REPORT ITU-R BT.2020

OBJECTIVE QUALITY ASSESSMENT TECHNOLOGY IN A DIGITAL ENVIRONMENT

(1999)

Summary

This is a Report on the status of the technology for objective quality assessment of audio and video.

The Radiocommunication Joint Working Party (JWP) 10-11Q inherited from Working Party (WP) 11E, WP 10C and Task Group (TG) 10-4 the task to define Recommendations on quality assessment. This Report addresses more particularly Question ITU-R 64/11 – Objective picture quality parameters and associated measurement and monitoring methods for television images. This Question reflects the actual interest of the broadcasting community in techniques for objective quality assessment and monitoring of broadcast audio and video. Digital television and radio is now in operation in several countries hence the demand for Recommendations is increasing.

Considerable progress has been achieved by the completion of Recommendation ITU-R BS.1387 – Method for objective measurements of perceived audio quality – on objective quality assessment of digital audio. But there is still a lot of work to be done concerning Recommendations on objective quality evaluation of video.

This Report is a first step towards resolving the remaining open issues. The Report is structured as follows:

– § 1: Evolution of measurement techniques from analogue to compressed digital.

– § 2: Review of Recommendations.

– § 3: Review of on-going activities and developments.

  – State of the art.

    This Report will include a review of the state of the art concerning quality assessment in the digital environment and identification of the main digital methodological approaches. The different approaches are defined using wherever possible definitions common to other WPs and Study Groups (SGs).

– § 4: JWP 10-11Q approach to the definition of future Recommendations.

  – Review of requirements for application specific areas.

  – Coordination with other SGs and WPs including Telecommunication Standardization SG 9 and SG 12.

    JWP 10-11Q intends to seek contributions from other SGs and WPs in order to better appraise the overall situation in digital measurement and possibly avoid the dissemination of similar but different solutions. It is believed that the identification of applications and requirements is the most reasonable way to achieve that goal.

– § 5: Preliminary conclusions on targets and priorities for future Recommendations.

This Report will be maintained to take into account new requirements and to keep track of the evolution in digital objective quality evaluation.

1 Evolution of measurement techniques from analogue to compressed digital

This paragraph briefly explains the evolution of measurement from the use of indirect signal analysis to direct analysis of the content.

The well known logistic functions (e.g. the vertical blanking interval (VBI) test lines) that have allowed the design and monitoring of analogue TV are no longer valid:

– The signal structure for broadcast transmission has changed. It is now based on the use of digital transport streams for which protocol analysers have been developed.

– Digital delivery requires compression to be effective using complex non-linear encoding techniques. The use of such non-linear techniques impedes the use of traditional test signal analysis.

– Moreover, quality is now strongly content dependent and therefore time varying, which adds another level of complexity.

For these reasons there is low correlation between classic objective measurements (e.g. power signal-to-noise ratio (PSNR)) and the related video and audio quality.

Possible solutions are a combination of digital stream and picture content analysis. The first one is relatively easy to handle as the system behaviour and features are perfectly defined in specifications. As a consequence new objective picture assessment models have been developed. Digital objective quality evaluation now relies on feature extraction and perceptual model processing or some combination of both (thereby taking simultaneously into account the encoding processes and the characteristics of human perception).

The following is a preliminary list of measurement applications addressed by this Report:

– Codec and statistical multiplexers development, evaluation and installation.

– In and out of service network monitoring.

– Quality assessment of compressed production material.

– Monitoring of generic input material.

– Real time continuous monitoring.

It is therefore envisaged to recommend specific models on which measurement equipment would be developed for quality assessment and monitoring. It is currently admitted that different models could be adopted for different application specific domains.

2 Review of Recommendations

2.1 Existing Recommendations

Audio: Recommendation ITU-R BS.1387 – Method for objective measurements of perceived audio quality.

Video: ANSI [1996].

2.2 Planned Recommendations

Video: (NOTE 1 – Some of the existing objective picture quality measurement methods are being evaluated by the Video Quality Experts Group (VQEG). VQEG is an informal organization encouraged by Radiocommunication SG 11 and JWP 10-11Q, Telecommunication Standardization SG 9 and SG 12.)

Radiocommunication JWP 10-11Q – Objective assessment of video quality; in cooperation with the Video Quality Experts Group (VQEG).

Telecommunication Standardization SG 9 preliminary draft new ITU-T Recommendation J.OVQ – Objective measurement methodologies for perceptual video quality for digital cable television.

Telecommunication Standardization SG 12 draft new ITU-T Recommendation P.OVQ – Objective assessment of video quality (full reference); in cooperation with the Video Quality Experts Group (VQEG) this study item relates to video quality assessment at bit rates of 768 kbit/s and higher.

Telecommunication Standardization SG 12 draft new ITU-T Recommendation P.RSQ – Reduced source bandwidth double-ended objective video quality assessment; this class of measurement is needed when the source and compressed video are not available at the same location.

Telecommunication Standardization SG 12 draft new ITU-T Recommendation P.LBQ – Objective video quality assessment at low bit rates (~16 kbit/s to 1.5 Mbit/s); this study item will cover low bit rate videoconferencing and multimedia applications.

Telecommunication Standardization SG 12 draft new ITU-T Recommendation P.TRQ – Objective video quality assessment with transmission impairments on packet, mobile and other networks.

3 Review of on-going activities and developments

3.1 Identification of the main digital methodological approaches

3.1.1 Double ended systems

A generic double ended system is designed to operate, with two inputs, one the reference material and one the material under test. Usually these systems are not necessarily required to operate in real time and may work only with a limited library. The aim of these systems is basically the assessment (or the ranking) of the performance of digital codecs, nevertheless they can be used to assess the quality provided by a complete digital delivery chain that includes coding, transmission and decoding. The quality indication of these kinds of systems is usually expected to be the most accurate.

3.1.2 Double ended systems using reduced reference

These systems are tailored to provide monitoring of the performance of a digital transmission network. The main feature of these systems is represented by the ability to assess the quality in real time and in service without the use of dedicated reference signal. The quality information is collected at the entrance of the network and delivered to any nodal point together with the signal. At the nodal point where quality is to be assessed, the quality information is recalculated locally and compared with the received information to perform the quality check. The quality indicators provided by these systems may be not as accurate as in the case of the double ended systems (with complete reference). These systems provide an indication of the availability of the service guaranteed by the transparency of the transmission process.

3.1.3 Single ended systems

This family of systems is based on the analysis of existing material “as it is”. The origin of the impairment is not known and it is difficult to go beyond some limitations. Basically the single ended systems look for some particular *a priori* impairments possibly originated by a generic digital coder or due to some discontinuities on a digital transmission link. Also for these reasons the quality indicators provided by these systems are limited in performance and at the present time do not cover all the possible impairments. These systems can also be used to provide an indication of the availability of the service

3.2 State of the art

3.2.1 Status of the systems currently available or shortly available

Table 1 summarizes the current known situation. All have been classified according to their family (D = double ended; S = single ended; RRD = reduced reference double ended).

3.2.2 Forthcoming developments

We are aware that the above listed and other laboratories and companies are studying other systems to objectively assess video and/or audio quality.

Tektronix has demonstrated a single-ended measurement technology based on the detection of several artifacts that may occur in compressed digital transmission systems.

ACTS Project QUOVADIS demonstrated how to monitor quality of service (QoS) using objective quality parameters of audio and video. Field trials have been made using new instruments and have provided encouraging results to convince the European Commission (EC) to promote another Project called MOSQUITO dealing with QoS.

ECI Telecom (Israel) has designed a computer program that operates as a video content analyser based on a double ended system.

Finally studies are in progress inside the Institute of Electrical and Electronics Engineers (IEEE) to provide a pool of test scenes degraded in a controlled way, for which the corresponding subjective and objective quality scores are provided. These will hopefully represent a good pool of reference material to test the forthcoming systems.

TABLE 1

Company or laboratory	Partner	Country	Commercial product	Audio	Video	System type	Real time	In service	VQEG test[1]
CCETT		France	X		X	S			
CCETT		France	X	X		D/S			
CRC		Canada	X	X		D			
CRC[2]		Canada	X	X		D			
FHG[2]	Opticom	Germany	X	X		D	X		
KDD		Japan	X		X	D			X
KPN[2]	Opticom	The Netherlands Germany	X		X	D			
Mitsubishi	NHK	Japan	X		X	D			X
Opticom		Germany	X	X		D			
Rohde & Schwarz	IFN	Germany	X		X	S			X
Snell & Wilcox		United Kingdom	X		X	S			
TDF		France	X	X	X	RRD			
Tektronix	Sarnoff	United States of America	X		X	D			X
CQqD		Brazil			X	D			X
EPFL		Switzerland			X	D			X
KPN	Swiss Telecom	The Netherlands Switzerland			X	D			X
NASA		United States of America			X	D			X
NTIA		United States of America			X	RRD			X
Tapestries	EC ACTS	European consortium			X	D			X

(1) See Note 1 in § 2.

(2) These products were produced and sold prior to completing the PEAQ standard (Recommendation ITU-R BS.1387 – Method for objective measurements of perceived audio quality). Some of these products are still commercially available.

4 JWP 10-11Q approach to the definition of future Recommendations

4.1 Review of requirements for application specific areas

It is important to define the applications and possible associated quality of service. While usual broadcasting applications are well defined, it is acknowledged that the broadcasting community is diversifying its activities by developing new multimedia applications delivered to the end-user via any available delivery network.

4.1.1 The questionnaire

JWP 10-11Q has prepared and distributed a questionnaire to seek the requirements and needs from the broadcasting community in objective quality assessment technology.

In the analysis of the data collected from the questionnaire, it is considered to be important to take into account the nature (or the role) of the company providing the answers. For this reason the resulting data will be separately considered taking into account the following preliminary categories:

– Broadcasters.

– Network providers.

– Regulation bodies.

The questionnaire has been approved during the current meeting and will be distributed to as many as possible entities acting in the framework of the TV arena. Preliminary responses have already been received but more input is needed and expected.

4.2 Coordination with other SGs and WPs including Telecommunication Standardization SG 9 and SG 12

JWP 10-11Q intends to seek contributions from other SGs and WPs in order to better appraise the overall situation in digital measurement and possibly avoid the dissemination of similar but different solutions. It is believed that the identification of applications and requirements is the most reasonable way to achieve that goal.

5 Preliminary conclusions

With the rapid change from analogue to compressed digital, JWP 10-11Q recognizes the need for standards covering objective quality measurements.

However haste must not overtake the proper evaluation of the objective methods. Considering the importance of the matter, JWP 10-11Q is allocating significant resources to the preparation of the decision process that will follow the delivery of the VQEG results.

Taking into account the information contained in this Report and future development of evaluation procedures it is envisaged that *JWP 10-11Q will recommend one or more models, methods and procedures* as necessary to cover application specific areas and user requirements.

REFERENCES

ANSI [1996] ANSI T1.801.03, Digital transport of one-way video signals – Parameters for objective performance assessment. *American National Standards Institute*. United States of America.