Robots Controlled by Brain Waves

**Outcome:** Using only brain waves, a human user was able to direct a robot to autonomously search and reach for a target object in its environment. The robot’s neuromorphic algorithms for visually guided reaching and locomotion and the brain-computer interface (BCI) technology for deciphering user intent were developed by researchers at Boston University’s Neuromorphics Lab, Neural Prosthesis Lab, and Center of Excellence for Learning in Education, Science, and Technology (CELEST).

**Impact/benefits:** BCIs are the only currently viable means of communication for individuals suffering from profound paralysis. By inferring user intent from task-modulated neurological signals and then translating those intentions into actions, BCIs can enable these individuals increased agency. Mobile robots with reaching capabilities that can autonomously translate a limited set of high-level commands into complex environmental interactions greatly expand on the power of this technology, paving the way for not only therapeutic robotic assistants, but also hands-free control of robots in other scenarios, such as military applications.

**Explanation:** Using the non-invasive electroencephalogram (EEG), a user’s brain waves can be detected in real-time by using electrodes placed on the surface of the scalp. By presenting flickering images on a screen corresponding to high-level actions, such as the desired target, the BCI technology can use the EEG signals to determine which flickering image, and thus action, the user is attending to. This command is wirelessly transmitted to the waiting robot, which then autonomously complies with the search and retrieval request. By analogy, this is like having a dog fetch a ball – the dog knows how to find, move toward, retrieve, and return the ball, the only command that needs to be given is “fetch the ball”. This allows for maximization of the limited commands obtainable from EEG-based BCIs.

**Figure 1.** Controlling an EEG-based BCI application (**left**). A virtual robot has just completed an autonomous, visually guided search, visually guided reach, and grasp of a target object (**right**).