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Abstract—Brain Computer Interface (BCI) is defined as a combination of hardware and software that allows brain activities to control external devices or even computers. The research in this field has attracted academia and industry alike. The objective is to help severely disabled people to live their life as regular persons as much as possible. Some of these disabilities are categorized as neurological neuromuscular disorders. A BCI system goes through many phases including preprocessing, feature extraction, signal classifications, and finally control. Large body of research are found at each phase and this might confuse researchers and BCI developers. This article is a review to the state-of-the-art work in the field of BCI. The main focus of this review is on the Brain control signals, their types and classifications. In addition, this survey reviews the current BCI technology in terms of hardware and software where the most used BCI devices are described as well as the most utilized software platforms are explained. Finally, BCI challenges and future directions are stated. Due to the limited space and large body of literature in the field of BCI, another two review articles are planned. One of these articles reviews the up-to-date BCI algorithms and techniques for signal processing, feature extraction, signals classification, and control. Another article will be dedicated to BCI systems and applications. The three articles are written as base and guidelines for researchers and developers pursue the work in the field of BCI.

Index Terms—Brain Computer Interface, BCI, BCI signals, BCI technology, hardware, software, BCI challenges, Future directions.

I. INTRODUCTION

FOR generations, humans dream about the interaction with computer through brain activities. It was a fantasy thing that the scientists and others dream about through science fiction movies and imagination. This dream comes true and currently we are able through advanced electronic devices to capture the brain signals and control the real world devices. Certainly, still there are some of the constraints and challenges but we believe that in the few coming years, there will be too much to do with brain signals and effective solutions for many of its current research problems.

Brain Computer Interface (BCI) is a complete system including the software and hardware that manipulate human signals to control Computers and different communication devices. However, some other definitions are presented in the literature as follows:

- Donoghue et al. in [65] defined the BCI as Brain Machine Interface (BMI) in which its major goal is to provide a command signal from the cortex that controls disabled body parts or physical devices, such as computers or robotic limbs.
- Wolpaw et al. in [69] defined the BCI as a device that provides the brain with a new, non-muscular communication and control channel.
- Schwartz et al. in [2] defined the BCI as “Microelectrodes embedded chronically in the cerebral cortex hold promise for using neural activity to control devices with enough speed and agility to replace natural, animate movements in paralyzed individuals.”

Such definitions describe the overall functionalities of the BCI in terms of capturing the brain signals, processing the received signals, classifying them, and utilizing these signals for control. Therefore, the terms BMI and BCI could be used interchangeably describing the communication between the brain and the computer and/or external devices.

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