EEG Correlates of Difficulty Level

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Dataset description

Works that make use of this dataset should cite the original paper [Jao et. al., 2021]. Use of this dataset can explore the variations of EEG signals under various task difficulty levels, where a subject is naturally performing a piloting task in a simulated environment [Jao et. al., 2021]. Decoding such EEG correlates may help the subjects to stay in their optimal zone of task performance, decrease (increase) the task difficulty level when the subject feels the task is too difficult (easy) for instance.

The feasibility of decoding such EEG correlates is not only validated through offline analysis but also in a two-session closed-loop experiment [Jao et. al., 2021]. This public dataset only contains the first session (offline) data downsampled from 2,048 Hz to 256 Hz. Additional behavioral data and online sessions data are not included in this release. This dataset is made available in Oct. 2021.

Experimental protocol

Setup

Biosemi ActiveTwo is used to record 64 channels of EEG and 3 channels of EOG, where a hardware event trigger is recorded as an 8-bit signal. Before the task, we recorded one-minute of eye closing and opening as their baseline of the day.

Task

The subjects sat in front of a monitor and used their right hand for a flight joystick. They were instructed to pilot the simulated drone through a series of circular waypoints. The subjects controlled the roll and pitch while the drone had a constant velocity when flying straightly. Each subject went through 32 trajectories, where each trajectory had 32 waypoints with the same size and lasted around 90 seconds. There were 16 different levels (sizes of waypoints) for each

subject, and the level decreased from level 16 to level 1, and then increased from 1 to 16. The 16 levels were normalized to each subject's skill based on their performance and sigmoid regression. See [Jao et. al., 2021] for more details.

After each trajectory, the subjects reported a numeric level between 0 and 100 for the assessment of perceived (subjective) difficulty level. They also declared whether the trajectory was easy, hard, or extremely hard. The definition of easy was that the subject felt in good control of the drone, while the opposite corresponds to the other two. The extremely hard was differentiated as a level that the subject feels herself cannot manage the level in reasonable training time.

Participants

Thirteen subjects (8 females; Mean age 22.6; SD 1.04) participated in the study. The protocol was approved by the local ethical committee and all the subjects provided written consent. All subjects had a normal or corrected-to-normal vision and reported no history of motor or neurological disease, except one subject who previously experienced vasovagal syncope but not during this study. We, therefore, do not further disclose who is the subject.

Data Description

Each subject has two files, taking subject s1 for instance, the filename first indicates subject ID, followed by the date of recording, and the postfix shows whether it is baseline or the task (ends with wpsize).

Each file has data struct with the following fields:
- EEG: timepoint-by-channel matrix
- EOG: timepoint-by-channel matrix
  - First channel: below the outer canthus of the right eye
  - Second channel: between eyebrows
  - Third channel: below the outer canthus of the left eye
- Trigger: indicates events (to be addressed later)
- Header: contains information of previous and downsampled sampling rate as well as the channel information when reading the bdf file
- Channel labels: indicates the name of electrodes in the EEG field
- FIR_resample: the returned finite impulse filter coefficients when calling the resample function, to downsample to 256 Hz, from MATLAB.
- subjective_report (does not exist in baseline): a 32-by-3 matrix
  - First column: trial number
  - Second column: difficulty level between 0 and 100 (Easy to Hard)
  - Third column: descriptive difficulty level, 0: easy, 1: hard, 2: Extremely hard

Trigger for Baseline:

- 1: start of eye close
- 2: stat of eye open
- 255: end of eye close or eye open

Trigger for Task:
- 1: begin of a trajectory (start of a count down before the drone moves)
- 16: a waypoint is miss (the drone failed to go inside the waypoint)
  - Note: first appearance of 16 indicates that the drone starts to move
- 48: a waypoint is hit (the drone went inside the waypoint)
- 255: end of a trajectory (3 seconds after finishing the final waypoint)

Contact

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References

- P. -K. Jao, R. Chavarriaga and J. d. R. Millan, "EEG-Based Online Regulation of Difficulty in Simulated Flying," in *IEEE Transactions on Affective Computing (Early Access)*, doi: 10.1109/TAFFC.2021.3059688.