CruX Team 2 - RC Car

Alisha Ly, Anish Thalamati, Audrey Ngai, Avantika Aggarwal, Hanna Boughanem, Mateo Umaguing, Paige Lee, Sree Nagaraj, Srivarsha Rayasam

Narrative

Model car ~ wheelchair

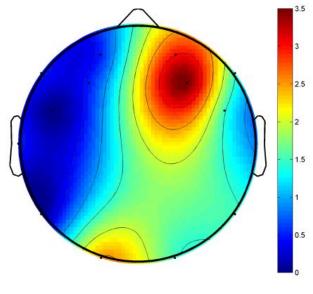
Steady State Visual Evoked Potential (SSVEP)

SSVEP classification -> model car control

Significance



Paraplegic Application



SSVEP Research

Overall Aim

Develop a brain-computer interface (BCI) that can control the movement of a model car.

Specific Aims

Successfully collect EEG signals via OpenBCI headsets.

Create a brain-computer interface to classify SSVEP signals using analytical or ML methods.

Navigate a model car through a maze via a brain-computer interface.

Data Flow Diagram Physical Device Python Script Neural Noisy neural signals signals Environment Brain Scalp/hair Noisy EEG Noisy EEG Arduino Script signals signals SSVEP Saved Data OpenBCI Cap OpenBCI GUI Cyton Monitor LSL Direction buttons EEG Processing Software GUI Butterworth Bandpass Filter Preprocessing (5-50 Hz) Notch Filter (60 Hz) ICA Artifact Removal FFT, SNR, PSD, 1D-LGP, LNDP, Signal Statistics (mean, kurtosis, etc.) Feature Extraction Processed EEG BT direction signals commands Direction Direction Command Arduino BT Car Classification Scripts Script Audiovisual feedback Decoded direction Saved neural commands signal data

Classifier Data

Signal Statistics

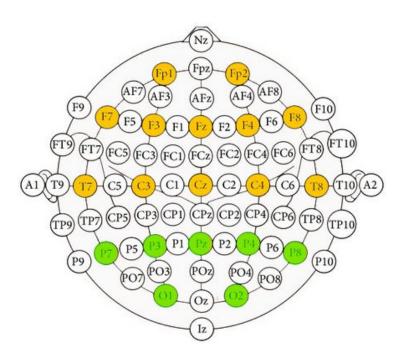


Fig. 2 - Electrode Channels of Interest

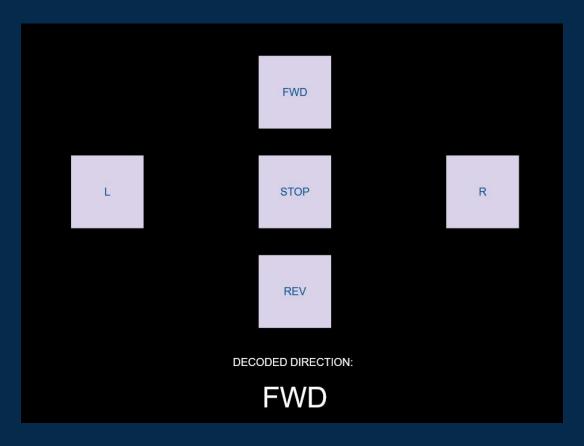


Fig. 3 - Graphical User Interface

Blink/Jaw Clench

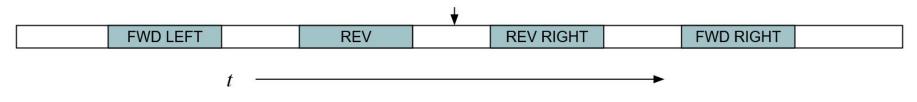


Fig. 4 - Training Session Example

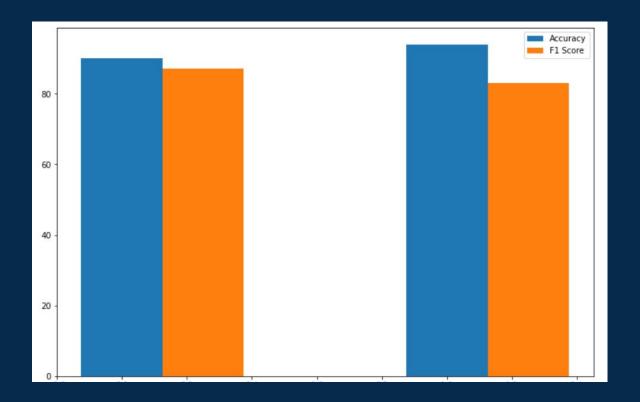


Fig. 5 - Simulated Classifier Accuracy and F1 Scores

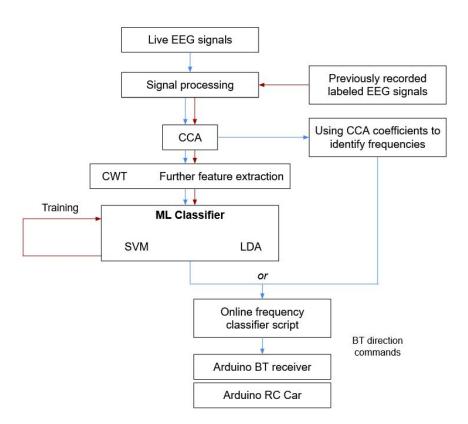


Fig. 6 - SSVEP Classification Schematic

References

Amareswar, Enjeti, et al. "Design of Brain Controlled Robotic Car Using Raspberry Pi." 2021 5th International Conference on Trends in Electronics and Informatics (ICOEI), 2021, https://doi.org/10.1109/icoei51242.2021.9452957.

Hongtao Wang, et al. "Remote Control of an Electrical Car with SSVEP-Based BCI." 2010 IEEE

International Conference on Information Theory and Information Security, 2010, https://doi.org/10.1109/icitis.2010.5689710.

Hu, Li. Chapter 2 EEG: Neural Basis and Measurement - Springer. Edited by Zhiquo Zhang, Springer, https://link.springer.com/content/pdf/10.1007/978-981-13-9113-2 2.pdf.

Ma, Pengfei, et al. "A classification algorithm of an SSVEP brain-Computer interface based on CCA fusion wavelet coefficients." Journal of Neuroscience Methods, vol. 371, 1 April 2022, https://doi.org/10.1016/j.jneumeth.2022.109502

Rashid, Mamunur, et al. "Current Status, Challenges, and Possible Solutions of EEG-Based

Brain-Computer Interface: A Comprehensive Review." Frontiers in Neurorobotics, vol. 14, 2020, https://doi.org/10.3389/fnbot.2020.00025.

Wang, Hongtao, et al. "The Control of a Virtual Automatic Car Based on Multiple Patterns of

Motor Imagery BCI." Medical & Biological Engineering & Computing, vol. 57, no. 1, 2018, pp. 299-309., https://doi.org/10.1007/s11517-018-1883-3.

Yu, Yang. "Toward Brain-Actuated Car Applications: Self-Paced Control with a Motor Imagery-Based Brain-Computer Interface." ScienceDirect, 25 Feb. 2016, https://www.sciencedirect.com/science/article/pii/S0010482516302074?via%3Dihub.

Zhao, QiBin, et al. "EEG-Based Asynchronous BCI Control of a Car in 3D Virtual Reality

Environments." Chinese Science Bulletin, vol. 54, no. 1, 2009, pp. 78-87., https://doi.org/10.1007/s11434-008-0547-3.