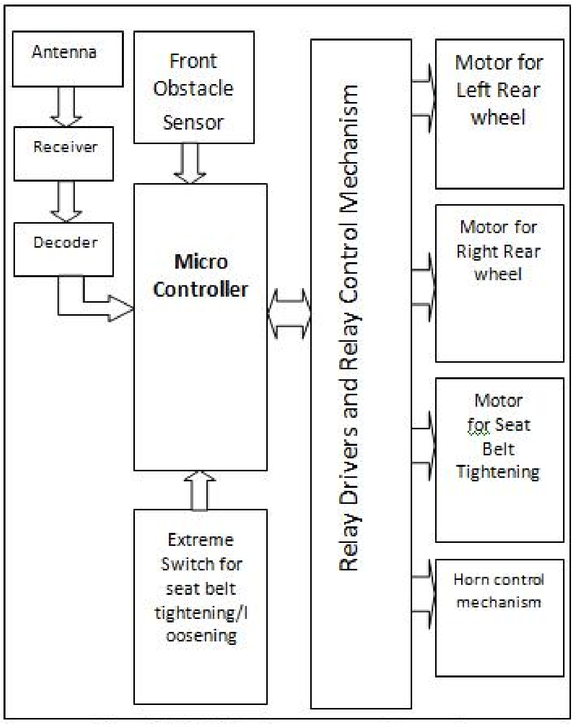

Figure 2. Module-2 Components and connections.

Voice Command Recognition

Speech signal is time variable actually. We usually process speech signal in a very short time, for instance, in 20ms, such a short time, the signal can be considered invariable, and this is the basic point of processing of speech signal. The process of our speech recognition is to extract feature from an acoustic signal and then recognize it. Feature extraction step involve Mel Frequency Campestral Coefficients (MFCC) and the linear prediction coefficients (LPCC). The MFCC parameter achieves the highest recognition accuracy when compared with LPCC. The recognition stage can be achieved by many processes such as Dynamic Mme Warping (DTW) which is based on pattern comparison, Hidden Markov Modeling (HMM) which is based on statistics model, Neural Networks (NN) which is based on neural network . In some small vocabulary application, the speech recognition that is based on pattern matching

is more convenient and efficient than the other algorithms. The more simple control commands are, the more intelligent a robot should be. Simple isolated words speech recognition technique can give highest accuracy of recognition results in shorter time requiring less powerful hardware. So DTW is appropriate for small vocabulary and real time operation. In process of speech recognition using DTW, features which represent the voice would be extracted and then be compared with the data in database. The database is obtained through signal analysis, that stage can be called "training" of the speech data. The Considering for our system, we need real time operation and our commands are simple, so speech recognition technique DTW which is based on pattern-comparison is selected, and we extract MFCC as feature of the speech command. In our system, the process of speech recognition can be divided into five parts

1. Acquire voice signals through microphone and make analog-to-digital conversion through soundcard
2. A series of pre-process signal analysis
3. Mel Frequency Campestral Coefficients (MFCC) calculation
4. Pattern matching calculation using DTW
5. Perform action.

The speech command is given as an input to a system, and the system would recognize it and perform an output action accordingly. The goal in speech recognition has always been to achieve recognition accuracy as high as possible. The robot should understand speech commands, the system convert words into a representation of what the robot should do. With the speech command, the robot can take the corresponding actions while avoiding obstacles. The whole scenario is depicted in Fig 3.

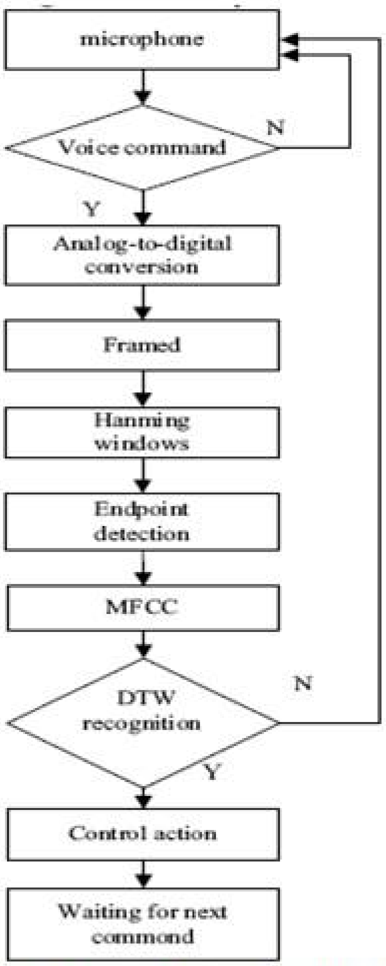

Fig. 3 Voice command recognition flow chart.

Conclusion

We have proposed the integration of voice recognition and navigation system into robotic vehicle which helps for disabled people. This speech-control system, though quite simple, shows the ability to apply speech recognition techniques to the control application. Our robot can understand control Commands spoken in a natural way, and carry out action. The method is proved for realtime operation.

References

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