Research lowers errors for using brain signals to control a robot arm

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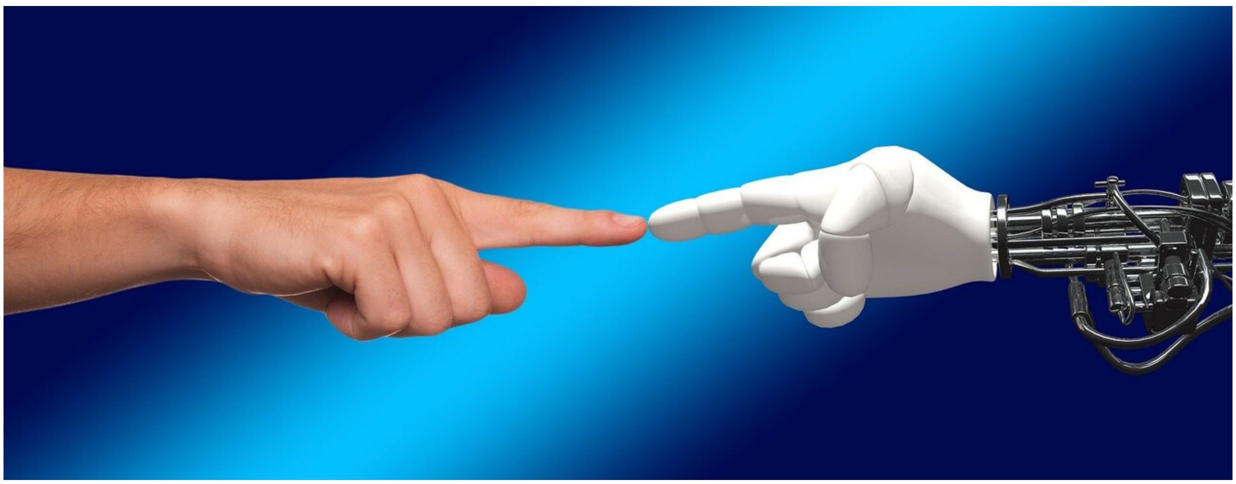

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Brain-computer interfaces have seen a large influx of research in an effort to allow precise and accurate control of physical systems. By measuring brain signals and implementing a clever feedback scheme, researchers from India and the UK have reduced the positional error in brain-controlled robot arms by a factor of 10, paving the way to greatly enhancing the quality of life for people suffering from strokes and neuro-muscular disorders.

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Brain-computer interfaces (BCI) have seen a large influx of research in an effort to allow precise and accurate control of physical systems, such as position control of robotic arms, using only signals generated from the user's brain. Existing brain-computer interfaces, however, are hindered by two major challenges. First, most of the existing routines for BCI utilize open-loop control. In other words, the routines do not incorporate any feedback during the brain signal-driven movement to correct for any errors. This results in the failure of the system to take corrective actions and leads to large positional errors, such as a robot arm overshooting the desired position and pose.

Second, contemporary BCI are designed to respond to inputs sequentially without finer adjustments, leading to further errors in positional control. Additionally, many BCI utilize multiple sensors to drive the functionality of the device under control. Sensors such as infrared spectroscopy, electroencephalography (EEG), and functional magnetic resonance imaging may be used in combination to process signals from the brain.

In this study, published in *IEEE/CAA Journal of Automatica Sinica*, researchers relied solely on EEG, due to its non-invasiveness, fast response time, and low cost. By using sophisticated processing techniques, the researchers were able to partition different brain signals from the EEG necessary to control a robot arm. The team then made use of a well-known brain signal, the P300, which appears when a subject notices a significant but rare stimulus. In this case, when the subject notices the robotic arm does not reach the position they originally desired.

"The P300 is used to freeze the current motion of the robotic arm," said Amit Konar, Professor in the Department of Electronics and Tele-Communication Engineering, Jadavpur University and co-author of the study. "Since elicitation and detection of the P300 signal requires a finite amount of time, the robotic link crosses the target position by a small amount before motion is stopped. The link is then moved in the reverse direction of the last motion before it is stopped."

Each subsequent stoppage and reversal of the robotic link reduces the speed at which the arm is moving, until a minimum speed is met and the movement ceases. By introducing P300 brain responses to the arm movement via a feedback mechanism, the team was able to bring the error of arm movements down from 2.1% to 0.20% when compared to the previous state of the art BCI.

The team plans to build on their BCI design by developing a more robust, noise-insensitive control interface, moving ever closer to realizing sophisticated, mind controlled physical symptoms that will drastically improve the quality of life of individuals with neuro-muscular disorders.

More information: Arnab Rakshit et al. A hybrid brain-computer interface for closed-loop position control of a robot arm, *IEEE/CAA Journal of Automatica Sinica* (2020). DOI: 10.1109/JAS.2020.1003336

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