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A Real Time LabVIEW based Low Cost Virtual Control Personal Assistive System for Disabled using Motion Intention and Speech

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Abstract: ***In the recent past, due to the rapid spread of robotic technology, there is an increase in heed towards the design of self rehabilitation devices for physically challenged persons. Thus, in this paper, we develop "A Real Time LabVIEW based low cost virtual control personal assistive system for disabled using motion intention and Speech". Towards this, at the beginning the motion intention is estimated through the user muscle activities in real-time using Electromyogram (EMG) electrodes. Thus, the EMG electrodes control the system in proportion with users' motion intention. However, sometimes there is a problem in the estimation of motion intention due to poor muscle activity in weak persons and surrounding environment. In that case, to modify the user's motion and to avoid accidents, speech recognition technology is introduced as an alternative. Therefore, this system helps the disabled people to input their data by mapping both EMG signals and Voice commands using LabVIEW. The proposed virtual control personal system is tested using a Robot model and developed on Arduino platform. The possible enhancements of developed control system may also be discussed for potential applications in medical, home and industrial environments.***

Keywords: Arduino Uno, Disabled people, Electromyography (EMG), LabVIEW

I. INTRODUCTION

In the last two decades, there has been a considerable increase in the development of robotic based assistive devices for people with disabilities, due to their effective support to improvement in the traditional therapy. Towards this, researchers investigated the use of electrophysiological signals such as EMGs, EEGs and EOGs to provide some level of support with limited peripheral mobility for physically challenged and elderly people over their environment [1].
The assistive control devices based on Electrooculography (EOG) and Electroencephalogram (EEG) suffers from too much dependency on hardware devices like keyboard and mouse to operate a computer.

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In addition, there exist several techniques to estimate the motion intention of the user in real-time [2] [3]. Therefore, Scientists investigated the use of EMG signals in to control and navigate the rehabilitation devices based on muscles activity [4] [5]. EMG based assistive devices are being proposed in medical fields to reduce the work pressure and to provide external lift to the elderly and disabled people Authors in [6] developed a robotic control system to provide the necessary assistance for the improvement of a patient's movement recovery based on electromyography (EMG) signals. In addition, the control system is able to be present coded instructions, adjustable thresholds for the automatic performance. This robot personal assistive device would be used to provide repeated motor practice in an effort to promote neurological recovery. However, at times there may be detritions in the user's motion due to weak personality and leads to misunderstand between user reflex and surrounding environment. To this end, there has been plethora of research done for the design and development of personal assistive control systems for disabled based on voice and gesture commands. Control and working of these systems does not depend on any muscle force or physiological parameters [7]. Thus, in this paper, we develop "A Real Time LabVIEW based low cost virtual control personal assistive system for disabled using motion intention and Speech". . The paper is structured as follows. The proposed work is summarized in Section II. Section III illustrates performance analysis of proposed algorithm. Finally, section IV concludes the work.

II. PROPOSED WORK

Figure 1 illustrates the architecture of the EMG based rehabilitation system. It includes six modules in the following order: 1. Set of four EEG sensors, 2. A module for EMG signal acquisition from Elbow, 3. Mobile phone with inbuilt microphone for voice commands, 4. Bluetooth device for wireless transmit ion of voice commands, 5. LabVIEW software module to visualize and coordinate both EMG and Voice commands, 6. Rehabilitation device.

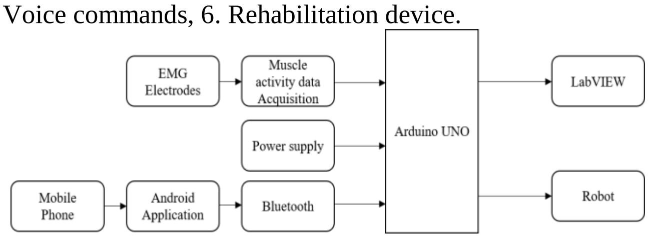

Fig.1(a). Block diagram of the EMG based rehabilitation system.

Fig. 1(b). EMG sensors

At the beginning, the Electromyogram (EMG) signals from the patient are extracted based on muscle activity and EMG electrodes. The captured EMG signals are in the form of electric in nature are not suitable as input signals to the controller due to presence of noise and lower amplitude levels. The acquired signals are then preprocessed (Amplified, Filtered and Rectified) before feature extraction is to be done from the directly obtained EMG signal. From the literature, one of the best feature extraction techniques for the real time motion intention is the Root Mean Square (RMS) [8]. RMS of the raw EMG signal is obtained using the equation given below:

$$Root\ Mean\ Square = \sqrt{\frac{1}{S}\sum_{i=1}^{n} {a_i}^2}$$

Where 'S' is number of segments (S=200) and 'a' is amplitude of the EMG signal. Finally the extracted signal is used as input to the arduino Uno.

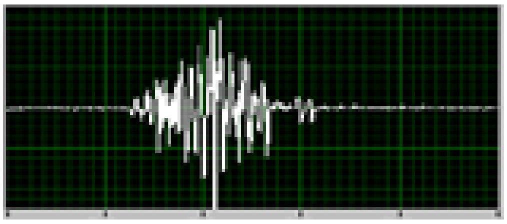

Fig.2(a). EMG Signal

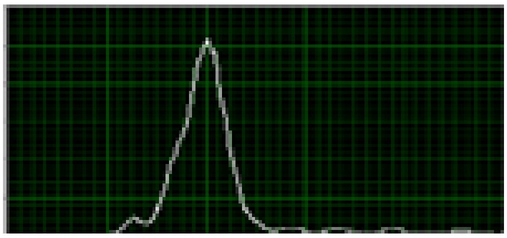

Fig.2(b). RMS signal

Figure 2 illustrates the comparison between raw EMG signal before preprocessing and RMS EMG signal. It is clear that the RMS EMG signal is more significant and can be directed to a dedicated Arduino module for necessary control strategy. The suitable control signal for the robot will be given by the LabVIEW. However, sometimes there is a problem in the estimation of motion intention due to poor muscle activity in weak persons and surrounding environment. In that case, to modify the user's motion and to avoid accidents, speech recognition technology is introduced as an alternative.

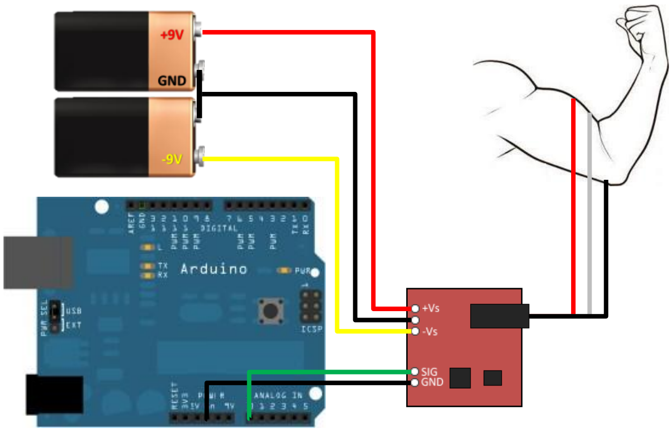

Fig.2(c). Reading input from muscle using EMG sensor.

Speech recognition module architecture

In addition to EMG motion intention strategy for the control of rehabilitation system, LabVIEW based speech recognition system is introduced. The speech recognition module includes three major blocks: 1. Mobile phone with inbuilt Microphone (Major part of Control unit), 2. Bluetooth, 3. RS232. From the diagram it is evident that the control unit is nothing but an android based mobile with microphone, Bluetooth and LabVIEW. When the patient speaks with the commands (Left, Right, Front, Back, Stop and Run) for robot operation through the inbuilt microphone, the suitable commands are read and fetched through control unit. Then, transmits the commands to LabVIEW for further analysis and then corresponding output will be given to assistive device through Bluetooth module. Thus, the proposed system helps the disabled people to input their data by mapping both EMG signals and Voice commands using LabVIEW. Figure 3 shows the work flow of the proposed system.

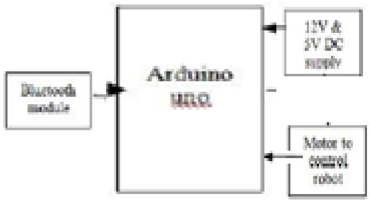

Fig.3(a). Speech recognition module

The Bluetooth module shown in fig.3(b) works in two operating modes, one is the Data mode and second is the Command mode. In data mode, the device can send and receive data from external Bluetooth devices. In command mode device can set the default mode. We can operate the device in either of these two modes using selected pin.In addition, it is very easy to pair the bluetooth module with microcontrollers as the device works using the Serial Port Protocol (SPP). Then power the module with +5V and connect the Receiver pin of the Bluetooth module to the Transmitter of controller unit and Transmission pin of module to receiver module of controller unit.

Fig.3(b). Bluetooth Module

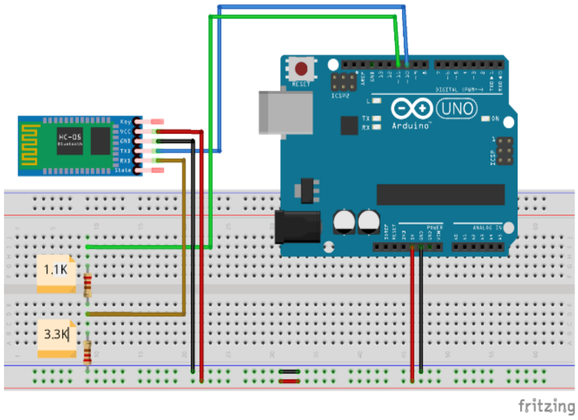

Fig.3(c). Transmitting fetched data from bluetooth to control unit

III. IMPLIMENTATION AND SIMULATION RESULTS

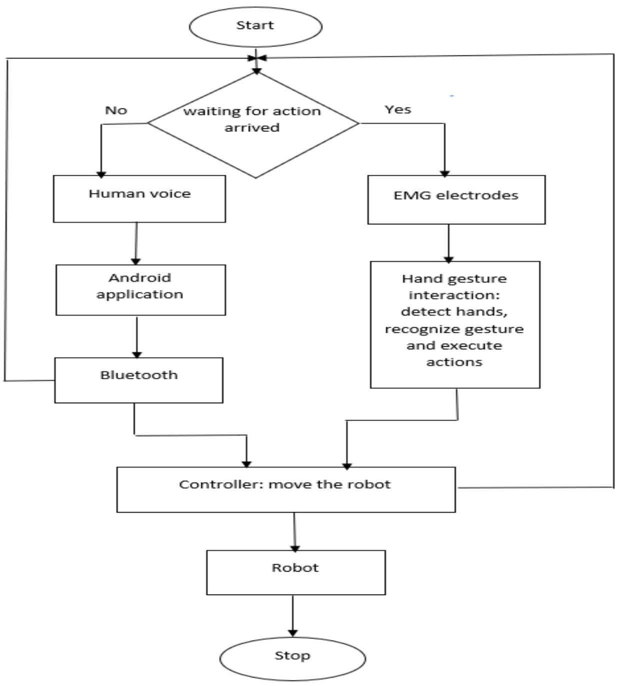

Fig.4. Workflow of the control system

Step 1: Illustrates the action required based on the comparison of two inputs such as, motion intension and voice commands

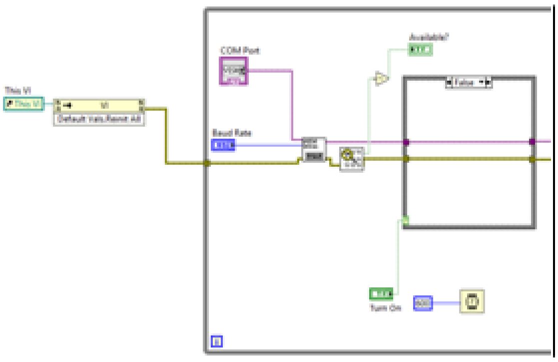

Fig.5. LabVIEW schematic of step 1

Step 2: Reading the inputs from both EGM and Speech recognition module architectures

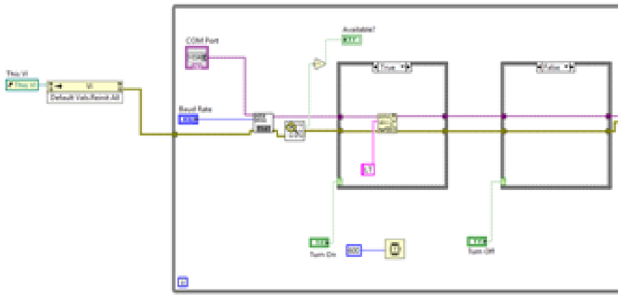

Fig.6. LabVIEW Schematic of step 2

Step 3: Fetching and analyzing both the inputs using LabVIEW

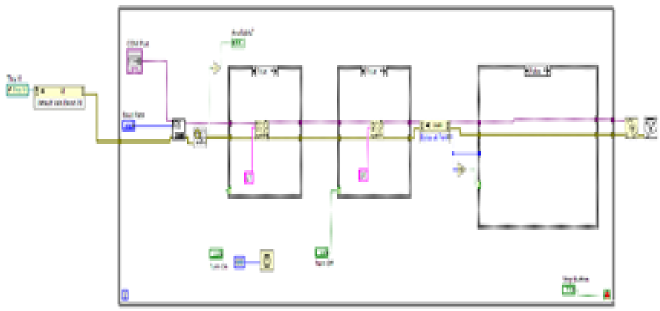

Fig.7. LabVIEW Schematic of step 3

Step 4: Transmitting the signals to the Arduino Uno

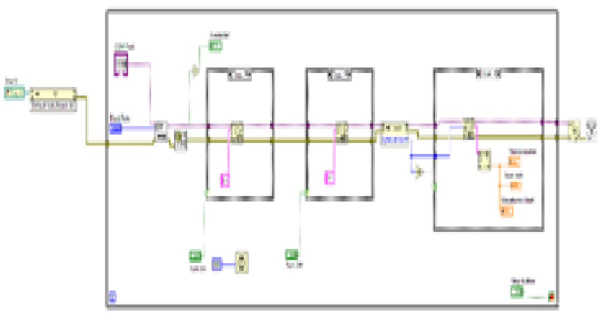

Fig.8. LabVIEW Schematic of step 4

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Step 5: Transmitting the output of Arduino to rehabilitation system for movement

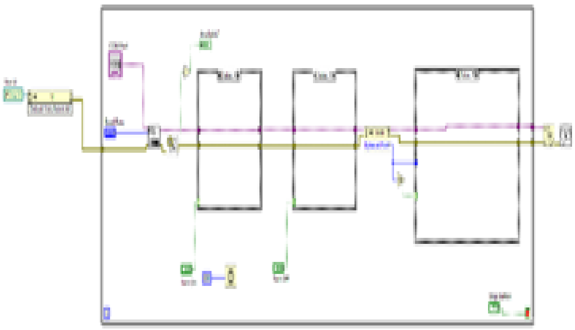

Fig.8. LabVIEW Schematic of step 5

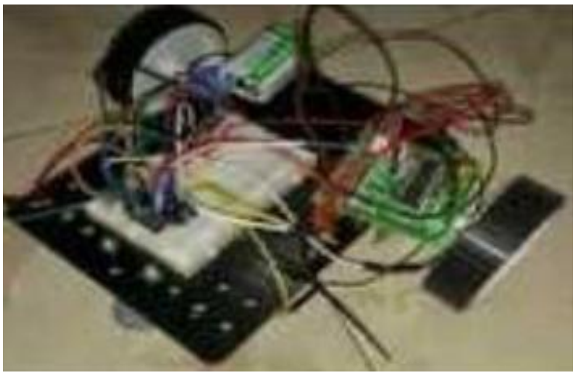

Fig.9. Motion Intention and Speech control system

IV. CONCLUSION

In the proposed work, a motion intention using EMG and Speech recognition control system has been designed. The designed system is tested on the rehabilitation control device for different commands. Due to the speech recognition unit makes the assistive system work with better ease and accuracy. The robot is simple to design and also works with better efficiency with less user training, thus making the system stable, user friendly and cheap. Further, as a part of future work, the system can be used in different applications to serve the disabled people. The system can be extended to gaming activity on the move for physically challenged and elderly people. In addition, inclusion of GSM module leads to remote monitoring of the patients.

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