

# Dataset Description for RCQoEA-360VR: Real-time Continuous QoE scores for HMD-based 360° VR dataset

## 1 Dataset Description

RCQoEA-360VR dataset offers a novel multimodal database a novel multi-modal dataset for continuous Quality of Experience (QoE) evaluation in virtual reality (VR) environments. The dataset captured continuous QoE annotation data, synchronised physiological signals (electrocardiogram and galvanic skin response), behavioural data (eye and head movements) and post-viewing QoE ratings gathered through a within-VR interface. The dataset is available at: <https://github.com/sowmyyav/RCQoEA-360VR-Dataset>.

The dataset includes the raw and processed data collected from 32 participants (P1-P32). Each participant watched 360° video sequences of 30 seconds with each video shown under eight different quality configurations derived from the VQEG database, resulting in a total of 40 unique video conditions (V1-V40). The following description of the data uses the letter PXX to denote the IDs of the participants (XX are natural numbers in the set {1,2,...,32}) and VXX to denote the IDs of the videos (XX are natural numbers in the set {1,2,...,40}). The **RCQoEA-360VR-Dataset** directory contains the following six subfolders:

### 1. QoE\_Annotation\_Data

This directory is organized into two subfolders: Continuous\_QoE\_Score and Post\_Video\_QoE\_Score, representing two stages of subjective quality evaluation.

#### • Continuous\_Annotation\_Data

The continuous QoE scores were annotated using a touchpad, allowing participants to express their perceived video quality in real time through up/down movements, captured at a frequency of 10 Hz. These values were logged within a normalized range of [-1, 1], reflecting moment-to-moment variations in quality perception during video playback. The raw continuous annotation data is stored in a .txt file named RCQoE\_PXX\_VXX\_<timestamp>.txt per participant. Each .txt file contains three variables—ID, TimeStamp, and RCQoE.

#### • Post\_Video\_QoE\_Score

Post-video QoE scores were collected at the end of each video using a 5-point Mean Opinion Score (MOS) scale: 1-Bad, 2-Poor, 3-Fair, 4-Good, and 5-Excellent. The post-video MOS ratings are saved in individual files following the naming convention PostQuestion\_PXX\_VXX\_<timestamp>.txt. Each of these files contains: ID, MOS (recording participant's final rating), and timestamps StartTime and StopTime: indicating when the video started and stopped.

Based on the video start and end timestamps in this file, we filter out the logged data during each video playback period (by clipping from video start and end time). Then the

video playback time relative to the video start time 0 is calculated with millisecond accuracy, which is added to each sample data as Timestamp in second.

## 2. Behavioral\_data

This directory contains raw recordings of eye movement data in .xml format and head movement data in .txt format.

#### • EM\_Data

Eye movement data acquired from the HMD Tobii eye tracker were sampled at 120Hz. Each sample contains the following information: the camera Euler angles for the HMD/Head rotation, rotation(x;y;8 z) (x,y,z values are in range of [0;360]); the left, right and combined eye gaze direction as a normalized vector in world space, direction(x, y, z) (x, y, z values are in range of [-1,1]); the left pupil diameter (LPD) and right pupil diameter (RPD) are in millimeters. These data were extracted and saved in EM\_P<XX>\_V<YY>\_<timestamp>.xml file format per participant.

Where:

- PXX = Participant ID (1-32)
- VYY = Video ID (1-40)
- <timestamp> = Time of recording (e.g., 20230731T134820) denotes the start time of the recording in YYYYMMDDTHHMMSS format.

#### • HM\_Data

Head movement tracking monitors rotations, orientations and positional movements continuously in terms of x, y and z rotations (yaw, pitch and roll) from the headset at 120Hz. The head movement samples is saved in files named using the convention HM\_P<XX>\_V<YY>\_<timestamp>.txt, following the same naming structure as the eye movement data. The data is organized in a tabular format with the following fields: ID (sample index), TimeStamp (in nanoseconds), HMDRX, HMDRY, and HMDRZ.

## 3. Physiological\_data

The Physiological\_data directory is divided into two main subfolders: ECG and GSR.

#### • ECG

Within the ECG folder, the data is further organized into two subdirectories: Raw\_ECG\_Data and Processed\_ECG\_Data.

The Raw\_ECG\_Data folder contains files named in the format ecg\_PXX\_VYY.csv, where PXX represents the participant ID (1-32) and VYY denotes the video number (1-40). These files include the raw ECG signal data recorded from Polar H10 chest belt at 130Hz during each video session. As previously mentioned, based on the video start and end timestamps in PostQuestion\_PXX\_VXX\_<timestamp>.txt file, we kept the raw

physiological data during the video playback period from each participant and saved it.

The `Processed_ECG_Data` folder contains `ECG_equal_length_data.csv`, which includes pre-processed ECG signals trimmed to a uniform length across all participants and videos. This allows for easier input into machine learning models or physiological signal analysis pipelines. The folder also includes `KubiosHRVresults_equal_length_clean_nonan.csv`, which provides HRV features extracted using Kubios HRV Scientific (v4.0.3) across all participants and videos. This file includes detailed physiological metrics—such as mean heart rate, SDNN, RMSSD, and LF/HF ratios—facilitating comprehensive analysis of autonomic nervous system responses.

- **GSR**

The GSR directory is divided into two subfolders: `Raw_GSR_Data` and `Processed_GSR_Data`. The `Raw_GSR_Data` folder contains files named as `gsr_PXX_VYY.csv`, each storing multi-channel sensor data recorded using a Shimmer device. This data is also filtered out based on the video start and stop time. These files include timestamps and various physiological signals such as accelerometer, gyroscope, GSR (skin conductance and resistance), and PPG-derived metrics (HR) captured using Shimmer GSR unit at 130Hz. Key columns relevant for GSR analysis are `Shimmer_F5D4_GSR_Skin_Conductance_CAL` and `Shimmer_F5D4_GSR_Skin_Resistance_CAL`, provided alongside metadata like sampling timestamps and unit information.

The `Processed_GSR_Data` folder includes `GSR_SC_equal_length_data.csv` and `GSR_SR_equal_length_data.csv`, representing skin conductance (SC) and skin resistance (SR) signals, respectively, standardized to equal lengths across all participants and video sessions. Additionally, `PPG_HR_equal_length_data.csv` provides heart rate data derived from PPG signals, also aligned in duration for consistent physiological analysis.

## 4. Questionnaires

The Questionnaires directory stores the data records of three subjective assessment questionnaires: SSQ (Simulator Sickness Questionnaire), IPQ (Igroup Presence Questionnaire), and NASA-TLX (Task Load Index). All data are stored in .xlsx format.

- **SSQ (Simulator Sickness Questionnaire)**  
Administered at three time points:
  - `SSQ_PreTest.xlsx`: Before the experiment
  - `SSQ_Block1.xlsx`: After completing Block 1
  - `SSQ_Block2.xlsx`: After completing Block 2
- **IPQ (Igroup Presence Questionnaire)**
  - `IPQ_Block1.xlsx`: After Block 1
  - `IPQ_Block2.xlsx`: After Block 2
- **NASA-TLX (Task Load Index)**
  - `NASA_TLX_Block1.xlsx`: After Block 1
  - `NASA_TLX_Block2.xlsx`: After Block 2

Each questionnaire file includes responses from all 32 participants, labeled using identifiers P1 through P32. Additionally, the file `participants_information.csv` contains detailed metadata about each participant, which contains

background metadata such as age, gender, prior VR experience, and other relevant demographic details. The questionnaires used for participant background form, SSQ, IPQ and NASA-TLX are provided in Appendices 1, 2, 3, and 4, respectively.

## 5. Scripts

The Scripts directory contains all supporting code and tools used for data extraction, preprocessing, and analysis. It includes the `Unity_RCQoEA` folder containing Unity project (developed in C#) used in the experiment. In addition, `Physiological_DataPreprocessing` folder provides a collection of Python scripts and Jupyter notebooks for processing physiological data (ECG, GSR, PPG), aligning timestamps, and analyzing subjective ratings. These scripts perform tasks such as extracting timestamps from raw files, merging and formatting ECG/GSR signals, preparing data for Kubios HRV analysis, and computing summary statistics for QoE ratings.

## 6. Stimuli

The stimuli videos used in the experiment is available in the [Stimuli/CONTENTS](#) folder.

## APPENDICES

The appendices presented in this section provide supplementary materials related to the experimental evaluation of the RCQoEA-360VR dataset. Appendix 1 gathers participant background information. Participants completed both pre- and post-experiment Simulator Sickness Questionnaires (Appendix 2), as well as the IPQ Presence Questionnaire (Appendix 3) and the NASA-TLX Questionnaire (Appendix 4) to assess their subjective experiences during the VR tasks. Appendix 5 includes the semi-structured interview questions asked at the end of the experiment to gain further insights into participant experiences.

# Appendix 1 – Background Information

## RC-QoE-A-360VR Research Background Information

Participant ID: \_\_\_\_\_

Age: \_\_\_\_\_

Wear Glasses: ☐ Yes ☐ No

Gender: ☐ Male ☐ Female ☐ Other

Experience Using VR headset:

- ☐ First Time
- ☐ Less than 5 times
- ☐ 5-20 times
- ☐ More than 20 times
- ☐ Every day

Profession / Occupation: \_\_\_\_\_

## Appendix 2– Simulator Sickness Questionnaire

### Simulator Sickness Questionnaire

Kennedy, Lane, Berbaum, Lilienthal (1993)\*\*\*

Date: \_\_\_\_\_ - \_\_\_\_\_ -2023

Participant ID: \_\_\_\_\_

#### Pre-Experiment

Instructions: Circle how much each symptom below is affecting you right now.

|                                |             |               |                 |               |
|--------------------------------|-------------|---------------|-----------------|---------------|
| 1. General discomfort          | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 2. Fatigue                     | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 3. Headache                    | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 4. Eye strain                  | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 5. Difficulty focusing         | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 6. Salivation increasing       | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 7. Sweating                    | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 8. Nausea                      | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 9. Difficulty concentrating    | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 10. 《 Fullness of the head 》   | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 11. Blurred vision             | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 12. Dizziness with eyes open   | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 13. Dizziness with eyes closed | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 14. * Vertigo                  | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 15. ** Stomach awareness       | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |
| 16. Burping                    | <u>None</u> | <u>Slight</u> | <u>Moderate</u> | <u>Severe</u> |

\* Vertigo is experienced as loss of orientation with respect to vertical upright

\*\* Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

\*\*\* Original version: Kennedy, R.S., Lane, N.E., Berbaum, K.s., & Lilienthal, MG(1993). Simulator Sickness Questionnaire: An enhanced method for quantifying simulator sickness. International Journal of Aviation Psychology, 3(3),203-220

## IPQ Presence Questionnaire

Participant ID: \_\_\_\_\_

You will notice that some questions are very similar to each other. This is necessary *for statistical reasons*. And please remember: Answer all these questions only referring to this *one* experience.

did not feel    ☐    ☐    ☐    ☐    ☐    ☐    ☐    felt present

-3           -2           -1           0           1           2           3

**7. I was not aware of my real environment.**

fully disagree   ☐   ☐   ☐   ☐   ☐   ☐   ☐   fully agree  
-3   -2   -1   0   1   2   3

**8. In the computer-generated world I had a sense of "being there" .**

not at all   ☐   ☐   ☐   ☐   ☐   ☐   ☐   very much  
-3   -2   -1   0   1   2   3

**9. Somehow I felt that the virtual world surrounded me.**

fully disagree   ☐   ☐   ☐   ☐   ☐   ☐   ☐   fully agree  
-3   -2   -1   0   1   2   3

**10. I felt present in the virtual space.**

fully disagree   ☐   ☐   ☐   ☐   ☐   ☐   ☐   fully agree  
-3   -2   -1   0   1   2   3

**11. I still paid attention to the real environment.**

fully disagree   ☐   ☐   ☐   ☐   ☐   ☐   ☐   fully agree  
-3   -2   -1   0   1   2   3

**12. The virtual world seemed more realistic than the real world.**

fully disagree   ☐   ☐   ☐   ☐   ☐   ☐   ☐   Fully agree  
-3   -2   -1   0   1   2   3

**13. I felt like I was just perceiving pictures.**

fully disagree   ☐   ☐   ☐   ☐   ☐   ☐   ☐   fully agree  
-3   -2   -1   0   1   2   3

**14. I was completely captivated by the virtual world.**

fully disagree   ☐   ☐   ☐   ☐   ☐   ☐   ☐   fully agree  
-3   -2   -1   0   1   2   3

## Appendix 4 – NASA-TLX Questionnaire

### NASA-TLX

Date: \_\_\_\_ - \_\_\_\_ - 2023

Participant ID: \_\_\_\_

#### Block 1

(Mark spaces, not lines. You can change ratings you've done earlier, if you wish)

**How much mental activity was required?**

Low |  | High

**How much physical activity was required?**

Low |  | High

**How much time pressure did you feel?**

Low |  | High

**How hard did you work (mentally & physically)?**

Low |  | High

**How satisfied were you with your performance?**

Poor |  | Good

**How much frustration did you experience?**

Low |  | High

## Rating Scale Definitions

| Title                             | Endpoints        | Description   |
|-----------------------------------|------------------|---|
| <b>Mental Demand</b>              | <i>Low/High</i>  | How much mental, visual and auditory activity was required? (e.g. thinking, deciding, calculating, looking, listening, scanning, searching)   |
| <b>Physical Demand</b>            | <i>Low/High</i>  | How much physical activity was required? (e.g. pushing, pulling, turning, controlling)  |
| <b>Time Pressure</b>              | <i>Low/High</i>  | How much time pressure did you feel because of the rate at which things occurred? (e.g. slow, leisurely, rapid, frantic)  |
| <b>Effort Expended</b>            | <i>Low/High</i>  | How hard did you work (mentally and physically) to accomplish your level of performance?  |
| <b>Performance Level Achieved</b> | <i>Poor/Good</i> | How successful do you think you were in doing the task set by the experimenter? How satisfied were you with your performance? Don't just think of your score, but how you felt you performed. |
| <b>Frustration Experienced</b>    | <i>Low/High</i>  | How much frustration did you experience? (e.g. were you relaxed, content, stressed, irritated, discouraged)   |






## Appendix 5 – RCQoEA-360VR Interview Questions

Participant ID \_\_\_\_\_



Date: \_\_\_\_/\_\_\_\_/2023

### RC-QoE-A-360VR Interview Questions:

1. Which video do you prefer? Why?

| VSenseLuther (VL)   | VSenseVaude (VV)  | OculusMotion (OM)  |
|---|---|--|
|  |  |  |
| Animation content and a main character  | A girl speaks to the camera   | Camera moving in a City – day and night  |

| NokiaFlamenco (NF)   | BrazilMusic (BM)  |
|--|---|
|  |  |
| Indoor dance course  | Band playing Brazilian music  |

2. Can you find the differences among these videos in QoE?

3. Did you feel uncomfortable or distracted when you rated the videos? What can be improved?

4. What other input methods besides a touchpad would you prefer?

Participant ID \_\_\_\_\_

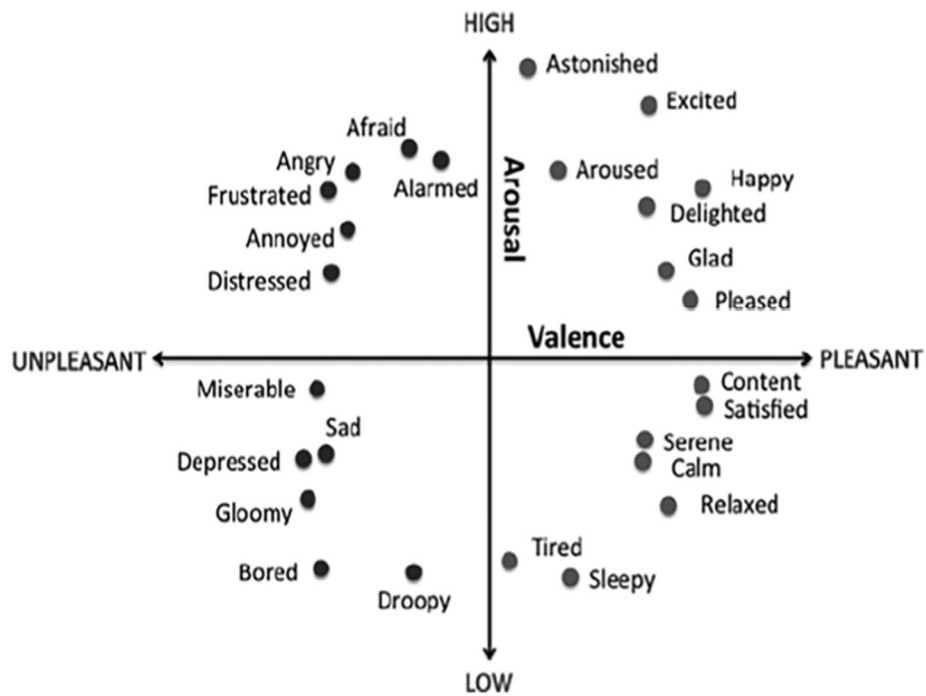
Date: \_\_\_\_/\_\_\_\_/2023

5. Did you feel uncomfortable or distracted wearing the PolarH10 chest strap/Shimmer GSR sensors?






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6. What is your mood?



**Table 1. Properties of the selected test video clips**

| Video Name and Description  | Screenshot   | Resolution             |
|---|--|------------------------|
| VSenseLuther (VL) Video with animation content and a main character. Contains various shots (indoors and outdoors) and audio. |    | 4,096 x 2,048<br>30fps |
| VSenseVaude (VV) Video where a girl speaks to the camera. Contains audio and various indoor and outdoor shots                 |    | 4,096 x 2,048<br>30fps |
| Oculus Motion (OM) Camera moving in a city. Contains music and two shots: one in daylight and one at night.                   |   | 3,840 x 2,160<br>30fps |
| NokiaFlamenco (NM) Indoor dance course, with ambient audio. Contains stitching artifacts.                                     |  | 3,840 x 2,160<br>30fps |
| BrazilMusic (BM) Indoor scene of a band playing Brazilian music. With audio.  |  | 4,096 x 2,048<br>30fps |

**Table 2. Properties of the training video clip.**

| Video Name and Description  | Screenshot   | Resolution          |
|---|--|---------------------|
| OculusBeach (OB)<br>Scene with music of a beach at sunset with people dancing and moving. |  | 3,840 x 1,920 30fps |