

Comparative Study on Computers Operated By Eyes and Brain

Gaurav Jindal¹, Shweta Gupta²

¹Gitarattan International Business School
gauravjindal05@gmail.com

²Gitarattan International Business School
shweta79870@gmail.com

Abstract: *This research paper is based on the comparative study on Computer operated by Eyes and Brain. The working, advantages, disadvantages and usage of these systems in day to day life is discussed in this paper. The computer operated by eyes use the eye gazed system and camera to capture the movements of eyes. The computer operated by brain uses the Brain computer Interface (BCI) which captures the muscle movement of the brain.*

Keywords: Computer Operated Eyes, Computer Operated Brain, BCI

1. Introduction

Today human interact with the computer using many ways, such as by hands; by speech; by eyes; brain waves and many more. Human interact with computer using hands and speech has become very common. But the interaction with computer using eyes and brain is not so common. These two technologies are useful to the people who are physically unable to operate computer by their hand and speech.

Motivation behind using the computer operated by eyes and computer operated by brain:

There are situations that prohibit the use of hand, such as when user hands are disabled or continuously occupied with other tasks [1]. The eye can move very quickly in comparison to other body parts. Furthermore, as many researchers have long argued [2] [3], target acquisition usually requires the user to look at the target first, before actuating cursor control. Theoretically this means that if the eye gaze can be tracked and effectively used, no other input method can act as quickly. Increasing the speed of user input to the computer has long been an interest of HCI research.[1]

Reducing fatigue and potential injury caused by operating keyboard and pointing devices is also an important concern in the user interface field. Repetitive stress injury affects an increasing number of computer users. Most users are not concerned with RSI until serious problems occur. Utilizing eye gaze movement to replace or reduce the amount of stress to the hand can be beneficial.[1]

Its main purpose is to provide assistance in communication to severely paralyzed patients –especially those who suffer from amyotrophic lateral sclerosis (ALS) and it is useful for patients who cannot use any other body part to control the computer.

2. Computers operated by Eyes

In the Computer operated by eyes we need to use various techniques for eye gazing mentioned in literature [4]. Some of the techniques are Electro-Oculography [5], Limbus, Pupil and Eyelid Tracking [6, 7, 8, 9, 10, 11, 12], Contact Lens Method, Cornea1 and Pupil Reflection Relationship [7, 8, 11], Purkinje Image Tracking, Artificial Neural Networks [13] and Head Movement Measurement [14, 15, 16, 17].

In Electro-Oculography the electrodes are placed either at the above or below the eyes or on the left and right side of the eyes. Whenever the eyes moves from center towards the electrode then that electrodes sees the positive side of the retina and the other electrode sees the negative side of the retina. The recorded eye movement is the measure of eye position.

Eye can act as an input device to the computer by looking at the screen continuously. The user had to keep its head straight for giving an input to the computer. Slight head movement is allowed to the user. There is a mark placed on the optical wore by the user. This mark tells the computer that eyes are ready to give input and in the right position. The camera is used to capture the pupil movements. The icons present on the screen of the computer are comparatively bigger than the usual one, because the eyes have to concentrate on the screen to select the icon. So to prevent the computer from any mistake because of icons are small they are kept bigger. There is some specified time is mentioned to select an icon on the screen. The user had to look on the icon he/she want to select for a specified time and after the time expire the icon get selected.

Once the icon gets selected the color of icon also changes. The color of icon changes once again if the user wants to double click it. This will happen by staring at icon once again for a specified time. These eye movements are so

quick that the mouse pointer moves smoothly on the screen. The eye movements of pupil can be calculated by Longest Line Scanning (LLS) and Occluded Circular Edge Matching (OCEM). In this the computer screen is divided into three parts: Center, Right and left. The distance is calculated from centre point to the left and right.

Advantages of eye operated Computer

- People without hand can operate computer smoothly.
- No extra wiring required to give input just the camera and the software is required.

Disadvantages of eye operated Computer

- Slight head movement is allowed.
- Special training is required to operate the computer.
- Particular distant must be maintained between the computer and the user.
- Problem in finding out the center of the eye if the eyes are small.
- Wait for a particular time to select an icon.

Application of eye operated system

- Laptops
- Tablets
- Wheel Chair
- Used in playing games

3. Computers operated by Brain

In Computer operated by brain provides a new way of communication with the computer for severely paralyzed people who had no control over their muscular activity. A Brain Computer Interface (BCI), often called Mind Machine Interface (MMI) is the direct communication channel between the brain and the computer. There are several methods for recording brain activity, but the most accurate method is EEG. EEG gives the high temporal resolution and it is easy to apply.

The BCI works because our brain is filled with neurons, individual nerve cells connected to one another by dendrites and axons. Every time we think, move, feel or remember something, our neurons are at work. The path taken by the signals are insulated by myelin, and some of the electronic signals are not captured. They get escaped. The captured signals can be detected, their meaning can be interpreted and they can be used to direct the device. It can also work the other way around.

To do the interpretation of signal and using them as a command can be done by a set of electrodes this is called as a device Electroencephalography (EEG). This device is attached to the scalp of the user. The limitation to this device is that the skull blocks many electrical signals. To

prevent the electrical signal lost the device can be implanted directly into the gray matter of the brain, or on the surface of the brain, beneath the skull. By this means much more signals are received by the device and the electrodes are placed on the area where the appropriate electrical signals generated. This approach has many problems. This approach requires the intense surgery to implant the electrodes on the brain surface and moreover the formation of scar tissues on the brain surface will leads to the same problem as before. This scar tissue ultimately blocks signals.

The measuring unit of electrodes is the minute difference between the voltages if the neurons. The signals captured are amplified and filtered to use further. This signal is then interpreted by the computer program.

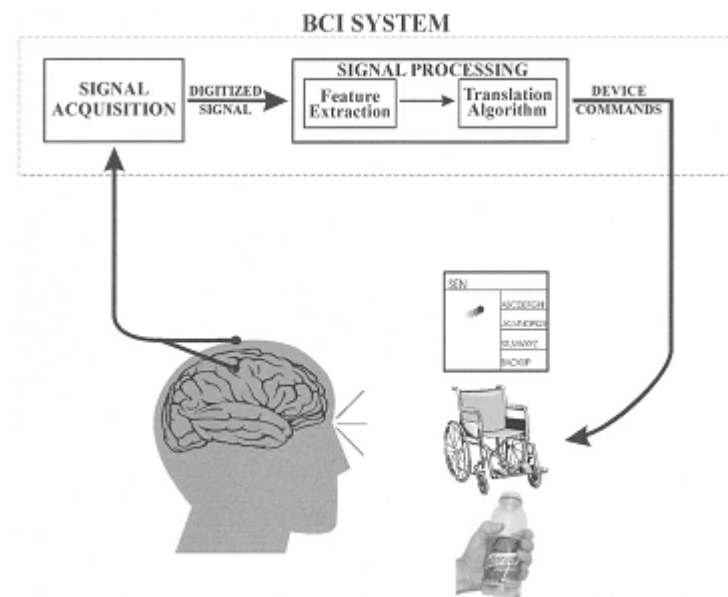


Figure 1: BCI System

In the case of a sensory input BCI, the function happens in reverse. A computer converts a signal, such as one from a video camera, into the voltages necessary to trigger neurons. The signals are sent to an implant in the proper area of the brain, and if everything works correctly, the neurons fire and the subject receive a visual image corresponding to what the camera sees.

Advantages of BCI

- Help in creating a direct pathway between the human and external device like computer.
- Develop better sensing system.
- Can be operated any where in the world because of linguistic independence.
- Disadvantages of BCI
- Risk of formation of the scar tissue on the brain.
- Lost of money investment is required in the setup.

- Signals are weak and prone to interference.
- Surgery of brain might be risky and cause brain death.
- Chemical reactions inside brain can not be detected by the BCI.

Table 1: Difference between the Computer operated by Eyes and Computer operated by Brain

<i>Basis</i>	<i>Eye operated Computer</i>	<i>Brain operated Computer</i>
Equipments Needed	Video camera, Spectacles with 2-D mark, Software to calculate the eye movement on screen.	Electroencephalograph (EEG), Computer program for interpretation, Pens to write signals, Video Camera.
Training	There is training required to give to the user regarding the usage of the computer.	No training is required.
Equipments to be worn on the body.	Spectacles with 2-D mark	Electroencephalograph attached to the scalp.
Distance from the computer	The user should sit at the particular distance from the computer to give input.	The user can sit apart from the computer with in the room.
Direction of the user.	User must sit in front of the screen and camera.	User can sit in any direction.
Body movement	The user must not move its head frequently in order to give input. Slight movement of head is allowed.	The user can move any of its body part. But this technology is mainly useful for disabled.
Time taken	Time taken by this type of computer is more than the brain operated computer. Because it takes time to select the icon.	Time taken is less as compared to the eye operated computer. Because it directly capturing brain signals and converting them into commands.
Barrier	Coverage of the top and bottom of the limbus by the eyelids and	The skull blocks the electrical signal, and it distorts what does get through.

	Excessive coverage of the eyes by eyelids (in some cases). [20]	
Typing	For typing it uses the virtual keypad embed on the screen and the speech recognition software.	For typing it uses the brain signal only.
Signal	It does not show any signal or any working of the input given on the screen such as distance calculation etc.	It shows the electronic signal on the screen and then proceeds.
Cost	It is less expensive as compared to the	It is more expensive than the eye operated computer.
Error	In this system there is error because of the coverage of eyes. The calculation of centre of eye is calculated wrong and the wrong calculation of distance.	There is less error as compared to the eye because it takes direct signal from brain. But signal may corrupt due to the skull and formation of scar tissue.

4. Application of the BCI

Possible communication channel for the people suffering from diseases like paraplegia, amyotrophia.

- Surgical implanted devices used as replacement for damaged neurons.
- Applied in professional gaming
- Applied in robotics.

5. Conclusion

In this paper the basic functionality of both the Eye operated computer and Brain operated computer is discussed. How these two system works and what are their differences is discussed. Moreover, these two different systems are used for the people who are disabled. These systems help disabled person to communicate with the other people to share their views and ideas and can earn their lively hood also without being dependent on other for this. The Pros and cons and comparison between both the devices is discussed her.

References

- [1] Manual and Gaze Input Cascaded (MAGIC) Pointing Shumin Zhai Carlos Morimoto Steven Ihde IBM Almaden Research Center.
- [2] Ware, C. and H.H. Mikaelian. An evaluation of an eye tracker as a device for computer input. In CHI+GI: ACM Conference on Human Factors in Computing Systems and Graphics Interface. 1987. Toronto.
- [3] Jacob, R.J.K. What You Look At is What You Get: Eye Movement-Based Interaction Techniques. In CHI'90: ACM Conference on Human Factors in Computing Systems. 1990: Addison-Wesley/ACM Press.
- [4] Laurence R. Young And David Sheena, Survey of Eye Movement Recording Methods, Behavior Research Methods and Instrumentation, Vol. 7, No. 5, pp. 397-429, 1975.
- [5] Arie E. Kaufman, Amit Bandopadhyay, Bernard D. Shaviv, An Eye Tracking Computer User Interface, Research Frontier in Virtual Reality Workshop Proceedings, IEEE Computer Society Press, pp. 78-84. October 1993.
- [6] Glenn A. Myers, Keith R. Sherman, And Lawrence Stark, Eye Mornitor, IEEE Computer Magazine, Vol. March, pp. 14-21, 1991.
- [7] Yoshinobu Ebisawa, Improved Video-Based Eye-Gaze Detection Method, IEEE MTC '94, Hamamatsu, May, 1998.
- [8] Thomas E. Hutchinson, K. Perston White, Jr., Worthy N. Martin, Kelly C. Reichert, and Lisa A. Frey, Human-Computer Interaction Using Eye-Gaze Input, IEEE Trans. on Systems, Man, and Cybernetics, Vol. 19, No. 6, pp. 1527-1534, 1998.
- [9] C. Colombo, S. Andronico, and P. Dario, Prototype of a Vision-Based Gaze Driven Man-Machine Interface, Proceedings IEEE/RSJ International Conference on Intelligent Robots and Systems, August, 1995.
- [10] Christophe Collet, Alain Finkel, and Rachid Gherbi, CapRe: A Gaze Tracking System in Man- Machine Interaction, Proceedings of IEEE International Conference on Intelligent Engineering Systems, September, 1997.
- [11] Baoshen Hu and Minghua Qiu, A New Method for Human-Computer Interaction by using Eye Gaze, Proceedings of IEEE International Conference on Systems, Man and Cybernetics, October, 1994.
- [12] Rainer Stiefelhagen, Gaze Tracking for Multimodal Human-Computer Interaction, Diplomarbeit, Universitiit Karlsruhe, September, 1996.
- [13] Shumeet Baluja and Dean Pomerleau, Non- Intrusive Gaze Tracking Using Artificial Neural Networks, CMU Technical Report, CMU-CS-94-102, School of Computer Science, Carnegie Mellon University, January, 1994.
- [14] Philippe Ballard and George C. Stockman, Computer Operation via Face Orientation, Pattern Recognition, Vol.1. Conference A: Computer Vision and Applications, Proceedings., 11th IAPR International Conference, 1992.
- [15] Thanrat Horpesert, and Yaser Yacoob, and Larry S. Davis, Computing 3-D Head Orientation from a Monocular Image Sequence, Proceedings of the Second International Conference on Automatic Face and Gesture Recognition, October, 1996.
- [16] A. H. Gee and R. Cipolla, Determining the Gaze of Faces in Images, Technical Report, CUED/FINFENG/ TR 174, Department of Engineering, University of Cambridge, March, 1994.
- [17] David Young, Hilary Tunley, and Richard Samuels, Specialized Hough Transform and Active Contour Methods for Real-Time Eye Tracking, Cognitive Science Research Paper, 386, School of Cognitive and Computing Sciences, University of Sussex, July, 1995. II
- [18] Vision-Based Eye-Gaze Tracking for Human Computer Interface Kyung-Nam Kim* and R. S. Ramakrishna, Department of Information and Communications, Kwangju Institute of Science and Technology.