

Unity3D-based app for 360VR subjective quality assessment with customizable questionnaires

Carlos Cortés , Pablo Pérez and Narciso García

Abstract—This document describes an interactive virtual reality tool for subjective assessment designed under the scope of ITU-T Study Group 12 and the Video Quality Experts Group in the development of the future ITU-T Recommendation P.360-VR for the subjective assessment of 360 videos using Head-Mounted Displays (HMDs). The tool has been designed under the Unity3D engine to be used on multiple HMDs. Furthermore, it can be configured for a variety of custom or predefined questions while the video sequence is played and/or after its ending. The head tracking is also registered in degrees. The voting method is gaze-based using joysticks keys for confirmation.

Index Terms—Video 360, Quality, Quality of Experience, Virtual Reality, Subjective assessment

I. INTRODUCTION

The popularization of Virtual Reality (VR) devices has led to an increased interest for measuring the Quality of Experience (QoE) in immersive environments. Moreover, 360 video opens a new paradigm on video quality measurement, requiring application-related questionnaires [1] [2]. Although there is no standardized methodology for measuring the quality of experience on VR applications [3], techniques from 2D video assessment can be extended for 360 videos in some way [4]. Thus, following the ITU recommendations for subjective quality assessment, this new tool has been designed to help QoE VR experiments be easier to repeat, replicate, and reproduce [5].

Stemming from previous monitoring applications [6], a tool for 360 subjective assessment of 360 videos in HMDs called Miro360 was developed [7]. This tool was devised under the Immersive Media Group of VQEG and follows the ongoing recommendation ITU-T P.360-VR [5].

The main limitation of Miro360 is that it is only compatible with Android HMDs. This problem becomes relevant when comparing different devices [8]. To overcome this limitation, a Unity3D version of Miro360 is presented on this paper in order to make an application compatible with multiple devices while keeps fully compatible with the Android-based ones. Other features have been added such as custom questionnaires support, randomization algorithm and a new interaction system.

II. FEATURES

The application has been developed for multiple HMDs support by using the Unity3D engine. Attending to the configuration file the application supports:

- Labeling videos with custom ids.
- Custom questionnaires and scales.
- Custom start and duration of the video.
- Custom in-sequence questionnaires period.
- Randomize the contents according to the recommendation of the ITU-R BT.500-13.

A randomizing algorithm is also provided within the application following the recommendations of the ITU-R BT.500-13 that forbids two equal consecutive contents [5]. Attending to configured time constraints there are two possible questionnaires discrete or continuous.

Once the application has started, a playlist is generated according to the configuration file. The custom questionnaires are also generated at this step. Then, the session will start running the different videos and questionnaires assigned to each sequence until the end of the playlist.

A. Head tracking

Head tracking positions are provided by the application within the voting log file in degrees. Figure 1 shows an example of the head positions of several users during a 360 video session (red dots) and their mean (blue line). Besides, vertical grey bars stand for periods of voting during the video. From the results, it is possible to see the difference between each user behavior.

B. Interaction

The tool supports two different methods of performing interaction following the ITU-R BT.500 for subjective assessments.

On the one hand, scoring is the method used at the in-sequence continuous questionnaire (SSCQE). It is implemented by a white square at the top-right corner of the user's viewport. Placing the finger on the top/down part of the touchpad, the user can increase/decrease the score on a 0-99 scale.

On the other hand, for the voting method, used on discrete questionnaires (SSDQE), it is only necessary to fix the label with the gaze and select the highlighted content pressing the touchpad button.

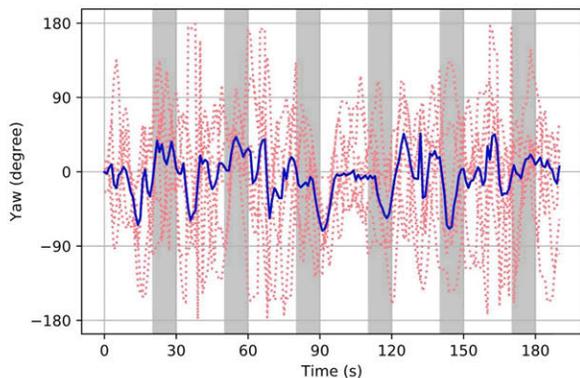


Fig. 1. Head Tracking Angles.

C. Randomized playlist generator

ITU-R BT.500 recommendation suggests using a randomized playlist for subjective assessments in video 360. In addition that the playlist must be different for each experiment session, the recommendation states that two equal contents should not be shown consecutively. The tool provides two ways of generating a randomized playlist. Firstly, the video playlist structure is explained. It is possible, in the configuration file, to label each container with a text (src_id Figure 3). Many videos can be labeled with the same content label. The data structure can be seen as a matrix where every row is a label and each column is a video.

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots \\ \vdots & \ddots & \\ a_{K1} & & a_{KK} \end{bmatrix} \quad (1)$$

If random order is selected:

- For uniform content (all labeled contents have the same number of videos), a hierarchy random algorithm is used. The method stores the number of different labeled contents (rows). Each iteration takes randomly a content (a_K) from the stored ones, then, a video labeled with that content is played (column), the video (a_{KK}) will not be played again during the session. The selected content will not be selected again during the content iteration. This means that for each content iteration every content (row) will be played at some quality (columns).
- For no uniform content, a random playlist is generated iteratively until there is no consecutive content. For this method, there is a limit of 1000 iterations.

Timestamp	Nsequence	Uri	State	Tag	Value
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Fig. 2. Log file format

D. Configuration File

The configuration file is a JSON with three main sections as the Figure 3 shows: scales, questionnaires and sequences.

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"scales" : [{
  "name": "exp",
  "scores": ["new", "inite", "profi", "expri", "legnd"]
}],
"questionnaires": [{
  "name": "rpq",
  "items": [
    {
      "scale": "exp",
      "text": "Example question",
      "tag": "RPQ.MS"
    }, 1]]],
"sequences": [{
  "uri": "E:/video.mp4",
  "src_id": "full",
  "start": 34,
  "duration": 10,
  "post_seq_questions": [
    "acr"
  ]
}],
"randomize": false

```

Fig. 3. JSON file example.

These three parameters define custom questionnaires with their own scale. In addition it is possible to configure how and when the application will show the questionnaires.

E. Log file

The log file has the structure shown in Figure 2. Timestamp is defined in nanoseconds, Nsequence is the ordinal number of the video in the entire session. Uri is the absolute path of the video, State can be IDLE if the video is not started, VIDEO if the video is playing or QUESTIONNAIRE. The Tag field can be either the tag of the questionnaire given by the JSON file or LookAt when a video is being played. Value can be the head orientation in degrees (pitch, yaw and roll) or the value of the vote.

III. CONCLUSIONS

We have presented a Unity3D based application to assess subjective quality of 360 video tested with HTC Vive Pro. The tool enhances previous tools for the development of ITU-T P.360-VR, the future ITU-T recommendation.

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