

MAUS – A Dataset for Mental Workload Assessment on N-back Task Using Wearable Sensor

Dear users,

This document describes the data structure of MAUS Dataset. MAUS dataset focused on collecting easy-acquired physiological signals under different mental demand conditions. We used the N-back task to stimuli different mental workload statuses. This dataset can help in developing a mental workload assessment system based on wearable device, especially for that PPG-based system. MAUS dataset provides ECG, Fingertip-PPG, Wrist-PPG, and GSR signal. User can make their own comparison between Fingertip-PPG and Wrist-PPG. Some study can be carried out in this dataset

In brief, each of 22 persons (2 females) recorded in the dataset is represented with a 35-minutes recording of physiological signals (ECG, Fingertip-PPG, Wrist-PPG, and GSR). The experiment flow is shown in Figure 1.

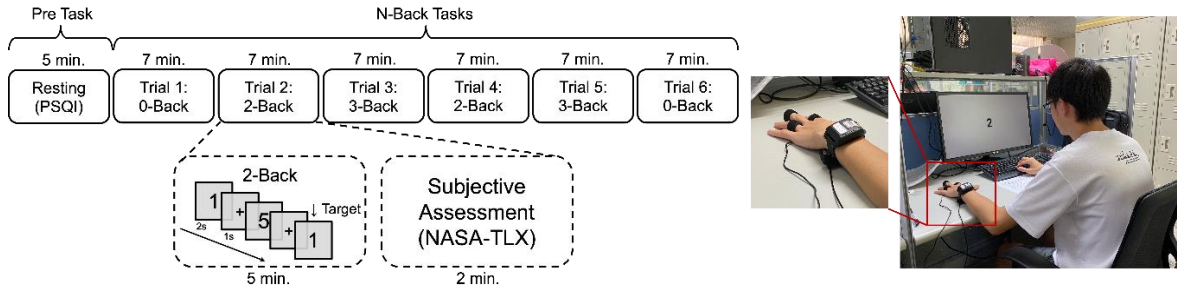


Figure 1: Experiment Flow of MAUS Dataset

At the start of the experiment, there would be five minutes resting session, and participants were asked to fill out the Pittsburgh Sleep Quality Index (PSQI) questionnaires.

After the resting session, there would be six trials of the N-back task. In the N-back task, the user had to memorize the last N one-digit numbers of a series of rapidly flashing numbers in succession. When a stimulus was identical to the N -th number preceding the stimulus number, the subject had to respond by pressing the space bar on the keyboard.

The MAUS database content is summarized in Table 1. If you decide to use the MAUS dataset, please, do not hesitate to cite the database.

Next, we will describe our database:

- Data structure
- File description
- Apparatus and signals
- Stimuli

Participants and modalities	
No. of participants	22 (20 males, 2 females)
Recorded signals	ProComp Infiniti ECG (256 Hz)
	GSR (256 Hz)
	PPG (256 Hz)
	PixArt Watch PPG (100 Hz)
Experiment setup	
N-back task	0-back: low MW; 2,3-back: high MW
No. of trials	6 (0, 2, 3, 2, 3, 0 -back)
Trial duration	7 min. (5 min. N-back + 2 min. Resting)
Total duration	47 min. (5 min. Resting + 7 min. * 6 trials)
Sleep evaluation (PSQI)	
Rating scales	Sleep quality, Sleep latency, Sleep duration, Habitual sleep efficiency, Sleep disturbances, Sleeping medication, Daytime dysfunction
Rating values	0-21 (each 0-3)
Subjective MW rating (NASA-TLX)	
Rating scales	Mental demand, Physical demand, Temporal demand, Performance, Effort, Frustration

Figure 2: Dataset Content Summary

1. Database structure (MAUS.zip)

The database is organized in 2 folders and a documentation:

- *Data* – raw signal recordings for the individual participants, including extracted Inter-Beat-Interval sequence and participants' respond in N-back task
- *Subjective_rating* – subjective rating of sleep quality and NASA-TLX
- *MAUS_Documentation.pdf* – documentation of dataset description and details.

A detailed tree of the folders is shown in Figure 2.

MAUS

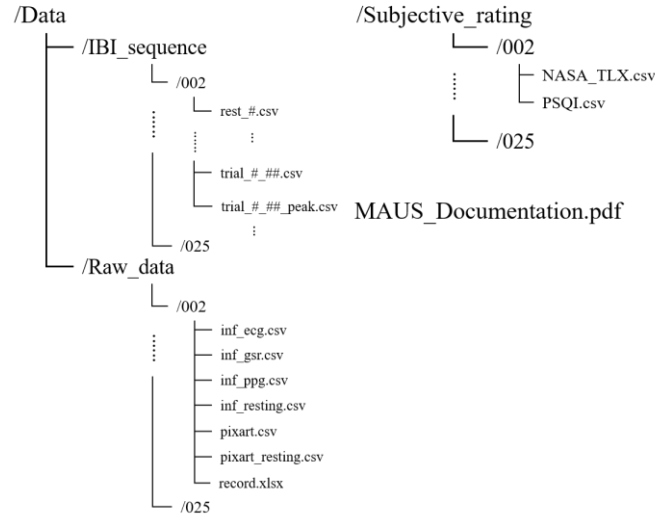


Figure 3: Data Structure of MAUS Dataset

2. File description

- **rest_#.csv** – IBI during resting period (calculated from PixArt-PPG), # represent segment no.
- **trial_###.csv** – IBI during trial period (calculated from PixArt-PPG), # represent trial no., ## represent segment no.
- **trial_###_peak.csv** – Location of PPG peaks (calculated from PixArt-PPG), # represent trial no., ## represent segment no.
- **inf_ecg.csv** – raw ecg data (Procomp Infiniti) for all trials
- **inf_gsr.csv** – raw gsr data (Procomp Infiniti) for all trials
- **inf_ppg.csv** – raw ppg data (Procomp Infiniti) for all trials
- **inf_resting.csv** – raw ecg, gsr and ppg data (Procomp Infiniti) during resting period
- **pixart.csv** – raw wrist-ppg data (Procomp Infiniti) for all trials
- **pixart_resting.csv** – raw wrist-ppg data (Procomp Infiniti) during resting period
- **record.xlsx** – timestamp and responses of participant to N-back task
- **NASA_TLX.csv** – NASA Task Load Index measurement
- **PSQI.csv** – Pittsburgh Sleep Quality Index (PSQI)
- **MAUS_Documentation.pdf** – the current document.

3. Apparatus and signals

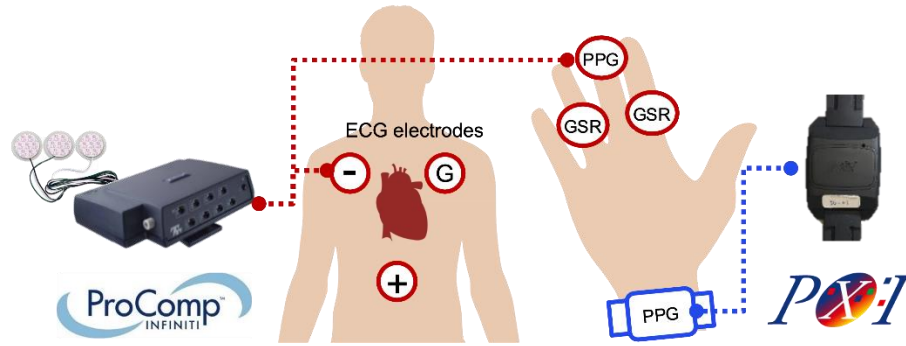


Figure 4: Sensor Placement and Apparatus

- **Procomp Infiniti:** The Procomp Infiniti was used to record ECG, GSR, and PPG at a sampling rate of 256 Hz. Single lead ECG was measured by electrodes placed on both shoulders and one on the abdomen. GSR was measured via two electrode straps fastened around the index and ring finger of participants' non-dominant hands. PPG was measured by a sensor pressed against the palmar surface of the middle fingertip with an elastic strap fastened tightly to acquire better signal quality.
- **PixArt PPG Watch:** The PPG was recorded from wristtype PPG sensors with green LED at a sampling rate of 100 Hz. The watch was worn on the non-dominant hand to avoid the movement of answering on the keyboard. The data would then be transmitted to a tablet through Bluetooth.

The dataset consists of recordings of physiological signals:

1. ECG recordings.
2. Fingertip-PPG recordings.
3. GSR recordings.
4. Wrist-PPG recordings.

4. Stimuli

We used N-back task to elicit different mental workload condition. In the N-back task, the user had to memorize the last N one-digit numbers of a series of rapidly flashing numbers in succession. When a stimulus was identical to the n -th number preceding the stimulus number, the subject had to respond by pressing the space bar on the keyboard. As N increased, the task's difficulty increased, as subjects had to memorize more numbers and keep shifting the memorized sequence. Therefore, adjusting the N could stimulate different levels of MW. There would be 0-, 2-, and 3- back three kinds of tasks. The 0-back task could be viewed as a lower MW state, while the 2- and 3- back tasks were regarded as a higher MW state. These three kinds of tasks were arranged in a counterbalanced order (i.e., $0 \rightarrow 2 \rightarrow 3 \rightarrow 2 \rightarrow 3 \rightarrow 0$) for a total of six trials.

5. Volunteer's statistics

Our database contains 22 healthy participants (2 females) from the university's graduate students. The average age among the participants was 23 years with a 1.7 standard deviation. Prior to the experiment, each subject signed a consent form. Next, they were informed of a set of instructions explaining experimental procedures and the meaning of the self-assessment questionnaires.