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Case ID:M17-048P^
Published: 3/16/2021

Hybrid Brain Interface for Robotic Swarms Using EEG Signals and Joystick Inputs

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Background

Brain Computer Interfaces (BCI) have gained increased attention over the last decades because they offer intuitive control in a plethora of applications where other interfaces (e.g. joysticks) are inadequate or impractical. Moreover, these kinds of interfaces allow people with motor disabilities such as amyotrophic lateral sclerosis (ALS) and spinal cord injuries (SCI) to interact with the world, whether that means controlling the motion of a cursor on a screen or interacting with an actual robotic platform.

There are many types of BCIs and each one of them exploits different functions of the human brain. Most BCIs rely on the analysis of electroencephalography (EEG) signals and their features. Unfortunately, existing systems typically allow only binary control or require lengthy training sessions before the user can achieve acceptable control. Additionally, the number of degrees of freedom directly controlled through those interfaces is quite limited, only one or two in most cases. To address these issues, researchers have proposed various hybrid BCI systems. These may combine (a) different types of EEG signals simultaneously, (b) EEG signals with other biological signals such as electromyograms (EMG) and electrooculograms (EOG), or (c) EEG signals with assistive technologies such as wheelchairs, mice, or keyboards. However, when multiple EEG modalities are involved, complexity increases as the user must switch among different interfaces, and in some cases considerable crosstalk across multiple interfaces jeopardizes the robustness of the system. Hence, a need exists for intuitive BCIs with effective control of multiple degrees of freedom.

Invention Description

Researchers at Arizona State University developed a hybrid BCI system that combines electroencephalogram (EEG) signals, or electrical brain activity, and joystick input to control of robotic swarms. For each user, a separate calibration procedure must be performed. The resulting system is robust across multiple subjects, it provides reliable output with minimum errors and can be used for real-time control of robots.

The main purpose is to increase the number of operations controlled by the users and to enable more agile and complicated control strategies for robotics systems, while remaining instinctive for the user. The system can be used for the intuitive and reliable control of many different robotic platforms, such as a swarm of aerial drones and ground robotics.

This technology is covered by U.S. Pat. No. 10,712,820.

Potential Applications

- Control of aerial and ground robotics
- Search and Rescue drone systems
- Brain Computer Interfaces (BCIs) to assist individuals with motor disabilities

Benefits and Advantages

- Uses brain signals with joystick input to reliably augment the number of controllable degrees of freedom
- EEG signals can control both direction and magnitude/rate-of-change of a particular degree of freedom
- Non-invasive, easy installation