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Original Research Paper

Brain Operated Wheelchair Using a Single Electrode EEG Device and BCI

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Abstract: This paper predominantly explains the use of a simplistic uni-polar device to obtain EEG for the development of a Brain-Computer Interface (BCI). In contrast, BCI's eye-blinking stimuli can also be obtained. Consequently, focus and eye-blinking stimuli can be captured as control pulses in electric wheelchairs via a computer interface and electrical interface. This survey paper aims to provide a feasible solution to integrate a Brain-Computer Interface (BCI) with automated identification and avoidance of obstacles. The automated obstacle detection and avoidance system aims to provide a way to easily detect obstacles and easily correct the course.

Keywords: Brain Computer Interface, Electric Wheelchairs, Electrode Electroencephalogram.

1. Introduction

Wheelchairs are tools used for mobility of individuals whose walking is hard or impossible due to an illness or disability. There are several types of wheelchairs, including basic, lightweight, folding, multi-purpose, special types, and so on. Each of them has its benefits and drawbacks [1].

The development of the brain computer interface (BCI) aims to provide a communication channel from a human to a computer. The role of the brain control interface is to directly translate the brain activity into sequences of control commands. Communication can be either unidirectional, where information flows only from the brain to the machine, or bidirectional, which incorporates biofeedback. . BCI devices may give disabled people direct control over a neural based computer applications as a tool for communicating only by their thinking which is reflected in their brain signals. We record brain activity by means of a single electrode electroencephalogram (EEG) which is noninvasive, i.e, it does not involve the introduction of instruments into the body.

Many people with mobility disabilities rely on powered wheelchairs to get out and about. It was estimated in 2000 that there were over 11,350 electrically powered indoor / outdoor chair (EPIOC) users in the U.K. By itself, this number has steadily increased by more than 3500 per year.

BCl's are the only means of inferring user intent through direct measures of neural activity, typically via EEG signals [2]. A BCI system is designed to translate EEG signals from neural activity reflection to user action via system hardware and software [3] [4] [5] [6].

A large number of BCI systems were developed over the last several decades since they promise an alternative and effective way of communicating with the computer for individuals affected by neuro-muscular disorders.

In this context, we present a noninvasive brain-controlled wheelchair driven by electroencephalogram (EEG) signals to be used by paralytic users.

The device used to capture the EEG signal is the NeuroSky MindWave single electrode headset. This headset is capable of transmitting the EEG signal electronically to the PC (personal computer) via Bluetooth. The EEG signals are then processed and converted into a neurological command by using the PC software.

2. Structure of BCI

BCI is an unconventional communication system which enables users to translate brain activity, measured by an EEG device into a control signal. A brain-computer interface acquires brain signals, analyses them and converts them into electrical or digital signals which then can be used by a machine [2] [3] [5].

The main function of a BCI is to restore motor functionality to people disabled by neuromuscular disorders such as cerebral palsy and spinal cord injury.

Figure 1 shows a basic schematic of a BCI system.

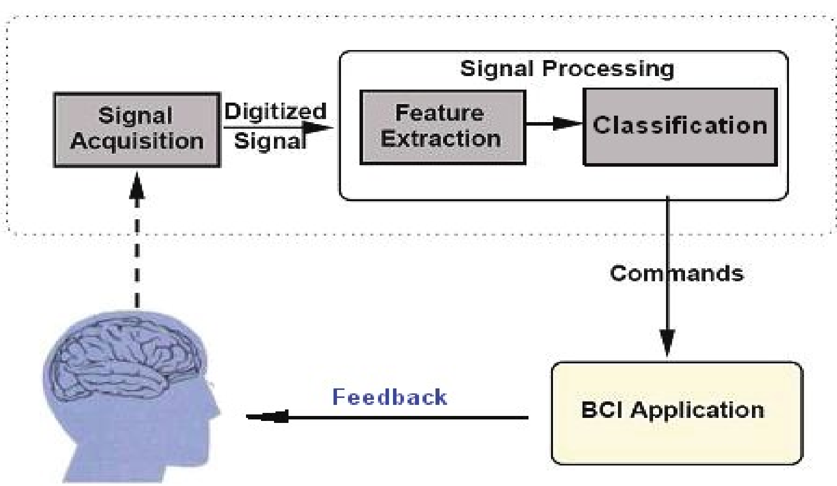

Figure 1. The Brain Computer Interface System

The schematic model of a BCI system, as seen above, consists mainly of 4 parts [7] [8] [9] [10] [11].

- The first part is the human brain which generates the brain activity signal.
- The second part of this system is the signal acquisition system which collects the EEG signals from the human brain.
- The third part is the Signal Processing unit which again comprises of subsystems which helps in extracting the right feature from the raw EEG data
- The fourth part is the command which is sent to BCI applications which then use these commands to perform the following function.
- The block of signal processing includes pre-processing, feature extraction, and classification.

3. Framework

Figure 2 shows the proposed framework of the wheelchair system.

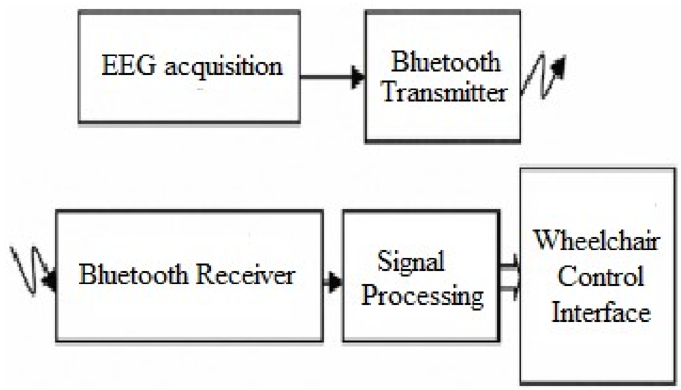

Figure 2. Framework of the Wheelchair System

The proposed framework of the Brain Operated Wheelchair System consists of the wheelchair part and the controller part. The wheelchair part consists of an EEG signal acquisition system and a wireless Bluetooth transmission system which transmits this data to the controller. The Controller part consists of the wireless receiver module along with a signal processing block and a wheelchair control interface.

Table 1 depicts the commands for the operation that control the wheelchair using the BCI.

Table 1. Commands for the Controller the wheelchair using the BCI

ACTION	SIGNAL
Turn clockwise	Attention
Move Forward	2 eye-blink pulse
Stop	2 eye-blink pulse

A person is required to concentrate for brief period of time to turn the wheelchair clockwise at a slow constant rate.

If the wheelchair is stationary and the system registers a 2 eye-blink pulse then the wheelchair starts moving forward at constant rate. If the system registers a 2 eye-blink pulse when already in a forward motion the wheelchair comes to a stop.

4. Methodology

In the receiving part, integration of a Bluetooth module is done with a software interface by using MATLAB.

This paper also tells about the two types of EEG signal classification done for the purpose of driving the wheelchair.

The raw EEG signal is used to convert electrical voltage to control the electric wheelchair, while the long EEG signals were further classified into digital signals such as attention and mediation.

Figure 3 shows the flowchart for the Bluetooth receiver and EEG classifier.

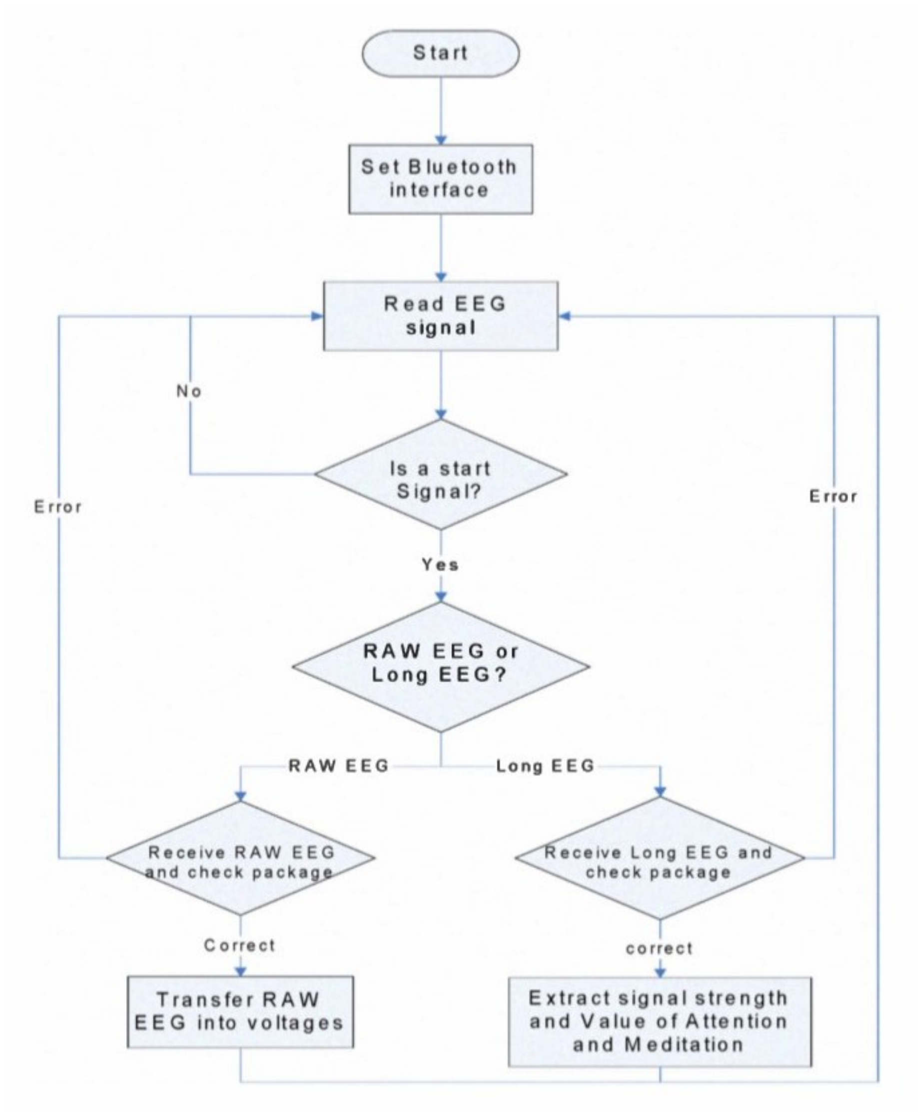

Figure 3. Flowchart of the Bluetooth Receiver and EEG Classifier

This system, a compass panel and one eye-blinking pulse are used to decide the moving direction. Also, the wheelchair stops moving if it encounters an obstacle or 2 eye-blink pulse. The wheelchair will then move forward if it encounters a brief "attention" signal.

Alongside this there is a two-organize Obstacle Detection Based on a quick striking impediment recognition calculation.

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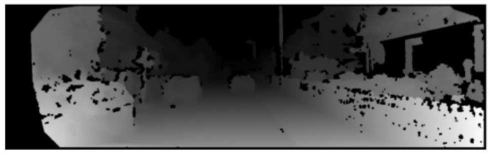
(a) The input image.



(b) The disparity image.

(c) The red parts means the obstacles.

Figure 4. Obstacle Detection Based On a Quick Striking Impediment Recognition Calculation

This is done through straightforward 4 stages:

Stage 1 Use the striking snag recognition calculation to distinguish notable impediments. To distinguish remarkable items dynamic filtering is presented. We check the difference picture push by push, we set an edge esteem and on the off chance that the divergence esteem is more prominent, at that point we mark these focuses as deterrents. Utilizing along these lines' huge numbers of the ground focuses are expelled. Among the rest of the ground focuses held in the remarkable hindrance map because of the improper parameter choice, we at that point perform segment by segment by segment. On the off chance that the quantity of every dissimilarity esteem is not exactly the given limit, then the relating indicates are set zero. By along these lines, the ground focuses and the little deterrent focuses are evacuated.

Stage 2 Compute 3D point cloud and refine the striking obstruction recognition. This stage is quick henceforth we use zone filling calculation which depends on morphological recreation. There is a channel is utilized to evacuate the leftover commotion. Since the section examining evacuates landscapes on a similar tallness so a 3D point cloud is processed for the striking deterrent guide and remaining part. At that point the base stature is gotten and any item more noteworthy than this is delegated a remarkable article.

Stage 3 Use an improved space-variation goals (SVR) calculation to distinguish little obstructions. First while filtering we diminish the goals by 1/n. Second, the calculation checks the tested focuses, on the off chance that one good point is discovered, at that point the truncated triangle is re-filtered. Third, pixels whose comparing 3D directs are up toward Euclidean separation f separated from one another are set apart as impediment focuses and thus the thick obstructions are recognized.

Stage 4 Merge the striking snag map and the little impediment guide to get the last hindrance recognition calculation results.

5. Conclusions

BCI interface is built that can read EEG signals for driving a wheelchair without any kind of physical inputs. These EEG signals are read using a single Uni-polar electrode and fed into the computer system using a Bluetooth interface. The computer distinct the signals into 3 categories which are single eye blink pulse, two eye blink pulse and a constant attention signal. These signals are evaluated and then transmitted to the motor processor that drives the wheelchair and gives an easy control to the patient.

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