Past and Future of Multi-Mind Brain-Computer Interfaces

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1 Introduction

The advances on research in Brain-Computer Interfaces (BCIs) achieved in the last decades have made possible the implementation of innovative applications of these devices, which are not anymore limited to helping people with disabilities to communicate [1]. One of the main focuses of these new lines of investigation is on the use of neural signals to enhance human performance. Following this path, researchers have recently started to explore the possibility of using brain activity recorded from multiple users to further increase the performance over single-user BCIs and non-BCI systems. The promising results obtained by the first multi-brain BCIs have motivated scientists to apply this approach to a range of contexts, including collaborative control [2], decision making [3], games [4] and communication [5].

A few laboratories have started working on the development of multi-mind BCIs. However, these systems remain largely unfamiliar to the majority of the research community. Thus, the main aim of the proposed chapter will be to introduce this technology to the readers, starting with an in-depth description of such systems.

2 Contents

There exist different methods used for the creation of a multi-brain system (e.g., averaging neural signals, feature concatenation and voting), as well as techniques for group-member selection and metrics for assessing the performance of collaborative BCIs. All these aspects will be introduced and discussed in a systematic review of the literature devoted to multi-mind BCIs.

The authors of the proposed chapter have been amongst the first to use multi-brain BCIs for multiple applications, including joint real-time control of a spacecraft simulator [6], target localization [7], and decision making [8, 9]. The experience accumulated will be used to present a list of lessons learnt during the first years of development of this branch of research.

All the points described above will set the framework for a step-by-step tutorial which will be featured in another section of the manuscript. Finally, the chapter will conclude with a list of open problems and challenges that can be addressed in the future using multi-mind BCIs.

3 Scope

The proposed chapter contributes to the scope of this book along three main directions. Firstly, it gives the reader an insight into multi-brain BCIs, describing the main methods and techniques usually adopted in such systems. Secondly, it includes a systematic review on the main applications of collaborative BCIs, ranging from games to decision making. Last, but not least, it provides to new researchers a step-by-step tutorial on how to design an effective multi-mind BCI system.

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