25th Anniversary of the First Control of a Robot Using EEG Signals

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Introduction

Twenty five years ago, in 1988, electromagnetic energy emanating from the human brain was employed for the first time in history to control a physical object, a robot [1,2]. It was a milestone for Computer Science (pattern recognition, control), Systems Biology (conative biology, brain emanation patterns), and robotics. Another way of looking at it is that it was an engineering approach to psychokinesis. The approach was based on two interfaces: one toward a biological brain for EEG signal processing, and the other interface toward a physical object, in this case a robot; with today’s technology either interface can be wireless. This editorial marks the event and sheds some light on it from today’s prospective.

Brain-robot Interface

The setup of the system for an EEG driven robot control [1,2] consists of: 1) a human subject intentionally emanating various patterns in her/his EEG signals, 2) an interface toward a computer, a device which captures those signals, 3) a computer-based processing of EEG signals, including learning and pattern recognition algorithms, 4) an interface toward the physical object, a robot, and 5) a feedback (visual, audio, etc.), ensuring that the subject who controls the physical object observes results of her/his intentions which were emanated as EEG patterns.

Brain Signals

Various types of EEG signals may be used for object control and a taxonomy of EEG signals was introduced [3] which divided EEG signals into both spontaneous and event related, the latter being divided into both evoked and anticipatory, the latter being divided into both preparatory (e.g., readiness potential) and expectatory (e.g., contingent negative variation potential, or CNV). If spontaneous EEG is used, usually a frequency band is observed. Often the alpha band (8-13Hz) is used and its intentional change can be named Contingent Alpha Variation (CaV), motivated by the name for the CNV potential given in [4].

The 1988 Experiment

The scenario of the experimental research consisted of a human subject controlling a mobile robot to move along a closed black line, with predefined points where the robot should be started, stopped, and then restarted. The human subject generates increased CaV by entering alert state (by opening the eyes) which controlled the robot, while an interface can be wireless. This editorial marks the event and sheds some light on it from today’s prospective.

Discussion

Interestingly, it took 11 years for the second result of EEG control of a physical device to occur [5]. The 1999 research used signal recording with electrodes inside the brain of a monkey. That kind of recording is denoted invasive while that of 1988 is denoted non-invasive.

The 1988 and the 1999 result were the only ones in EEG-driven control of physical objects movement achieved in the 20th century. In the 21st century, starting 2000, there are many more reported results including ones using more advanced robots. Interested readers can find more detail in recent reports such as [6].

It should be noted that besides the challenge of controlling physical objects, there was a challenge of controlling virtual objects on the computer screen [7]. The first results were also achieved in the 20th century. Further detail about the first reports on EEG controlled objects, both physical and virtual, are given in [8].

Conclusion

In 1988 a new direction in science was opened: control of physical objects using brain signals. Today many researchers are following this direction under various terms such as the term of brain-robot interface (BRI) and the more general one brain-computer interface (BCI). With today’s technology, the computer is small in size so it can be a physical part of either EEG interface or physical object interface, rendering the term of brain-computer interface potentially obsolete for EEG control

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Received May 13, 2013; Accepted May 17, 2013; Published May 21, 2013


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of physical objects.

From 1988 forward, psychokinesis departed from the realm of science fiction and entered scientific reality.

References


