QUALINET – EUROPEAN NETWORK ON QUALITY OF EXPERIENCE IN MULTIMEDIA SYSTEMS AND SERVICES

COST ACTION IC1003
HTTP://WWW.QUALINET.EU

Document: Qi0306

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Date: 09/03/2013
Place: Prague/Klagenfurt, Czech Republic/Austria
Type: Input
Destination: WG4

WG4 Databases Whitepaper v1.5
QUALINET MULTIMEDIA DATABASE
ENABLING QOE EVALUATIONS AND BENCHMARKING

Introduction

The evaluation and benchmarking of QoE can be done only if database of proper multimedia content annotated with subjective ratings is available. One of the goals within the interests of the COST Action IC1003 QUALINET and its Working Group 4 (Databases and Validation) is to create such databases and take the steps to make these databases accessible to all researchers. This whitepaper presents an overview of this effort focusing on survey and description of currently available databases and on explanation how these databases can be used for QoE evaluations and benchmarking.

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QUALINET MULTIMEDIA DATABASE ENABLING QOE EVALUATIONS AND BENCHMARKING

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ABSTRACT

The evaluation and benchmarking of QoE can be done only if database of proper multimedia content annotated with subjective ratings is available. One of the goals within the interests of the COST Action IC1003 QUALINET and its Working Group 4 (Databases and Validation) is to create such databases and take the steps to make these databases accessible to all researchers. This paper presents an overview of this effort focusing on survey and description of currently available databases and on explanation how these databases can be used for QoE evaluations and benchmarking.

Index Terms— QoE, QUALINET, evaluation, databases, benchmarking

1. INTRODUCTION

A key for current and future developments in QoE resides in a rich and internationally recognized database of multimedia content of different sorts. This database should be available to the scientific community at large. Thus, one of the main interests of the COST Action IC1003 QUALINET (http://www.qualinet.eu) and its Working Group 4 (WG4) entitled Databases and Validation is to create such databases and take the necessary steps so as to make them accessible to all researchers.

As the base of future efforts the WG4 decided to list and summarize basic description of available multimedia databases based on literature search and on the feedback from the QUALINET members. As the number of databases in the list rapidly increases (at the time of writing this paper in March 2013, more than 110 multimedia databases from which about 55 are owned by QUALINET partners) the handling of the necessary updates starts to be inefficient. Based on these findings WG4 started to implement “QUALINET Multimedia Databases Online” platform. This Web site will be used as QUALINET’s main resource for sharing of the datasets among QUALINET members and the scientific community. Currently, there is no other resource of multimedia databases publicly available and similar to the proposed one. The QUALINET platform is intended to provide much broader functionality that other known similar solutions such as Consumer Video Digital Library (http://www.cdvl.org). The main difference lies in the fact that the “QUALINET Databases” will not contain only the multimedia content but also the subjective data such as MOS or eye-tracking data and detailed description of the datasets including scientific references.

The basic functionality of the “QUALINET Databases” is based on the idea that registered users (QUALINET members and approved users from the scientific community) will have access through an easy-to-use Web portal providing a list of multimedia databases and based on their user rights they will be allowed to browse information about the particular database and eventually download the actual multimedia content. Selected users and, specifically, database owners will have rights to upload or edit their items in the list of databases.

In the following paragraphs we present an overview of the actual multimedia content available in the “QUALINET Databases” focusing especially on the content created by the QUALINET partners.

2. OVERVIEW OF THE QUALINET MULTIMEDIA DATABASE

The actual “QUALINET Databases” document provides a list and summarizes basic description of available multimedia databases based on literature search and on the feedback from the QUALINET members. The listed datasets focus mainly on the publicly available audiovisual media content – some annotated with subjective ratings – and on some databases with special content.

One of the main resources used to create initial version of this overview was the Web site by Stefan Winkler [1]. Other databases were reported by the QUALINET members or found in the respective references. At the time of writing this paper, there are about 90 datasets listed in the “QUALINET Databases”, from which about half was created and is owned by QUALINET partners.

The described databases can be divided into three main categories: (1) *Annotated Multimedia Quality Databases*, (2) *Eyetracking Databases*, and (3) *Other Databases*. The databases with the direct utilization in QoE testing and benchmarking are mainly from (1) *Annotated Multimedia Quality Databases*. The further classification of the datasets is based on the actual content type: (1.1) *Annotated Image Quality Databases* and (1.2) *Annotated Video Quality Databases*. These databases of images or videos are annotated with the results from subjective tests. There is also special multimedia content available such as 3D images and videos or results from visual attention experiments. Only a very limited number of datasets is currently available in the audiovisual category. Very quickly growing content is in the category of (2) *Eyetracking Databases*. The “QUALINET Databases” contains about 22 datasets with subjective data on visual attention from which about 9 are owned by the QUALINET partners.

In the following we present a brief overview of the “QUALINET Databases” content. This overview is focused on the databases provided by the QUALINET partners.

2.1. Annotated multimedia quality databases

Currently (March 2013) the “QUALINET Databases” lists about 70 annotated multimedia datasets, from which about 50 are owned by the QUALINET partners. About 22 datasets are focused on images, of which 15 are owned by the QUALINET partners. About 28 datasets are focused on videos or audiovisual content, of which 26 are owned by the QUALINET partner.

2.1.1. Annotated image quality databases

A significant number of datasets available within the “QUALINET Databases” was created by the Institut de Recherche en Communications at Cybernétique de Nantes/Images et Video Communications (IRCCyN/IVC). The *IRCCyN/IVC Image Quality Database* includes JPEG, JPEG2000, and Locally Adaptive Resolution (LAR) coding and blurred images with very different types of distortion. Subjective evaluations were made using a Double Stimulus Impairment Scale (DSIS) method with five categories, 15 observers, and 10 original images were used [2].

The Media Information and Communication Technology Laboratory (MICT) at the University of Toyama offer their *MICT Image Quality Database* where the images are distorted with JPEG and JPEG2000 codecs. The *IRCCyN/IVC Scores on Toyama (MICT) Database* complements the MICT database with different protocol, different type of display device and different populations. The results of the two databases can be used to consider the display technology and the population in a quality model. There are 14 reference images and the degradations are JPEG and JPEG2000 coding [3][4].

The *IRCCyN/IVC DIBR Images Database* contains 96 still images and their associated subjective scores. Three different multi-view plus depth (MVD) sequences are considered in this database. Seven Depth Image Based Rendering (DIBR) algorithms processed the three sequences to generate, for each sequence, four new viewpoints [5].

The *IRCCyN/IVC 3D images dataset* contains 96 stereoscopic images and their associated subjective scores. This dataset is composed of the six reference images (undistorted) and 15 distorted version of each sources generated from three different encodings (JPEG, JPEG2000, blurring) symmetrically to the stereopair images [6]. The result of this database could be used to design new metrics for 3D quality assessment.

The *Wireless Imaging Quality (WIQ) Database* is available from the Radio Communication Group at the Blekinge Institute of Technology. In this case 40 images were evaluated by 30 non-expert viewers. The database focuses on gray-scale JPEG compressed images and distortions caused by a simulated wireless channel. Seven reference images and 80 distorted (test) images were used in the subjective experiments, and subjective scores for all 80 images are obtained from the two subjective experiments [7].

The subjective data on perceived ringing were collected for the *TU Delft Perceived Ringing Dataset* with the aim to better understand where human beings perceive ringing artifacts in compressed images and to develop a no-reference (NR) metric to predict perceived ringing annoyance in these compressed images [8][9].

The *MMSPG JPEG XR Image Compression Database* compares new JPEG XR technology to existing JPEG and JPEG 2000 algorithms, considering compression of high resolution pictures, by mean of a campaign of subjective quality assessment tests which followed the general guidelines provided by the AIC JPEG XR ad-hoc group. A detailed procedure for the statistical analysis of subjective data is also proposed [10].

The *MMSPG 3D Image Quality Assessment Database* contains stereoscopic images with a resolution of 1920x1080 pixels. Various indoor and outdoor scenes with a large variety of colors, textures, and depth structures have been captured [11].

The *LIRIS/EPFL 3D Model General-Purpose database* contains the 3D models of the corpus, the subjective opinion scores given by the observers and the values from several objective metrics. 88 models between 40K and 50K vertices were generated from 4 reference objects. Subjective evaluations were made at normal viewing distance, using a Single Stimulus Impairment Scale (SSIS) method with 12 observers [12][14].

The *LIRIS 3D Model Masking database* contains 26 models between 9K and 40K vertices generated from four reference objects. The only distortion is noise addition applied with three strengths, either on smooth or rough regions. Subjective evaluations were made at normal viewing distance, using a Multiple Stimulus Impairment Scale (MSIS) method with 11 observers [13][14].

There are other interesting annotated image databases created by the teams outside QUALINET and these are also listed in “QUALINET Databases”. These datasets are worth to mention for completeness. A typical example of image quality database is the *LIVE Image Quality Assessment Database* available from the Laboratory for Image & Video Engineering (LIVE) from the University of Texas at Austin, which has been used in many studies and it is popular among researchers. This LIVE IQAD database contains still images annotated with MOS ratings [15][16]. A color image database for evaluation of image quality metrics is available from the Tampere University of Technology. The *Tampere Image Database (TID2008)* contains a large amount of test images distorted with various techniques [17][18]. The Image Coding and Analysis Lab at the Oklahoma State University offer *Categorical Image Quality (CSIQ) Database* [19]. The *A57 Image Database* is of limited statistical due to the limited number of images and limited number of human subjects [20]. The *Multi-Sensor Images from the Collections of Manchester University* contains the data from a series of subjective image fusion evaluation trials performed as a part of an image fusion research activity [21].

2.1.2. Annotated video quality databases

There are various annotated video quality databases available. Significant number of video datasets included in the “QUALINET Databases” was created at IRCCyN/IVC. The *IRCCyN/IVC 1080i Database* contains several reference HD videos (no processing or degradation) and seven different videos encoded with Advanced Video Coding (AVC). There is one spreadsheet that contains the individual score and the MOS for each video for the SAMVIQ and ACR methodologies. A pretest with experts was done to find seven bit-rates to have seven different subjective scores [22].

The *IRCCyN/IVC SD RoI Database* contains the videos and associated subjective scores. The videos are provided with various contents encoded using AVC with or without error transmission simulations [23].

The *IRCCyN/IVC Eyetracker SD 2009_12 Database* contains eyetracker data and the associated videos. The videos are provided with various contents for the reference (without processing or degradation) and four error transmission simulations. The AVC-distorted videos are also provided [24].

The *IRCCyN/IVC SVC4QoE Replace Slice Video Database* has for each of the nine contents the reference (without processing or degradation) and 14 different Hypothetical Reference Circuits (HRCs). The HRCs are AVC and Scalable Video Coding (SVC) with simulated transmission errors. Several error concealments were tested using the SVC capability. There is one spreadsheet with the individual score and the MOS for each video for the results of subjective test using Absolute Category Rating (ACR) methodology [25].

The *IRCCyN/IVC SVC4QoE QP0 QP1 Video Database* contains for each of the 11 contents the reference (without processing or degradation) and 29 different HRCs. The HRCs are AVC and SVC. Several quantization parameter (QP) repartitions are tested between the base layer of the SVC stream and the enhancement layer [26].

The *IRCCyN/IVC SVC4QoE Temporal Switch Video Database* is built similarly as the datasets described above. This database has for the 11 contents the reference (without processing or degradation) and 36 different HRCs. The HRCs are AVC and SVC. Several switching conditions were created between the base layer and the enhancement layer [27].

The *IRCCyN/IVC H264 AVC vs SVC VGA Video Database* contains 56 (28 QVGA and 28 VGA) video sequences and the associated subjective results. Four different video source contents were used in QVGA and the same four contents in VGA with the reference (without degradation) and six different degradations, each format subjectively evaluated. The HRCs are based on AVC and SVC without transmission errors. For each sequence, a SVC bitstream with four layers was created, two in QVGA and two VGA. Some AVC bitstreams were generated to compare each layer of the SVC with AVC at the same bitrate and at the same Peak Signal-to-Noise Ratio (PSNR) [28].

The *IRCCyN/IVC H264 HD vs Upscaling and Interlacing Video database* contains 87 video sequences and the associated subjective results. Three different video source contents were used and for each sequence the reference (without degradation) and 28 different HRCs were subjectively evaluated. The HRCs are based on AVC in six different formats without transmission errors [29].

The other one of the QUALINET partners very active in creation of annotated multimedia datasets is Multimedia Signal Processing Group (MMSPG) at EPFL. The *EPFL-PoliMI Video Quality Assessment Database* contains 156 video streams encoded with H.264/AVC and corrupted by simulating the packet loss due to transmission errors over the network. The material includes one set of 78 video sequences at CIF spatial resolution and another set of 78 sequences at 4CIF spatial resolution. In total, 40 naive subjects took part in the subjective tests [30][31].

The *MMSPG 3D Video Quality Assessment Database* contains 3D video quality test material (1920x1080) where the test conditions represent different camera distances. The subjective test campaign was conducted using polarized stereoscopic display [32].

The *MMSPG Scalable Video Database* focuses on two scalable video codecs, i.e., SVC and a wavelet-based codec, 3 HD content videos, bit-rates ranging between 300 kbps and 4 Mbps, three spatial resolutions: 320x180, 640x360, and 1280x720, four temporal resolutions: 6.25 fps, 12.5 fps, 25 fps, 50 fps [33].

The *IT-IST Lisbon H.264/MPEG-2 Video Quality Database* contains original sequences, as well as coded ones using MPEG-2 and AVC, and corresponding MOS values [34].

The *LaBRI H.264 with Network Impairment Database* is a result of joint effort of Laboratoire Bordelais de Recherche en Informatique LaBRI (University of Bordeaux) and Communication Systems Engineering Dept. (Ben Gurion University of the Negev (BGU)). In particular, 20 different video sequences of 10 seconds were selected to compose a representative sample of broadcasted HDTV programs. Video sequences were encoded using AVC with a bit-rate of 6000kb/s. Two models of transmission impairments were applied to each video sequences [35].

The *Video Quality Database for Video over UMTS* was created at the University of Plymouth. It consists of 90 test conditions for video over UMTS networks [36].

Besides the above described annotated datasets on video quality produced by the QUALINET partners there are other widely used datasets worth to mention. The oldest public database on video quality is *VQEG FR-TV Phase I Database*. In this case the test conditions are focused on MPEG-2 compression typical distortions [37]. The video sequences from the *VQEG HDTV Database* are available in the Consumer Digital Video Library (http://www.cdvl.org). There are two annotated databases available from the Video Lab at the Polytechnic Institute of the New York University. The *Poly@NYU Video Quality Database* is focused on evaluation of scalable video coding with frame rate and quantization artifacts [38]. The *Poly@NYU Video Quality Database Packet Loss Database* consists of two parts: one is for quality evaluation of individual loss-impaired frames, and the other is for quality evaluation of entire loss-impaired segments (due to error propagation) [39]. The *LIVE Video Quality Database (LIVE VQD)* includes MPEG-2 and AVC compression and simulated transmission of AVC bitstreams through IP wired and wireless networks with errors. A set of 150 distorted videos were created from 10 reference videos (15 distorted videos per reference) using four different distortion types and the database was assessed by 38 human subjects [40][41].

2.1.3. Annotated audiovisual quality databases

As it can be seen from the sections above, many annotated databases of images and videos are available in the “QUALINET Databases”. However there is only one subjective audiovisual quality database available. The *Audiovisual Database for Video Calls over Wireless Networks* created at the University of Plymouth consists of 60 test conditions for video call over wireless networks. Subjective tests were performed according to ITU-T recommendations for audiovisual, video and audio, respectively. Absolute Category Rating (ACR) was used in experiments using a discrete 9-level quality scale for low-bitrate evaluations [42].

2.2. Eyetracking Databases

Analysis of visual attention in current multimedia systems is of high importance. There are various image and video databases available in the “QUALINET Databases” accompanied with subjective data obtained from eyetracking devices.

Similarly as for the subjective campaigns in the case of videos and images also for the eyetracking experiments there are various datasets available from IRCCyN/IVC. The *IRCCyN/IVC Eyetracker 2006 05* database contains eyetracker data and the associated images. There is no degradation on these images. It is a free task experiment. The dataset contains eyetracking data for 27 images [43].

The *IRCCyN/IVC Eyetracker data for the Berkeley segmentation dataset* contains eyetracking data from 25 observers and 84 uncompressed images from the Berkeley Segmentation Dataset [44]. There is no degradation on these images and it is a free task experiment [45].

The *IRCCyN/IVC Eyetracker SD 2008 11 Database* contains eyetracker data and the associated videos. The videos are several contents coded in H.264. The goal is to collect saliency maps to test an area of interest protection software on these videos. Dataset contains eyetracking data from 37 observers for 51 AVC SD videos [46].

The *IRCCyN/IVC Eyetracker SD 2009_12 Database* contains eyetracker data and the associated videos with various contents. The AVC videos are also provided and it is a quality task experiment. The dataset contains subjective ratings as well as eyetracking data from 30 observers for 100 SD videos [47].

The *Visual Attention for Image Quality Database (VAIQ)* is available from the Radio Communication Group at the Blekinge Institute of Technology. The database contains gaze patterns of 15 observers and saliency maps for 42 reference images from the IRCCyN/IVC, MICT, and LIVE databases [48].

The *TU Delft Eye-Tracking Release 1 database* contains data collected in order to better understand how people look to images under natural viewing conditions. Therefore, 29 source images of the LIVE image quality assessment database [15][16] were used as stimuli and the dataset contains saliency maps for 29 reference images obtained using 20 observers [49].

The *TU Delft Eye-Tracking Release 2 database* contains data collected in order to better understand how people look to images when assessing image quality. Dataset contains eyetracking data from 75 observers for 160 JPEG-compressed images [50].

The *TU Delft Interactions* was designed to investigate on the deviations of quality scoring saliency from free looking saliency. The stimuli used in the experiment consisted of several distorted versions of six original images selected from the LIVE database. Three kinds of distortions were considered, namely JPEG compression, White noise, and Gaussian Blur [51].

There are other available visual attention databases produced by the laboratories outside QUALINET. The *USC Eye-tracking data for complex video stimuli* consists of a body of 520 human eye-tracking data traces obtained while normal, young adult human volunteers freely watched complex video stimuli [52][53]. The *RUG Eye-Tracking Data* contains human fixation data captured during an eye tracking experiment [54]. The *LIVE DOVES: A database of visual eye movements* is a collection of eye movements from 29 human observers as they viewed 101 natural calibrated images [55]. The *USC iLab Video Dataset* contains 50 uncompressed YUV format video clips were presented to 14 subjects and their eye fixation points recorded over frames from each clip by an eye-tracker machine [56]. The *MIT CSAIL Dataset* contains collected eye tracking data of 15 viewers on 1003 images [57]. The *NUS Eye Fixation database* was acquired from undergraduate and graduate volunteers where subjects free-viewed image stimuli [58]. The *INB Video Eyetracking Dataset* contains eye movement data from 54 subjects for 18 outdoor scenes (HD), two Hollywood trailers (SD), and static images taken from the outdoor scenes [59]. The *Dynamic Images and Eye Movements (DIEM)* database created within DIEM project is an investigation of how people look and see and contains so far data from over 250 participants. The data can be used to visualize where people look while viewing film trailers, music videos, or advertisements (http://bit.ly/diemdata).

2.3. Other Databases

Besides the above listed annotated still and video image quality datasets or datasets focused on visual attention there are other valuable resources of visual material for the purpose of testing QoE in various applications. There are about 37 datasets described within the “QUALINET Databases” without the accompanied subjective content – among those – about five datasets are owned by QUALINET members. The available datasets can be classified according to the content to (1) Image, (2) Video and (3) 3D Visual Content categories.

There are various datasets in this category produced by the QUALINET partners. Here only a few selected ones will be briefly listed. The *TUM Multi Format Test Set* consists of 48 different video sequences in SDTV and HDTV formats. (http://www.ldv.ei.tum.de/videolab). The *Sensory Experience Dataset* contains video sequences enriched with sensory effects that steer appropriate devices capable of rendering these effects [60]. The *Dynamic Adaptive Streaming over HTTP (DASH) Dataset* with DASH Content consists of long sequences in high quality, freely available for DASH experiments [61].

3. CONCLUSIONS

In this paper “QUALINET Databases” resource for QoE testing and benchmarking has been introduced. The platform is accessible through the Qualinet homepage (http://www.qualinet.eu/) in the “QUALINET Databases” section of the main menu. A simple wiki page is used to inform about the implementation process and also current documents on “QUALINET Databases” are available there for download. The paper presents an overview and survey of the datasets available within “QUALINET Databases” with emphasis on the datasets created by the QUALINET partners.

4. ACKNOWLEDGMENTS

This work was partially supported by the COST IC1003 European Network on Quality of Experience in Multimedia Systems and Services – QUALINET, by the COST CZ LD12018 Modeling and verification of methods for Quality of Experience (QoE) assessment in multimedia systems – MOVERIQ and by the grant No. P102/10/1320 Research and modeling of advanced methods of image quality evaluation of the Grant Agency of the Czech Republic.

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