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Research Article

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Brain Computer Interface

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Abstract:

A brain-computer interface (BCI) called a brain-machine interface or a direct neural interface or a mind machine interface (MMI) or, is a direct communication pathway between a human or animal brain and an external device. In one-way BCIs, computers either accept commands from the brain or send signals to it but not both. Two-way BCIs would allow brains and external devices to exchange information in both directions but have yet to be successfully implanted in animals or humans. This technology provides communication and control capabilities to people with severe motor disabilities .These BCI can measure specific features of brain activity and translate them into device control signals.

Keywords: BCI , neural interface, control signals, motor disabilities ,MMI

I. INTRODUCTION

Many people with severe motor disabilities need augmentative communication technology. Those who are totally paralyzed cannot use conventional augment technologies, all of which require some measure of muscle control. Over the past two decades, a variety of studies has evaluated the possibility that brain signals recorded from the scalp or from within the brain could provide new augmentative technology that does not require muscle control for a comprehensive review. These BCI systems measure specific features of brain activity and translate them into device control signals. The features used in studies to date include slow cortical potentials, P300 evoked potentials, sensorimotor rhythms recorded from the scalp, event-related potentials recorded on the cortex, and neuronal action potentials recorded within the cortex [2]. These studies show that non muscular communication and control is possible and might serve useful purposes for those who cannot use conventional technologies. To people who are locked-in (e.g. Brainstem stroke, or severe polyneuropathy) or lack any useful muscle control ,a BCI system could give the ability to answer simple questions quickly, control the environment, perform slow word processing, or even operate a neuroprosthesis or orthosis . At the same time, the performance of this new technology, measured in rate and accuracy, or in the inclusive measure, information transfer rate (i.e., bit rate), is modest. Current systems can reach no more than 25 bits/min, 1 even under optimal conditions. The ultimate value of this new technology will depend largely on the degree to which its information transfer rate can be increased.[1],[7]

A. Principle

The system consists of a device that is implanted on the motor cortex of the brain. The principle is that the complete brain functions, brain signals are generated even though they are not sent to the arms, hands and legs. The signals are unspoken and deciphered into cursor movements, offering the user an alternate “BRAINGATE TRAJECTORY” to control a computer with supposed, just as societies who have the ability to move their fingers.

B. Brain Gate

It is an electrode chip. The chip contains 96 hair-thin electrodes that Intelligence the electro-magnetic sign of neurons firing in specific areas of the brain. For example, the area that panels arm crusade. When it is applied in brain, the electrical signal bartered by neurons within the brain. These signals are sent to the brain and it apparatuses body movement. All the signalling is touched by special software. eg (Custom Decoding Software, algorithms are written in C, JAVA and MATLAB). The signal guides to the computer and then the computer is skilful by patient. When a man forgotten about his past due to certain accidental matter or he had lost his part of his body, at that time this electrode chip can be understood
on his brain and vigorous the man as well.[6]

Types Of Brain Computer Interface

1) *One way BCI* :
   Computers either accept commands from the brain .
2) *Two way BCI* :
   Allow brains and external devices to exchange information in both directions.

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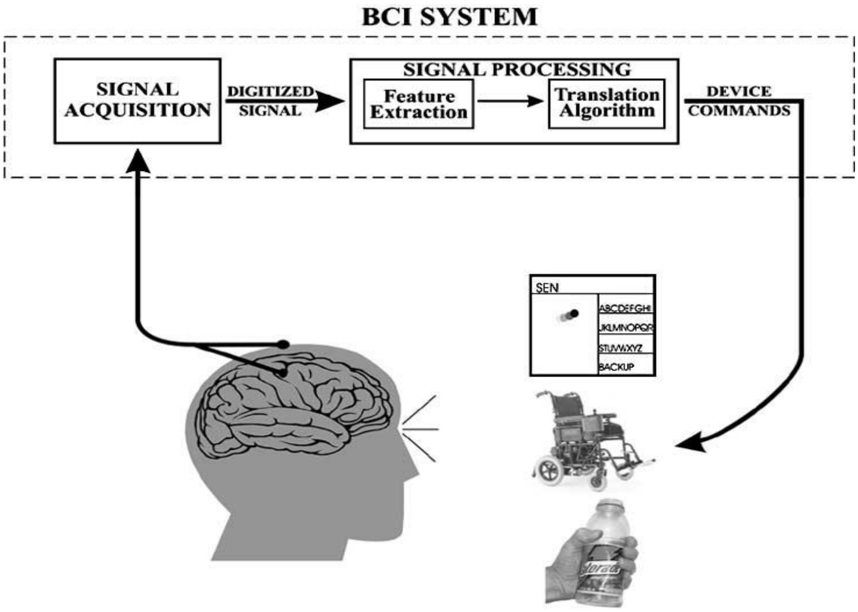

Fig..1 Basic Design Operation Of Any BCI System

II. IMPLEMENTATIONS OF BCI2000

A. System variables

BCI2000 incorporates three types of system variables: parameters, event markers, and signals. System parameters are those variables that do not change throughout a data file (i.e., during a specified period of online operation). In contrast, event markers record events that occur during operation and that can change from one data sample to the next. The inclusion of all event markers in the data file allows full reconstruction of the session and comprehensive data analyses. Each module has access to these event markers and can modify and/or simply monitor them. Finally, system signals are functions of the user's brain signals that are received and modified by the modules. Each module can request that the operator module create any number of system parameters (of different data types such as numbers, vectors, matrices, or strings) or event markers (each 1–16 bits long).[4],[3]

B. Platform

The BCI2000 system model accommodates any programming language, any development environment and any operating system. For our initial implementation, we chose C++ as the programming language because it is the highest level language that can satisfy all system requirements , and Borland C++ Builder as the development environment because it offers an excellent rapid-application development platform for C++. We chose Microsoft Windows 2000/XP as the operating system because it offers the most auxiliary components . Like most operating systems, it is not a real-time system. Thus, to ensure that it satisfied real-time requirements, we carefully designed the software to depend as little as possible on potentially lengthy operating system functions, and we assessed the time course of online operation for representative implementations of BCI2000.[4]

III. Modules of BCI

A. Source Module:

The source module digitizes and stores brain signals and passes them on without any further pre-processing to signal processing. It consists of a data acquisition and a data storage component. Data storage stores the acquired brain signal samples along with all relevant system in a data file. The documented file format consists of an ASCII header, followed by binary signal sample, and event marker values.

B. Signal Processing Module:

The signal processing module converts signals from the brain into signals that control an output device. This conversion has two stages: feature extraction and feature translation. In the first stage, the digitized signal received from the source module is subjected to procedures that extract signal features (e.g., firing rate of a cortical neuron etc.). In the second stage, a translation algorithm translates these signal features into control signals that are sent to the user application module. Each of the two stages of signal processing consists of a cascade of signal operators, each of which transforms an input signal into an output signal. [8]

C.** User Application Module**:

The user application module receives control signals from signal processing and uses them to drive an application. In most present-day BCIs, the user application is presented visually on a computer screen and consists of the selection of targets, letters, or icons. User feedback could also be auditory or haptic. Selection is indicated in various ways. Some BCIs also give interim output, such as cursor movement toward the item prior to its selection. Each of these applications could be realized with BCI2000.

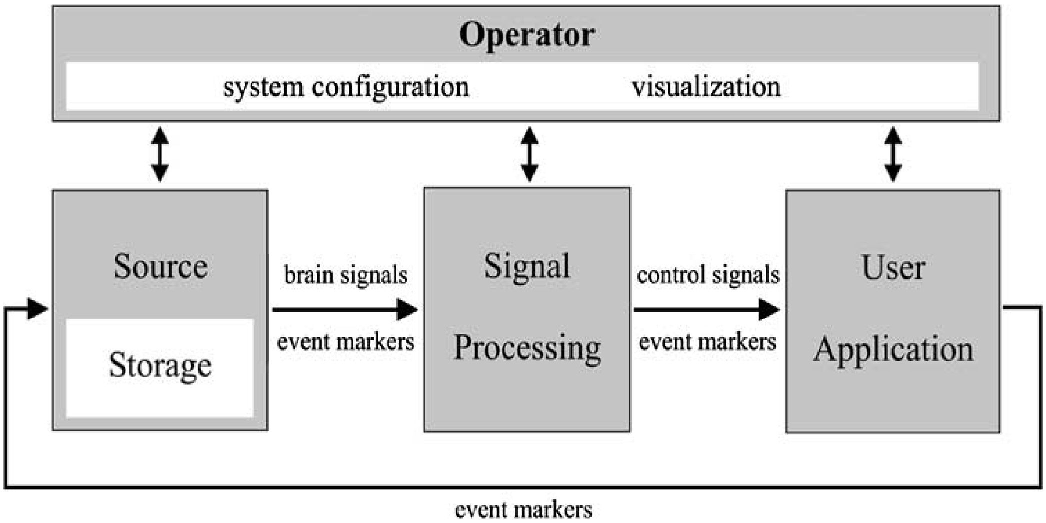

Fig.2 BCI Design

D. Operator Module:

The operator module defines the system parameters (e.g., the trial length in a specific application or a specific signal processing variable) and the onset and offset of operation. The system model does not specify how these definitions are made—they could come from an automated algorithm and/or from the investigator. In addition, operator can display information (e.g., a text message or a signal graph) sent to it from any other module without needing any prior information about the nature of this information. This allows an investigator to control an experiment and to receive real-time information about online events.[8],[7]

IV. BENEFITS OF BCI2000

BCI2000 provides a number of benefits to the investigator, to the software engineer, and to the user. The many BCI methods that have been created to date using BCI2000, and the rapid implementation of the system by a growing number of laboratories (i.e., more than 20 as of early 2004), illustrate its ease of use and practical advantages.

Benefits to the Investigator:

The primary benefit of BCI2000 to the investigator is the availability of a complete system that can already realize established BCI methods and that can be used with little or no change to the software to implement BCI paradigms that have not been previously reported (e.g., item selection using auditory evoked potentials). The growing number of contributions from laboratories using BCI2000 ensures that new methods are being developed
Continually.[5] BCI2000 is an open system that is available free of charge for research and educational purposes and that places no restrictions on how it might be used. To date, most groups using the system are following one of the following three patterns:

1) using the existing BCI2000 system without changing the software;
2) implementing new methods or system capabilities into BCI2000;
3) using BCI2000 as a platform to develop systems for research not related to brain-computer interfaces.

Benefits to the Software Engineer:

BCI2000 also benefits software engineers, who can build on the existing modules and on the application programming interface (API) that BCI2000 provides (e.g., functions that provide access to signals, parameters, event markers), and can thereby concentrate on the aspects are unique to a particular method.
Benefits to the User: BCI2000 is also directly beneficial to users with severe disabilities. Since it supports all major BCI methods that have been developed to date for use in humans, it can be configured to use the specific brain signal, analysis.

V. FUTURE DEVELOPMENTS OF BCI2000

A. Platform:

Future implementations of BCI2000 could support other program environment (e.g., Mat lab or Lab View), or operating systems (e.g., Linux, Windows CE™).

B. Modules:

1) *Source module:* BCI2000 currently supports data acquisition hardware from four different vendors (Section III-B1). This list can be readily expanded.
2) *Signal processing module:* Currently, BCI2000 can extract features from scalp-recorded sensorimotor cortex rhythms, cortical surface rhythms, slow cortical potentials, cortical single neurons, and P300 evoked potentials. Other brain signals, such as the error potential , cortical field potentials or neuronal activity, may require alternative feature extraction methods BCI2000 can readily implement such methods.
3) *User application module:* At present, most User Application modules in BCI2000 provide visual output on a computer screen. However, this output may not be suitable for users with decreased visual acuity (e.g., due to late-stage ALS) or gaze instability (e.g., due to cerebral palsy).[7] Solutions include a virtual reality display or auditory rather than visual feedback, both of which can be readily implemented using BCI2000. Additional applications under development include multidimensional cursor control (see [36] and [42]) and a web browser .
4) *Evolution of Specific Clinical Applications:* BCI2000 is able to satisfy the requirements of BCI research and development programs. On the other hand, once a specific BCI design is validated for clinical use, the flexibility of BCI2000 may become superfluous or even cumbersome. In such situations, reduced versions of BCI2000, in which some module components or even entire modules are fixed, could prove most convenient and efficient. Nevertheless, even in these cases, the continued adherence to the same common model and the standard BCI2000 data format should facilitate continuing oversight of system function and implementation of future modifications and expansions. [3]

VI. Conclusion

BCI2000 is intended to help BCI research and development move beyond the current stage of isolated laboratory demonstrations of highly specialized and mutually incompatible BCI systems. It provides a flexible general-purpose platform that facilitates the evaluation, comparison, and combination of alternative brain signals, processing methods, applications, and operating protocols that are essential for continued progress. By reducing the time, effort, and expense of testing new designs, by providing a standardized data format for offline analyses, and by allowing groups lacking high-level software expertise to engage in BCI research, BCI2000 can increase the rate of progress in both laboratory research and clinical applications. To achieve this purpose, BCI2000 embodies two basic principles. The first is a system model of four modules that encompass the four essential functions of any BCI system: signal acquisition, signal processing, output control, and operating protocol. As a result, BCI2000 should allow for implementation of any conceivable BCI design. The second principle is maximization of the independence, interchange ability, and scalability of each module and its components. As a result, a change in a module or a component should require little or no change in other modules or components. BCI2000 has proved able to satisfy the different signal processing needs of BCI designs based on sensorimotor rhythms, cortical surface rhythms, slow cortical potentials, and the P300 potential, and to provide the different outputs needed for several kinds of cursor control and for selection from a matrix. From the online operation of each design, BCI2000 produced complete data in a standardized format for analysis .So we can say as detection techniques and experimental designs improve, the BCI will improve as well and would provide wealth alternatives for individuals to interact with their environment.

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