BB-CB c-VEP Database

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If you use this dataset in your study, please cite the following paper:

Fernández-Rodríguez, Á., Martínez-Cagigal, V., Santamaría-Vázquez, E., Ron-Angevin, R., & Hornero, R. (2023). Influence of spatial frequency in visual stimuli for cVEP-based BCIs: evaluation of performance and user experience. Frontiers in Human Neuroscience, 17, 1288438.

A total of 16 healthy subjects (aged 29.63 ± 4.06, 11 males, 5 females) performed copy-spelling tasks in a c-VEP speller based on circular shifting. The system employed a binary m-sequence of 63 bits displayed at a 120 Hz rate using a black-background checkerboard (BB-CB) pattern; i.e. event "1" was encoded with a checkerboard pattern and "0" with a black flash. Eight different variations of spatial frequency (number of individual square pairs in the checkerboard stimulus) were evaluated: C001 (0 c/◦, 1×1 squares), C002 (0.15 c/◦, 2×2 squares), C004 (0.3 c/◦, 4×4 squares), C008 (0.6 c/◦, 8×8 squares), C016 (1.2 c/◦, 16×16 squares), C032 (2.4 c/◦, 32×32 squares), C064 (4.79 c/◦, 64×64 squares), and C128 (9.58 c/◦, 128×128 squares). A g.USBamp equipment of 16 channels was used at a sampling rate of 256 Hz. The evaluation was carried out in a single session, in which users performed (1) a calibration of 30 trials (2 runs) by looking at a command encoded with the original m-sequence, and a (2) a copy-spelling online task of 18 trials, for each of the conditions. A trial was composed of 8 cycles (repetitions of the m-sequence). Also, questionnaires were fulfilled to assess satisfaction and the relative eyestrain while looking at each m-sequence. For further information, check the paper above.

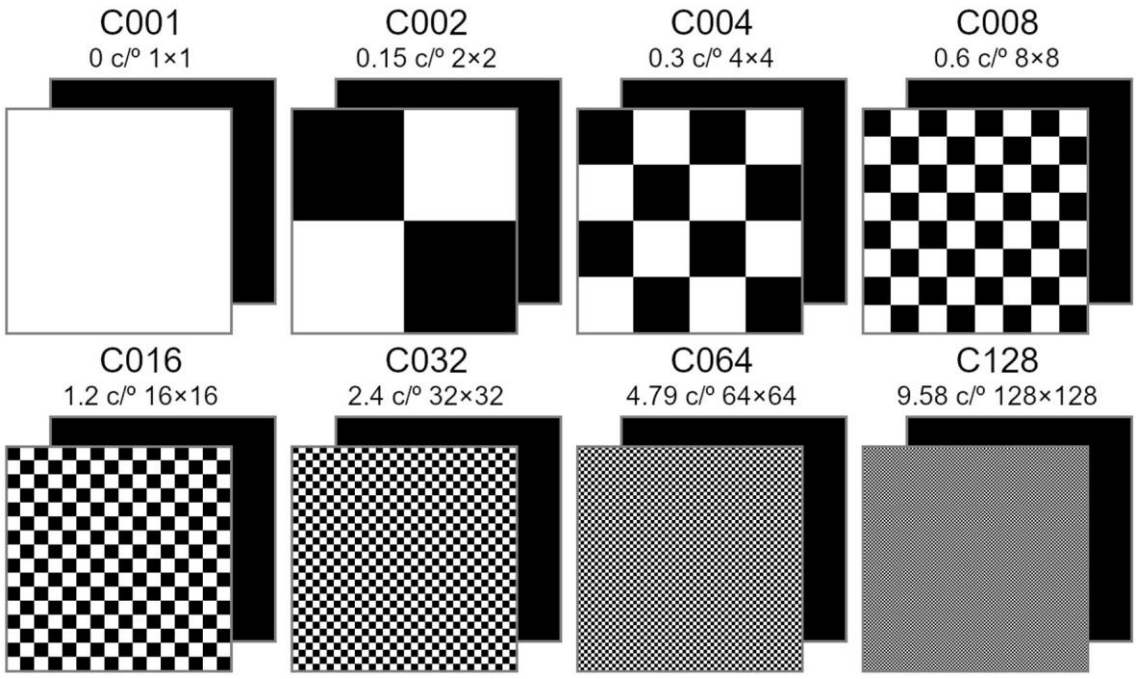

Figure 1. Black-background checkerboard (BB-CB) evaluated conditions.

Database structure:

- *_additional_info/requirements.txt* Requirements file for the python interpreter (recommended Python 3.10). Only the medusa-kernel package is being used (pip install medusa-kernel). The scripts were tested using medusa-kernel version 1.3.1. While they may work with more recent versions, full compatibility is not guaranteed, and code modifications might be required for proper functionality.
- *_additional_info/_questionnarie.csv* Satisfaction questionnaire ratings.
- *_scripts/example_load.py* Example script to load a file and export it as a dictionary.
- *_scripts/example_processing.py* Example script to process files using a simple CCA-based algorithm on a subject and a specific condition.
- *.*zip/* Contains the data for all subjects in folders. For each subject, different recordings are available.
    - *username_X_calib*.cvep.bson* This file contains the calibration recordings of each user. The X determines the condition. A total of 2 files like this are available for each subject and condition, as the 30-trial calibration was split into 2 recordings of 15 trials each.
    - *username_X_online.cvep.bson* This file contains the copy-spelling recordings of each user. The X determines the condition. All 18 online trials were made in a single run. The true labels are 123456789123456789.

Recording file structure:

When loading a file as a Recording class or as a dictionary, useful data is structured as follows:

- *eeg* Class containing useful data relative to the EEG recording
    - *times* Timestamp samples of the EEG
    - *signal* EEG signal organized as samples x channels
    - fs Sampling rate
    - *channel*_set Contains a structure that organizes the channel set (lables, coordinates, etc). Use channel_set.l_cha to get the labels.
- *cvepspellerdata* Class containing useful info relative to the paradigm
    - comma*nds_info* Position of each command in the matrix, including row, column, label and its code (already shifted). In calibration trials, only one command was shown displaying the original m-sequence.
    - *fps_resolution* Presentation rate in Hz
    - *onsets* Onsets vector containing a timestamp whenever a cycle is starting.
    - *cycle_idx* For each onset, the cycle displayed.
    - *trial_idx* For each onset, the trial displayed.