Brainstorm: A More Efficient Mind Controlled Keyboard

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Objectives

1. Improve the typing speed of current Virtual Keyboard systems
2. Create a robust testbed for future Research
3. Develop an end to end prototype capable of external communication
4. Generate a high quality SSVEP data set

Features

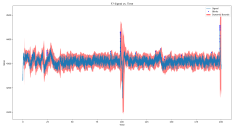
- Artifact Detection
- SSVEP Classifiers
- Natural Language Processing
- Event driven training
- Session Logging
- Backtesting

Performance

Speed: 40 characters per minute
Code: One open source codebase
Data: An open source data set containing over **50,000,000** labeled data points
Communication: The world's **first** recorded email sent with a mind controlled keyboard

Artifact Detection

Standard deviation and mean are calculated in data windows and used to provide each new point with a Z score. If this score exceeds 3.5, the point is classified as a peak and window values are calculated using a dampened version of the artifact, so that peaks don't corrupt the decision threshold.

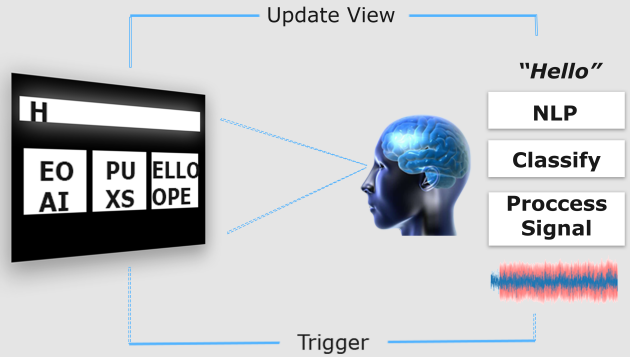


Frequency Classification

Features: Frequency Bands (HZ)
Bands: 4-8; 8-12; 12-18; 18-25; >25HZ
Calculated over 2 second windows
Electrodes: AF3, F7, F3, F4, F8, AF4
Model: Logistic regression
Decison: Majority Voting (across time)
Accuracy: .68

Training is conducted on 200 samples gathered at run time. Each frequency is played for 2.5 seconds before samples are collected to ensure the SSVEP signal is 'pure'. Model Validation is run on a seperate set of 100 samples also collected at run time.

System Flow

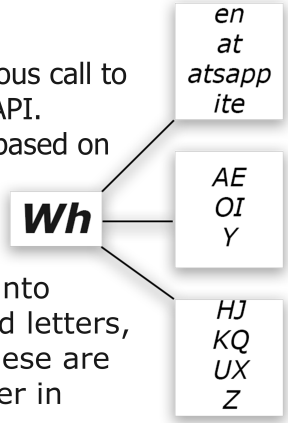


NLP

How
Conducted via an asynchronous call to Google's search suggestion API. Responses are then filtered based on agreement with current output.

WPM

What
Suggestions are divided into general letters, suggested letters, and suggested words. These are then presented to the user in flashing language boxes.



Hardware

Device: EMOTIV EPOC X EEG
Cost: $849
Connection: Wireless
Electrodes: 14 (wet)
Sampling Rate: 2048 HZ downsampled to 128 HZ

Brainstorm is the first SSVEP based keyboard to use the EMOTIV EPOC X. This device was chosen for its relatively low price and high quality signal.

Software

Repository

Languages: C#, Python
Architecture: Model View Controller

Overview

Brainstorm is a multithreaded Windows Form application. Data is collected via websockets that interface with the EMOTIV API and processed with ML applications from Accord.NET. Brainstorm sessions are automatically logged as CSVs and are processed via Python and MatPlotLib for data anlaysis. Developers can also test algorithms on old sessions with backtesting.