Using Brain Computer Interface (BCI) for Robotic Painting

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Introduction:

Children with severe motor impairment from early-life neurological disease and injury are often limited in their physical abilities despite being cognitively capable. Brain Computer Interface (BCI) technology aims to provide new ways of interaction for such children. BCI uses non-invasive headsets to measure brain activity recorded as electroencephalogram (EEG) signals. In response to periodic visual stimuli, the brain produces a decipherable pattern called steady-state visual evoked potentials (SSVEP). After time, the frequency of one's EEG signal synchronizes with the external stimulus. Mapping the frequencies for various controls creates a unique opportunity for innovative applications. Creating something on their own, such as a painting, brings children joy and enables independence.

Methods:

This project aimed to use SSVEP-based BCI to control a programmable Sphero SPRK+ robot. An Arduino controls 3 sets of LEDs, which act as the stimuli by each flashing at unique frequencies. A cart was designed to hold the circuit while moving with the Sphero to keep attention and provide direct user feedback. The Sphero was then used as an artistic tool by rolling over paint on a canvas. A Raspberry Pi 4 (RPi) was utilized for both the signal processing of the EEG data in Python and for driving the Sphero using Node.js. The RPi extracts features from the data to determine the frequency of the stimulus being focused on by the participants. It then drives the Sphero based on the controls being mapped from the stimuli.

Results:

We streamed and processed EEG signals based on SSVEP responses from an online dataset. The data then constructs an abstract painting by controlling the Sphero. This creates a unique and independent art piece of the user's desire. In the future, this can be tested and used in real-time by affected children for accurate user feedback.

Discussion:

This project demonstrates the capability of controlling programmable games with BCI for entertainment. Utilizing a RPi to process the data creates a compact and transportable system, while providing a cheaper option for usage outside of a laboratory. Further development of leisure based BCI can greatly help improve quality of life through promoting independence.

Figure:

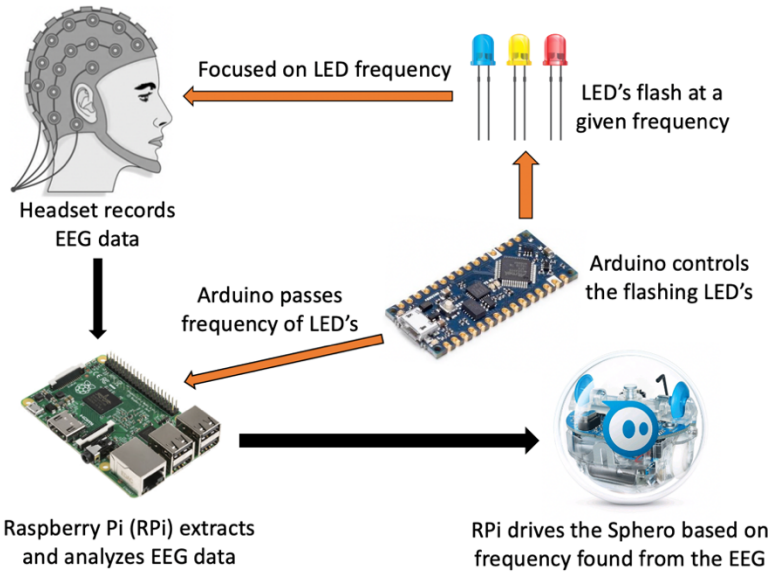

Figure 1: Communication flow chart of the various components of the SSVEP BCI system.