EEG BASED BRAIN CONTROLLED MOBILE ROBOT

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ABSTRACT

EEG-based brain-controlled mobile robots can serve as powerful aid for severely disabled people in their daily life, especially to help them move voluntarily. This project discusses about a brain controlled robot based on Brain–computer interfaces (BCI). BCIs are systems that can bypass conventional channels of communication (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. With these commands a mobile robot can be controlled. The intention of the project work is to develop a robot that can assist the disabled people in their daily life to do some work independent of others. We conclude this paper with a discussion of current challenges and future research directions.

Keyword: - *EEG, BCI System, and Direct communication*

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1. INTRODUCTION

Numerous patients are alluded to a neurologist to have an electroencephalogram (EEG), which records electrical motivations from the nerves in the head. "Electro" alludes to the electrical driving forces sent starting with one nerve cell then onto the next. These motivations are the way nerves converse with one another and get data from the mind. "Encephalo" alludes to the head, and "gram" alludes to the printed record. EEG exams are finished by putting cathodes on the scalp and seeing what the electrical motivations look like when the patient is alert, snoozing, in a room with a glimmering light or infrequently when the patient is requested that inhale profoundly again and again. At the point when the EEG is done, no power is put into or taken out of the patient. The electrical signs that the mind produces are essentially recognized and printed out on a PC screen or a bit of paper. An EEG decides the understanding's level of readiness or awareness is normal, irregularities in particular piece of the mind, propensity to have seizures or writhing and specific sort of epilepsy. Some of the time a patient may tend to have seizures, however his or her EEG is ordinary at the specific time it is finished. That is on account of individuals with a seizure inclination may have variations from the norm that go back and forth from hour to hour or normal. In these cases, a rehash EEG or a more drawn out time of EEG observing may be valuable. To control the wheelchair, EEG and Eye-Blinking signals are needed. Here this paper describes EEG and Eye-Blinking signals through a BCI interface. In this system we have a tendency to use simple unipolar electrode to record EEG signal from the forehead to construct a Brain-Computer Interface (BCI) primarily controls electrical wheelchairs through Bluetooth for unfit patients. We have got two signals like meditation and attention. In addition, we also extract the eye-blinking signals from BCI. Therefore, attention and eye-blinking signals are collected as the management signals through a Bluetooth interface and therefore the electrically interface in electric chair. The experimental results confirmed that this system will offer a convenient manner to control an electrical wheelchair.

2. SYSTEM DESCRIPTION

The central tenet of a brain-controlled mobile robot is to allow the user to control the mobile robot to reach the intended destinations safely and efficiently with the user' brain signals. The core technique that is applied to implement brain control robots is the BCI, which transmits EEG signals into user intensions and is indispensable for any brain control mobile robot. In addition to BCI, other techniques include 1) robot intelligence techniques in sensing surrounding situations, localization, path planning, and obstacle/collision avoidances and 2) shared control techniques, combining the BCI with the intelligence of robots to share the control over the robot [33], [34]. Since the intelligence of robots is a common issue which is involved in all autonomous mobile robots, we do not review it in this paper so as to make the scope of this paper manageable.

2.1 Brain-Controlled Mobile Robots

We divide brain-controlled mobile robots into two categories according to their operational modes. One category is called "direct control by the BCI," which means that the BCI translates EEG signals into motion commands to control robots directly. Various approaches to implement this method are shown in Table I. One typical example is the work of Tanaka etal. [21],who first developed a brain-controlled robotic wheelchair whose left or right turning movements are directly controlled by corresponding motion commands translated from user brain signals while imagining left or right limb movements, and tested this system in real-world situations. The robotic platform is illustrated in Fig. 2(a). Choi and coworkers [23], [28] also used a BCI based on motor imagery to build a brain-controlled mobile robot,asillustratedinFig.2(b),which can perform three motion commands including turning left and right and going forward, and validated this robot in a real world. This kind of robots does not need any additional robot intelligence. Thus, their cost and computational complexity are low. In addition, users can be in charge of their movements as much as possible, as in their own motion control. However, the overall performance of these brain-controlled mobile robots mainly depends on the performance of the non invasive BCIs, which are currently slow and uncertain. In other words, the performance of the BCI systems limits that of the robots. Further, users need to issue motor control commands rather frequently, often causing user fatigue. To address the two questions aforementioned that the robots directly controlled by a BCI meet, so as to make the user be able to control the robot over a long period of time, the second group of brain-controlled robots has been developed from a perspective of shared control, where a user (using a BCI) and an intelligent controller (such as autonomous navigation system) share the control over the robots. Compared with the robots that are directly controlled by the BCI, these groups can depend on the intelligence of the robots. Thus, the safety of driving these robots can be better ensured, and even the accuracy of intention inference of users can be improved. In addition, users spend less time using the BCI and are less likely to develop fatigue. The disadvantage of these robots is that the cost and computational complexity are high due to the use of an array of sensors (especially laser sensors),compared with the first group. Table II shows various systems of this group. Mill 'an et al. [34]

Table - 1:Brain-Controlled Mobile Robots Directly Operated By A Bci

Publication	Used brain signals	Classifier	Output commands
Tanaka *et al.* (2005) [21]	ERD/ERS	Nearest neighbor	Turning left and right
Choi *et al.* (2008-2011) [23][28]	ERD/ERS	SVM	Turning left and right and going forward
Pires *et al.* (2008) [24]	P300	Statistical classifier	Eight motion directions +stopping
Leeb *et al.* (2008) [25]	ERD/ERS	Linear classifier	Going forward
Craig *et al.* (2007) [26]	ERD/ERS and Alpha band	Artificial Neural Networks	Turning left and right, and stopping from alpha band
Dasgupta *et al.* (2010) [29]	SSVEP	SVM	Turing left and right, going forward, and stopping
Guger *et al.* (2009-2010) [30] [31][99]	SSVEP	LDA	Going forward and backward and turning left and right
Barbosa *et al.* (2010)[32]	ERD/ERS	Artificial Neural Networks	Turing left and right, going forward, and stopping
Hema *et al.* (2009)[96]	ERD/ERS	Artificial Neural Networks	Relax, going forward, and turning left and right
Cho *et al.* (2009)[97]	ERD/ERS	—	Turning left and right, and going forward and backward
Tsui *et al.* (2007-2009) [101] [102]	ERD/ERS	LDA	Turning left and right (in a virtual environment)
Bento *et al.* (2008)[105]	ERD/ERS	—	Turning right and left, going forward, and Stopping
Lee *et al.* （2012）[164]	SSVEP	Matched Filter Detector	Turning right and left and going forward

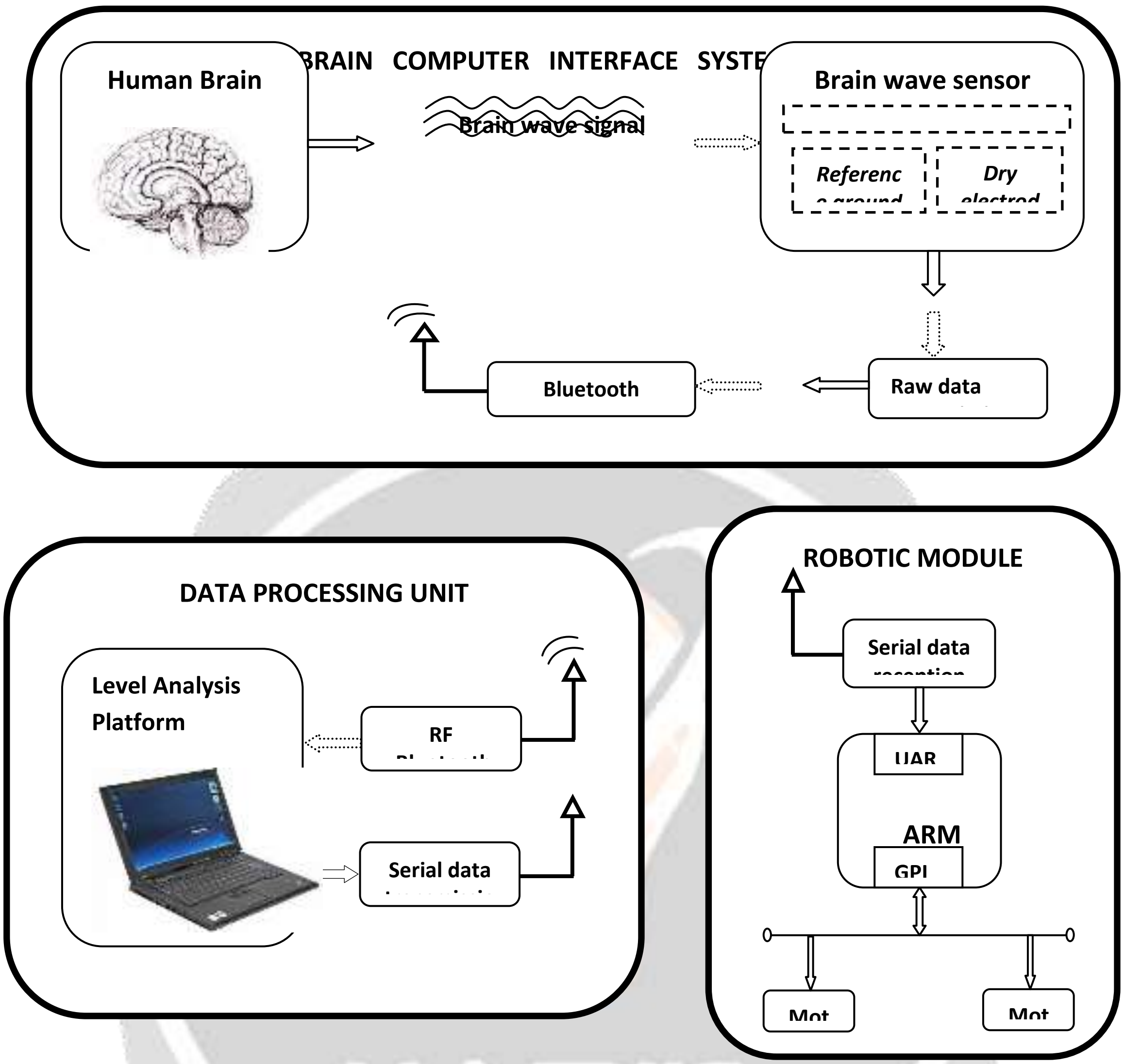

Fig -1 : Brain-Controlled Mobile Robots Directly Operated By A BCI

3. DISCUSSION AND CONCLUSION

The research and development of brain-controlled mobile robots have received a great deal of attention because they can help bring mobility back to people with devastating neuromuscular disorders and thus improve their quality of life. In this paper, we presented a comprehensive up-to-date review of the complete systems, key techniques, and evaluation issues of brain-controlled mobile robots. The major difference between brain-controlled mobile robots and other brain-controlled devices is that these mobile robots require higher safety because they are used to transport disabled people. Many researchers have developed various brain controlled mobile robots using different BCI techniques as well as other techniques such as intelligence techniques (in sensing situations, localization, and path planning) and shared control techniques so as to make these robots safer. However, much work remains to be done before brain-controlled mobile robots can be applied in practice, including finding ways to improve the performance (especially robustness) of BCI systems, to improve the overall driving performance given the constraints of the BCI system, and to establish standard evaluation method to facilitate the research and development of brain-controlled mobile robots. First, improving the BCI system performance (especially robustness) is critical to make brain-controlled mobile robots usable in real-world situations. One possible research direction is the online adaptation of the BCI classifier to drifts in the brain signals, considering the natural change of brain signals over time and the change of brain activity patterns as the users develop new capabilities with experience; preliminary results have shown the feasibility and advantage of this method [159]. Another direction is developing hybrid BCI systems and applying them in brain-controlled mobile robots. The BCI systems that are used in all existing brain-controlled systems rely on only one type of suitable brain signals (such as P300, ERD, or SSVEP) to translate user intentions into commands. However, the BCI systems that are based on a single signal do not work for all users [90], [111]–[113]. Some users cannot produce the necessary brain activity patterns for a particular kind of BCI systems. Recent studies have shown that some subjects could not yield corresponding brain activity patterns for an ERDBCI ,but they could produce the needed activity patterns for an SSVEP BCI and vice versa [39], [114]. Moreover, all the subjects who could not generate the ERD or SSVEP patterns could likely use a "hybrid" BCI that combines the two approaches to improve accuracy [39], [114]. Thus, to broaden the user coverage of brain-controlled mobile robot systems and improve accuracy of their BCI systems, variously bridge BCI systems should be further investigated and adopted. Furthermore, discovering some new modes of brain signals that are more stationary and distinguishable, and developing corresponding BCI systems represents another open and challenging research direction to improve the BCI system performance. These lessons are also useful for wider BCI applications. Second, under the constraint so for the limit and unstable performance of all existing BCI systems, finding ways to enhance and ensure the overall driving performance of the robotic systems is very important. From the perspective of shared control, some methods have been proposed to combine the BCI and robot intelligence to improve the overall performance of brain controlled mobile robots, as mentioned in Section II. However, current research only represents the first step toward this direction. We think that future potential directions are 1) developing new methods to combine the information from the BCI and robot intelligence, such as using BCI in conjunction with machine learning not only to control but also to teach the robot the motion task [165], [166], and 2) fusing additional useful information from other sources, such as predicted driver intentions. Third, to evaluate and compare the performance of different methods and systems, standardized performance evaluation method(involving subjects ,tasks and environments, and performance metrics) should be established. For example, most of the existing studies used healthy subjects to test and validate their proposed systems.

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