VOL. 10, NO. 17, SEPTEMBER 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

A REAL TIME PERSONALIZED SELF ASSISTIVE TECHNOLOGY FOR THE DISABLED PEOPLE BASED ON VOICE AND EOG

Archana JS. and K. Gangadharan
Department of Computer Science, Mohandas College of Engineering & Technology, Anad, Nedumangad, Thiruvananthapuram, India
E-Mail: archanajsmtech@gmail.com

ABSTRACT

Electrooculography (EOG) is a technology for recognition of eye movements. This technology is based on the principle of recording the polarization potential or corneal-retinal potential (CRP), which is the resting potential between cornea and retina. This potential difference between cornea and retina creates an electric field, and the electrical signal that can be measured is called Electrooculogram EOG is a very small electrical potential that can be detected by placing electrodes on the forehead around the eyes.

The EOG signals can be used for various activities, which include controlling rehabilitation aids. This paper presents about the automatic wheel chair which is controlled by EOG signals and voice. This paper aims to develop a personalized real time technology based on EOG and voice to control a wheel chair. The personalization is achieved with the help of neural network. This paper discuss about various types of techniques used to control a wheelchair, electrooculography, block diagrams and working of a prototype wheel chair , shows the result of voice recognition etc.

Keywords: wheelchair, hand-free control, electrooculography.

INTRODUCTION

Mobility is very much important to every creature. Wheelchairs are used by the people who cannot walk due to physiological or physical illness, injury or any disability. Wheel chair is a chair with wheels. People with physical disabilities and partial paralysis always find it difficult to navigate through their habitat or their home without the assistance of someone. Often after paralysis or physical disability the wheelchair is the most common means of locomotion for such people. But to navigate through one's own house by taking help of someone at every time can be inconvenient.

Conventional wheel chairs were manually controlled one. But recent development promises a wide scope in developing smart wheelchairs**,** with least interaction of human.

The section II presents the study of various types of automatic and intelligent wheel chairs. Section III gives brief idea about EOG and voice technique. Section IV explains about the experiment and results. Section V is the conclusion and future work.

LITERATURE REVIEW

Various types of controlling techniques are implemented on wheel chairs. Some of them are:

- Manually propelled
- Electric powered
- Gestures based
  - hand
  - Head
  - Eye
  - tongue
- Voice based
- Thought controlled

Manually Propelled

Manual wheelchairs are those that require human power to move them. There are handles behind the seat for someone else to do the pushing

The advantage of this type of wheel chair is it is very cheap. Disadvantage is that always need the help from other people.

Electric Powered

An electric-powered wheelchair is a wheelchair that is moved via the means of an electric motor and navigational controls, usually a small joystick mounted on the armrest, rather than manual power.

The advantage of this one over manually controlled one is that there is no need of a second party. The disadvantage is it is not suitable for the patients who can't move their hands. And there is no intelligence for the wheel chair; Socollision avoidance is responsibility of disabled person. The patient should be more careful all the time.

Gestures Based

Gestures are used for non verbal communication. Gesture is the movement of part of the body, especially a hand or the head; to express an idea or meaning. Here in the case of wheel chairs we are using the gesture to move the wheel chair. The advantage is that there is no need of any second party other than the disabled person. Usually some kind of sensors will be connected to the wheel chair for collision detection. So that the wheel chair will become more intelligent. Usually gestures of hand, head, eye, tongue etc. will be taken and their combinations also.

- **Hand Gesture**

The wheel chair will move according to the movement of hand. The intention behind this idea is to enable the physically handicapped people to navigate and move around their home without the help of anyone.

The recognition of hand gestures requires both hand`s detection and gesture`s recognition. The hand gesture module has been prepared by using a triple axis accelerometer sensor (ADXL 335). The accelerometer sensor senses the accelerating force (acceleration due to gravity or g) and thus gives a particular voltage for the x, y and z coordinate orientation [1].

This method is challenging, mainly due to the variability of the possible hand gestures and very difficult to detect in dynamic environments with cluttered backgrounds and variable illumination.

- **Head Gesture**

Traditional electric-powered wheelchairs are normally controlled by users via joysticks, which cannot satisfy the needs of elderly and disabled users who have restricted limb movements caused by some diseases such as Parkinson's disease and quadriplegics. Therefore a hands-free control system for intelligent wheelchairs based on visual recognition of head gestures is used.

EEG sensor called Emotiv EPOC, is used to detect head movements [2].Direction of wheelchair movement is determined by direction and amount of head tilt. For example, in [3] the movement of wheel chair is determined as follows:

- When person tilt his head in forward direction above 20 degree angle chair will move in forward direction.
- If person tilt his head in backward direction above 20 degree angle chair will move in backward direction.
- If person tilt his head in left direction above 20 degree angle chair will move in left direction.
- If person tilt his head in right direction above 20 degree angle chair will move in right direction.
- If person tilt his head at 45degree forward priority will be given to forward direction.

- **Eye Movement Based**

This method can be used even by patients who are paralyzed from shoulder downward. The advantage is that simple eye movements don't require too much energy. The mobility of eye movements can be recognized by various techniques such as based on Electrooculography, capturing video of eye movements etc. One of the disadvantages of this method is use of eye movement demand too much concentration.

- **Using Tongue Movement**

A wheel chair which uses the movements of the patient's tongue to operate it is invented for the people who cannot move their body parts, including their head. A sensor will be there to take the movements of tongue.

There are two ways to place sensors:

- Some systems mount sensors and circuits in a dental retainer for use within the mouth and wirelessly sending the signals [4].
- Use separate devices, placing sensors on a headband to bring them closer up to the cheeks, and then put on the tongue a magnet(piercing the tongue) [5][6].

There are so many advantages of this technique; it is useful for the patients with a minimum capacity of movement or practically nil. The disadvantage is the sensors should be kept in the mouth, which will be uncomfortable the patients. But we can't say this as a severe disadvantage.

Voice Based

Wheelchair control has been guided by voice commands delivered through speech recognition, motor control, a user interface, and central processor modules. Such systems usually require the user to record functional oral commands, e.g., "Forward" makes the wheelchair move forward and "Stop" makes the wheelchair stop.

In this method first the patient has to mount the wheel chair. Then the patient can give voice commands via a head phone. Voice commands are: Forward, Reverse Left, Right, stop etc.

The disadvantage of this method is different people have different slang. So recognition is little bit tough, background noise, gender etc will affect the performance.

Combined Techniques

The combinations of the above techniques are also used to control the wheelchair, like voice and vision based. This is the most commonly used combined mechanism.

Two driving methods are implemented as voice and vision. In vision method the wheel chair will automatically move to a particular direction as the patient moves his/her eye in that particular direction. The eyeball sensor basically works with the infrared sensors to detect the movement of the eye ball direction [7]. In voice driving mode, the wheelchair is controlled by means of various voice commands such as forward, backward, left, right, stop, and send.

Another kind of combined technique is to control the wheel chair by head movements and facial expression [2]. Three head movements are used to stop the wheelchair and display the turning commands in the graphical interface (GI) of the human machine Interface (HMI), while two facial expressions are employed to move forward the wheelchair and confirm the execution of the turning command displayed on the GI of the HMI.

Thought Control Wheel Chair

The wheelchair can be directed by brain signals detected using a cap fitted to the user. [8]. Audeo, a device which reads nerve impulses in the neck to help people speak and even control an electronic wheelchair. Designed

ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

to help people suffering from diseases like ALS which erode muscle control over time, Audeo has received numerous awards. Audeo Basic, the system which allows someone to speak only using nerve signals, is already available on a limited basis for trials [9].

ELECTROOCULOGRAPHY AND VOICE TECHNIQUE

The Electrooculogram (EOG) is the electrical signal that corresponds to the potential difference between the retina and the cornea of the eye [10]. This difference is because of the fact that occurrence of metabolic activities in the cornea region is higher than that in the retinal region. Usually the cornea maintains a voltage of +0.40 to +1.0 milli volts which is higher than the retina. When the eyes are rolled upward or downward, positive or negative pulses are generated. As the rolling angle increases, the amplitude of the pulse also increases and the width of the pulse is in direct proportion to the duration of the eyeball rolling process.

The EOG is the electrical recording corresponding to the direction of the eye and makes the use of EOG for applications such as HCI very attractive. EOG-based techniques are very useful for patients with severe cerebral palsy or those born with a congenital brain disorder or those who have suffered severe brain trauma [4].

EOG is a bio signal, in which human do not have much control over it. Because of this reason in this work a non bio signal that is, voice is going to combine with EOG. For the direction control EOG signals are used and for the motion control voice based commands is used.

This technology is a personalized one, which means that once after started using this technique the system will self adjust in such a way that it will be more suitable and reliable for individuals.

EOG signals will be different for individuals. Through calibration a particular potential value will be set in the system at the very first time. But that value may not be the exact one for the user. So in this work this value will be get adjusted as there is a difference between actual value and the desired value. Neural network concept is made use for this.

In the case of voice recognition the difficulty lies in slang, gender, style etc. These will be different for different people. So speech recognition is a challenging task. In this work neural network based voice recognition technique is used. The trained voices commands will be get adjusted with actual commands produced by the user.

Since the system is self adjusting according to the users, it is entitled as `personalized`.

Block Diagrams

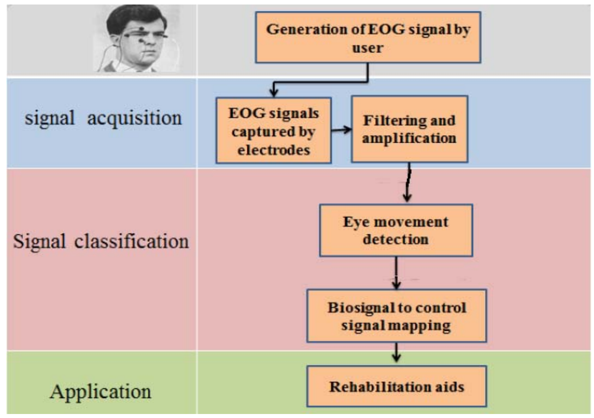

Figure-1. Basic block diagram of EOG.

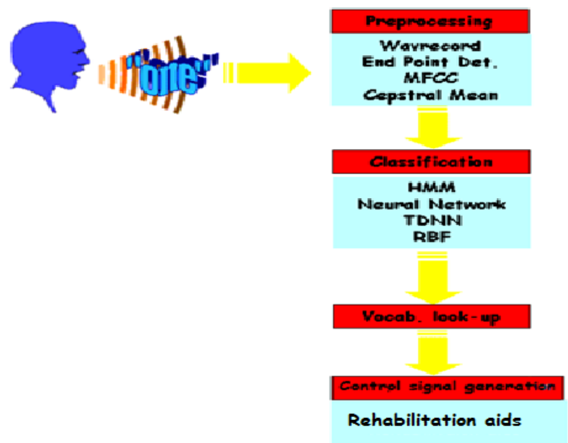

Figure-2. Block diagram of voice recognition.

The basic block diagram of EOG technique is as shown in Figure-1. The EOG signals from the user are measured by placing electrodes on the region surrounding the eye. They were recorded from two separate regions: horizontal and vertical. Horizontal electrodes were for detecting horizontal eye movements (left and right eye movement) and vertical electrodes were for detecting vertical movements (up and down cornea movements).

After processing the captured signal the next step followed is bio signal to control signal generation. Separate eye movements and duration between individual eye movements can be formulated to produce individual control signals. These control signals were used to control the movement of a wireless controlled wheelchair.

These control signals were parallel in nature; the encoder took parallel data, packaged it into serial format and then transmitted it with the help of the RF transmitter module. At the receiver end, the decoder received the signal through the RF receiver module, decoded the serial data and reproduced the original data in the parallel

VOL. 10, NO. 17, SEPTEMBER 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

format. The microcontroller controlled the direction of wheel chair motors depending on the incoming data.

The basic block diagram of voice recognition is as shown in Figure-2. The control signals are already recorded, that is already trained the system with some control commands. The sound wave from the user is captured. The application captures user speech using the MATLAB wav record function (up to 2 seconds after recording started). The captured data is then processed for classification. Classifiers were trained using the previously discussed data. All data was used to train since the user of the translator is thought of as the test set (translator has not seen user speech prior to use).

Once after the classification of captured data the control signals are generated. These control signals are passed to the rehabilitation aid, in our case it is a wheel chair.

EXPERIMENTS AND RESULTS

The voice is stored as in the form of matrix. The system will be trained by using commands such as ‘start’, ‘stop’ etc. Then captured voice commands in real time are also represented as matrix. Then correlations between these two are calculated. That is correlation between trained command and real time command. Figure-3 and 4.3 shows the correlation values between trained commands and tested commands. The first value corresponds to ‘start’ command and second value corresponds to ‘stop’ command.

Figure-3 shows the values which are tested by ‘start’ command against trained ‘start’ and ‘stop’ commands. The first value, 27.3565 shows the correlation between trained ‘start’ command and tested ‘start’ command. The second value, 13.5585 shows the correlation between trained ‘stop’ command and tested ‘start’ command. From this it is clear that the command ‘start’ is correctly recognized.

The Figure-4 shows the values in graphical form. First line (at point 1) shows the correlation of ‘start’ command and second line (at point 2) shows the correlation of ‘stop’ command. From the Figure-4, it is clear that the tested ‘start’ command is more correlated to trained ‘start’ command itself.

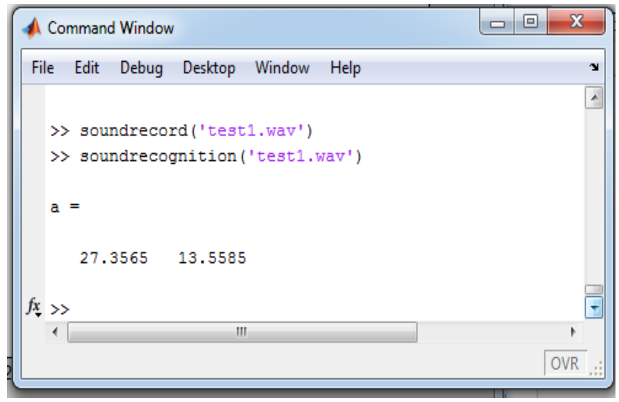

Figure-3. Correlation values when tested by ‘start’ command.

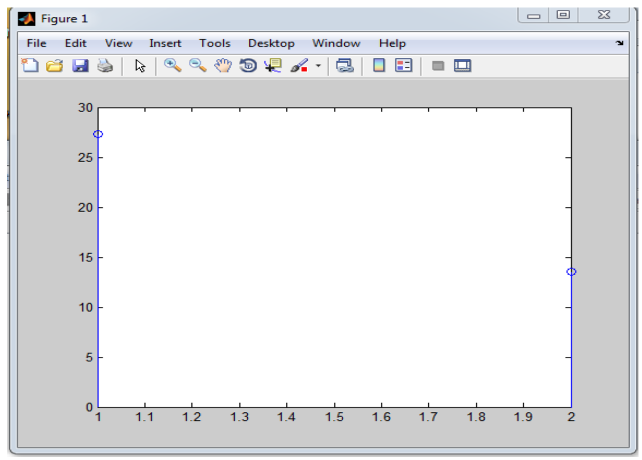

Figure-4. Graphical representation of correlation value when tested by ‘start’ command.

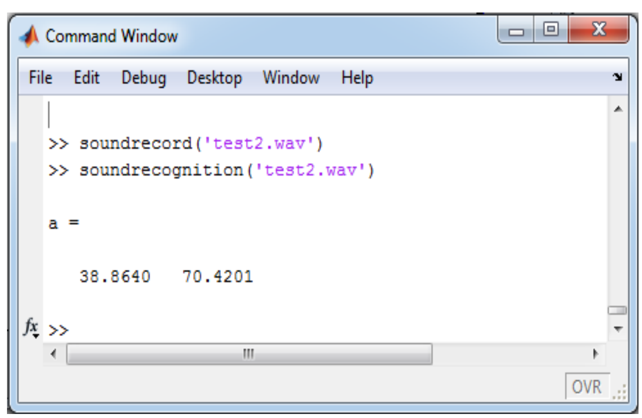

Figure-5. Correlation values when tested by ‘stop’ command.

Figure-5 and 6 shows the values when tested by using ‘stop ’command.

VOL. 10, NO. 17, SEPTEMBER 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

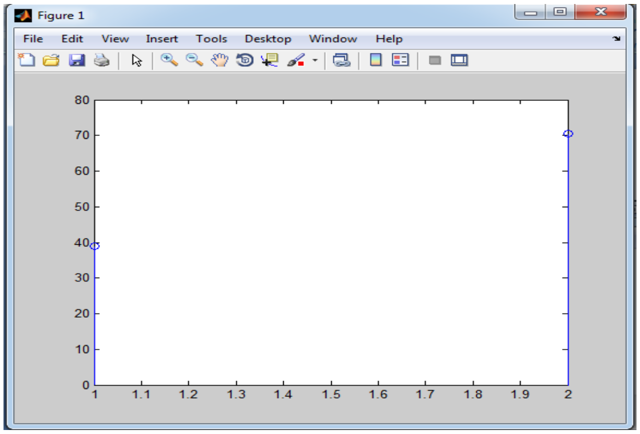

Figure-6. Graphical representation of correlation value when tested by 'stop' command.

Figure-5 shows the values which are tested by 'stop' command against trained 'start' and 'stop' commands. The first value, 38.8640 shows the correlation between trained 'start' command and tested 'stop' command. The second value, 70.4201 shows the correlation between trained 'stop' command and tested 'stop' command. From this it is clear that the command 'stop' is correctly recognized.

The Figure-6 shows the values in graphical form. First line (at point 1) shows the correlation of 'start' command and second line (at point 2) shows the correlation of 'stop' command. From the Figure-6, it is clear that the tested 'stop' command is more correlated to trained 'stop' command itself.

CONCLUSION AND FUTURE WORK

This paper presents briefly about various techniques used for controlling a wheel chair automatically. Each method has its own advantages and disadvantages. Some techniques use combination of methods, so that it can take the advantages of several methods.

This paper presented about EOG and voice based wheel chair. The paper consists of basic block diagrams and brief working.

The future work can be a combination of other two techniques instead of voice and vision, so that we can make use of the advantages of those two.

REFERENCES

[1] Shreedeepgangopadhyay, Somsubhramukherjee and Soumyachatterjee. "Intelligent Gesture Controlled Wireless Wheelchair for the Physically Handicapped" in Proceedings of Fifth IRAJ International Conference, 15th September 2013, Pune, India, ISBN: 978-93-82702-29-0.

[2] Ericka Janet Rechy-Ramirez, Huosheng Hu and Klaus McDonald-Maier," Head movements based control of an intelligent wheelchair in an indoor environment" IEEE proceedings 2012.

[3] Rakhi A. Kalantri, D.K. Chitre. 2013. "Automatic Wheelchair using Gesture Recognition" International Journal of Engineering and Innovative Technology (IJEIT) ISSN: 2277-3754, Vol. 2, No. 9, March.

[4] Malik Q A and Ahmad J. 2007. "Retina Based Mouse Control (RBMC)", World Academy of Science, Engineering and Technology, No. 7, pp. 318-321.

[5] Poonam S. Gajwani and Sharda A. Chhabria. 2010."Eye Motion Tracking for wheelchair Control", International Journal of Information Technology and Knowledge Management July-December, Vol. 2, No. 2, pp. 185-187.

[6] Amberlay Ruíz-Serrano, Rubén Posada-Gómez, Albino Martínez-Sibaja, "Development of a magnetic control system for an electric wheelchair using the tongue" IEEE 2013.

[7] Xueliang Huo, Jia Wang and Maysam Ghovanloo. 2008. "Introduction and preliminary evaluation of the Tongue Drive System: Wireless tongue-operated assistive technology for people with little or no upper-limb function", Journal of Rehabilitation Research &Development, Vol. 45, No. 6, pp. 921–930.

[8] Behnaz Yousefi, Xueliang Huo and Maysam Ghovanloo. "Preliminary Assessment of Tongue Drive System in Medium Term Usage For Computer Access And Wheelchair Control".

[9] G Uday Kiran, N. Nithesh Chakravarthi, K. R. Radhakrishnan. 2013. "Voice and Vision Controlled Wheelchair for Disabled" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 2 No. 6, June.

[10] Nolan Y. M. 2005. "Control and communication for physically disabled people, based on vestigial signals from the body", PhD thesis paper submitted to National University of Ireland, Dublin, pp. 7-18.

[11] Kohei Arai and Ronny Mardiyanto. "A Prototype of electric Wheelchair controlled by Eye-Only for Paralyzed User".

[12] GundaGautam, GundaSumanth, Karthikeyan K. C, Shyam Sundar, D. Venkataraman. 2014. "Eye Movement Based Electronic Wheel Chair For Physically Challenged Persons, International Journal Of Scientific & Technology Research ,ISSN 2277-8616, Vol. 3, No. 2, February.

[13] Rakhi A. Kalantri, D.K. 2013. "Automatic Wheelchair using Gesture Recognition" International Journal of Engineering and Advanced Technology

(IJEAT) ISSN: 2249 – 8958, Vol. 2, No. 6, August.

[14] Diksha Goyal and S.P.S. Saini. 2013.“Accelerometer Based Hand Gesture Controlled Wheelchair” in International Journal on Emerging Technologies, Vol. 4, No. 2, pp. 15-20.

[15] P. Jia, H. Hu, T. Lu and K. Yuan. “Head Gesture Recognition for Hands-free Control of an Intelligent Wheelchair”.

[16] Kohei Arai and Ronny Mardiyanto. 2011. “Eyes Based Eletric Wheel Chair Control System” (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 12.

[17] ToonGoedem´e, MarnixNuttin, TinneTuytelaars and Luc Van Gool. “Vision Based Intelligent Wheel Chair Control: the role of vision and inertial sensing in topological navigation”.

[18] Pedro Ponce, Arturo Molina and Rafael Mendoza “Wheelchair and Virtual Environment Trainer by Intelligent Control”.

[19] http://www.bbc.com/news/science-environment-12490048

[20] http://singularityhub.com/2009/11/16/audeo-lets-you-talk-or-control-wheelchair-with-your-thoughts-video/