A U S H A N G

FREIE UNIVERSITÄT BERLIN

Fachbereich Mathematik und Informatik

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D I S P U T A T I O N

Dienstag, 19. Dezember 2017, 10.15 Uhr

Ort: SR 032, Arnimallee 6 (!), 14195 Berlin

Disputation über die Doktorarbeit von

Herrn Omar Mendoza Montoya

Thema der Dissertation:

Development of a Hybrid Brain-Computer Interface for Autonomous Systems

Thema der Disputation:

A Novel Hybrid BCI Paradigm for Controlling Autonomous and Semi-Autonomous Wheelchairs

Die Arbeit wurde unter der Betreuung von **Prof. Dr. R. Rojas** durchgeführt.

Abstract: This work presents a novel control paradigm for EEG-based brain-computer interfaces (BCIs). This new approach combines P300-evoked responses and steady-state visual evoked potentials (SSVEPs) to decode the brain activity. The proposed paradigm was used to operate an autonomous wheelchair in different scenarios, including office buildings and open places.

In this paradigm, target places and other navigation commands are selected with a P300-based interactive menu, whereas the wheelchair is stopped by modulating SSVEP oscillations. To reduce the risk of producing inadvertent commands when the user is not using the interface, the P300-based BCI can only be used after unlocking this function with the SSVEP-based BCI. The main advantages of this hybrid design compared to P300-based interfaces are that the wheelchair can be stopped quickly without cognitive effort, and false positives for the options of the interactive menu are reduced to a level close to zero.

The control of false positives in the SSVEP-based BCI is also addressed in this work. To this end, it is proposed a new method for detecting SSVEP-related activity which requires minimal training and is easy to adapt. This new approach only requires resting state data to find the parameters of the classifier that maintains the false positive rate below the desired level. In the worst cases, no more than 0.067 false positives per minute were detected in the online tests with the wheelchair.

Another problem discussed in this research to improve the performance of brain-controlledapplications is the auto-calibration of P300-based BCIs. The implemented interface includes a new strategy for detecting a training set without user's intervention. The auto-calibration, combined with an auto-adaptation step, allows operating the interface in optimal conditions and reduces the influence of non-stationarities in long experimental sessions.

The results obtained in this research demonstrate that the proposed paradigm is very efficient in communicating the user's intentions to the autonomous device, even when the wheelchair navigates in unfamiliar places. It is shown that subjects without a priori knowledge of BCI technology can master the interface after a few minutes of training and achieve accuracies of 100%.

Die Disputation besteht aus dem o. g. Vortrag, danach der Vorstellung der Dissertation einschließlich jeweils anschließenden Aussprachen.

Interessierte werden hiermit herzlich eingeladen

Der Vorsitzende der Promotionskommission
Prof. Dr. R. Rojas