CS225A Final Project Report

Mind Over WAM

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Abstract

Assistive robotic technologies that use neural interface systems are designed to allow people with limited mobility to assert control with signals directly from their brains. These robotic systems require detection and analysis of raw brain signals, machine learning methods to extract these signals into useful commands, and the development of an interface between neural signals and robot control. In this project, we present a method for controlling a 4-dof RRRR WAM robotic arm with alpha brain waves of a test subject obtained via electroencephalography (EEG). We use the OpenBCI system electrodes and board to detect alpha waves and transmit them to digital signal. We then implement a support vector machine to classify alpha waves for robot control. A robust serial communication interface was developed to convert OpenBCI data into robot commands. An accelerometer embedded in the OpenBCI board was used to implement left-right motion of the robot. To assess the performance of our system, we successfully demonstrate two primary tasks: (1) alpha wave robot control and (2) alpha wave and accelerometer robot control. The methods developed in our project can be readily extended to include control from other brain regions and additional robotic tasks, paving the way for more complex interactions between robots and human brains.

1 Introduction

Brain-computer interfaces (BCIs), which describe the communication between a device and the human brain, are becoming a widely researched topic with applications ranging from gaming to neuromarketing and advertisement [1]. In addition to these non-medical applications, BCIs are proving to be useful tools in patient-assistive technologies as well. For patients with limited mobility, the majority of current assistive technologies rely on motor inputs for robotic control through manual interfaces such as joysticks and keyboards. However, for patients with extreme levels of motor impairment due to illnesses such as stroke, amyotrophic lateral sclerosis (ALS), and multiple sclerosis (MS), these technologies are ineffective at providing increased mobility. BCIs are beginning to fill this large gap in assistive technologies because they do not rely on motor input but rather use human brain waves alone to communicate with robots. In particular, electroencephalography (EEG)-based brain-controlled robots provide a robust, non-invasive method for assistive human technologies.

EEGs are particularly useful in brain-controlled assistive technologies due to their low cost, ease of use, and good temporal resolution [2]. However, there are several weaknesses in the use of EEG in robotics, such as the high level of noise in obtained measurements, which causes difficulty in task classification [2]. Current research efforts are aimed at addressing these challenges in order to provide robust and accurate pattern classification.

Our project uses EEG signals obtained from a test subject to control a WAM robot arm. In particular,