INTERNATIONAL TELECOMMUNICATION UNION

ITU-T J.143

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(05/2000)

SERIES J: TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Measurement of the quality of service

User requirements for objective perceptual video quality measurements in digital cable television

ITU-T Recommendation J.143

(Formerly CCITT Recommendation)

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ITU-T Recommendation J.143

User requirements for objective perceptual video quality measurements in digital cable television

Summary

This Recommendation describes user requirements for objective perceptual video quality measurements in digital cable television and similar applications.

Source

ITU-T Recommendation J.143 was prepared by ITU-T Study Group 9 (1997-2000) and approved under the WTSC Resolution 1 procedure on 18 May 2000.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSC Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

INTELLECTUAL PROPERTY RIGHTS

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

Digital television produces new Quality of Services considerations, with complex relationships between objective parameter measurements and subjective picture quality. Objective measurements with good correlation to subjective quality assessment are desirable in order to attain optimal quality of service in the operation of cable television systems.

ITU-T Recommendation J.143

User requirements for objective perceptual video quality measurements in digital cable television

1 Scope

This Recommendation describes users' requirements for objective measurements of perceptual video quality in digital video systems used in cable television and in similar applications. Such objective perceptual video quality measurements may be required for several applications, as described below.

- To measure the end-to-end performance of digital cable television systems from the signal source to the user's receiver. In this application the transmission chain includes the cable distribution system and may also include the satellite links, terrestrial links and/or broadband network links that provide source signals to the cable head-end.
- To measure the performance of a section of the total chain, which is sufficiently limited to be equipped with auxiliary measurement devices at appropriate points along the section under test.
- To measure the performance of single pieces of equipment (e.g. codecs) or of local chains of equipment in a laboratory or at the cable head-end premises.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

2.1 Normative References

- ITU-R BT.500-10 (2000), *Methodology for the subjective assessment of the quality of television pictures*.

2.2 Informative References

- ITU-T J.140 (1998), *Subjective picture quality assessment for digital cable television systems*.
- ITU-T P.910 (1999), *Subjective video quality assessment methods for multimedia applications*.

3 Terms, definitions and acronyms

See ITU-T J.1. This Recommendation does not use any unusual terms or abbreviations.

4 User requirements

4.1 Accuracy of perceptual video quality measurements

This requirement relates to the need for accurate measurements of perceptual video quality on programme material that is delivered by cable television, in spite of the great variety of its content and of its impairments.

The proposed perceptual measurement device should ideally provide an accurate measurement of perceptual video quality in normal broadcast/cablecast operation, irrespective of the programme content, of the digital encoding used for programme material, of the composition and performance of the transmission chain and of the compression ratio used.

Measurements should closely match the average scores that would be obtained from formal subjective assessment tests, performed by an independent laboratory or organisation in accordance with ITU-R BT.500. This should be true for a large set of still and moving test pictures, under various degrees of different distortions.

4.2 Availability of the input/reference video signal

Measurements of perceptual video quality may be needed both within a laboratory or a cable television head-end, and over larger parts of the cable television chain, or even over the whole chain.

Measurements within a laboratory, or within a cable head-end (e.g. from the head-end input signal to its output to the cable distribution network) obviously would benefit from the availability of the input video signal at the measurement point.

In other cases, when a larger part of the delivery chain needs to be measured (e.g. from the head-end input to the user's receiver) the input video signal would not normally be available. In those cases, perceptual video quality measurements may be performed with the assistance of reference data that travels with the programme signal and represents perceptual video quality measured at an upstream point, or in the total absence of any reference signal or data (See Appendix I).

4.3 In-service operation

There are applications where it is required that the perceptual measuring device should be capable of operating on-line in a cable television system; in this case the insertion of the measurement device in the chain should not adversely affect the performance of the chain.

4.4 Potential applications and related considerations

There are at least two distinct applications in which a cable television operator may wish to perform objective measurements of perceptual video quality.

– One application is to perform objective laboratory tests of perceptual video quality on new equipment, e.g. equipment that is considered for possible purchase. In this case, it would generally be possible to use a full reference, and emphasis would likely be placed on perceptual measurement accuracy. It would generally be recognised and accepted that the greater the required measurement accuracy, the more complex the perceptual model might be, and the longer the computation time required for each measurement.

– Another application is to install perceptual measuring devices along the programme chain, in order to monitor its performance on-line. In this case emphasis would likely be placed on measurement reliability and on measurement time, since the measurement devices would need to operate around the clock with little maintenance, and they would be expected to provide indications on quasi-real time. It would also generally be accepted that the measurement devices should operate without a full reference, i.e. with assistance data or

even without it. Care should be taken in sub-sampling due to the transient nature of impairments in digital video systems, especially in the presence of transmission errors.

– There is certainly a requirement to perform objective measurements of perceptual video quality on line and in real time in a cable television network. At this moment however the speed of computation of perceptual video quality might still be too high when a sufficiently complex perceptual quality model is used, and a compromise should likely be found between the measurement accuracy and its speed. This may be provided by measurement of specific picture impairments (such as MPEG Blockiness) that can be related to perceptual video quality.

– There will also likely be a need to perform objective measurements of perceptual video quality for a selected group of programs contained within one or more multiplexes. In this case the perceptual picture quality of the individual programme streams in the group can be expected to vary from moment to moment as a function not only of the individual stream content but also of the content of the other streams in the group and of statistical multiplexing. The way in which the perceptual video quality readings for the various individual streams should be combined in order to obtain a reading applicable to the group is currently under study.

4.5 Standardization and proprietary solutions

The development of complex and accurate perceptual quality models and the verification of their accuracy requires an important research effort, and it is natural that, while some researchers and manufacturers will be willing to share the details of their method, other manufacturers will be reluctant to do so, or to accept to license them to other manufacturers on an equitable and non-discriminatory basis, as is required by the ITU Patent Policy.

It should be stressed that it will not be possible for the ITU to recommend the use of the technology developed by those manufacturers who are not willing to abide by the ITU Patent Policy, and who insist that the details of their method should continue to remain their own property.

This situation would be regrettable, as it would harm the interests of broadcasters and cablecasters, as well as those of the whole market.

Furthermore, there is a risk that, if the details of a method are proprietary, its manufacturer may introduce those enhancements that may become possible from time to time, with the result that equipment from some manufacturer may no longer conform with the equipment of the same brand and model that has been tested and certified by independent international bodies, and it may provide a different degree of accuracy (better or worse). In this circumstance it might become impossible to compare results of perceptual quality tests performed by different laboratories or operators, since the results might have been obtained using different generations of a proprietary perceptual model.

5 Objective measurement of perceptual video quality

It is recommended that cable television operators and laboratories should perform objective tests of perceptual video quality using the method that best meets their needs (complete reference, partial reference or no reference) bearing in mind the information provided in this Recommendation.

It is also recommended that, when performances and applications are comparable, users of perceptual quality measurement devices should take into account the caveats recalled in 4.5, in the choice of the equipment appropriate to their needs.

Additional Recommendations on perceptual video quality measurements will be issued as soon as sufficient evidence is available on the characteristics and performance of the different measurement methods currently offered on the market or under study.

APPENDIX I

Measurement methodology

This appendix is intended to provide a more comprehensive description of the three main measurement methodologies for the objective measurement of perceptual video quality. They offer different approaches that provide differing levels of measurement accuracy, and require different information regarding the input/reference video.

I.1 Methodology using the full video reference

One way to evaluate the performance of systems is to make a comparison between the input or reference video at the input of the system, and the processed signal at the output of the system. (Figures I.1 and I.2). The comparison between input and output signals may require a spatial and temporal alignment process to compensate for any vertical or horizontal picture shift or cropping. It also may require correction for any offsets or gain differences in the luminance and chrominance channels. The objective picture quality rating is then calculated, typically by applying a human vision perceptual model.

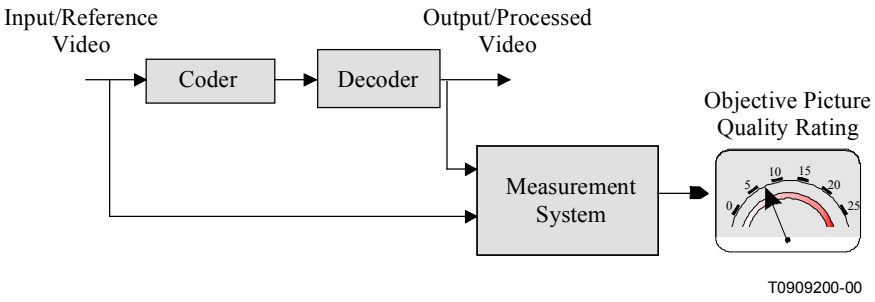

Figure I.1/J.143 – Objective picture quality rating for laboratory testing (e.g. of codecs)

Given the requirement for both input and output signals, this approach is also known as "double ended". As the diagnostic tool is based on a human vision model, rather than on specific coding artefacts, it is equally valid for analogue systems and digital systems. It is also valid for chains where analogue and digital systems are mixed, or when digital compression systems are concatenated.

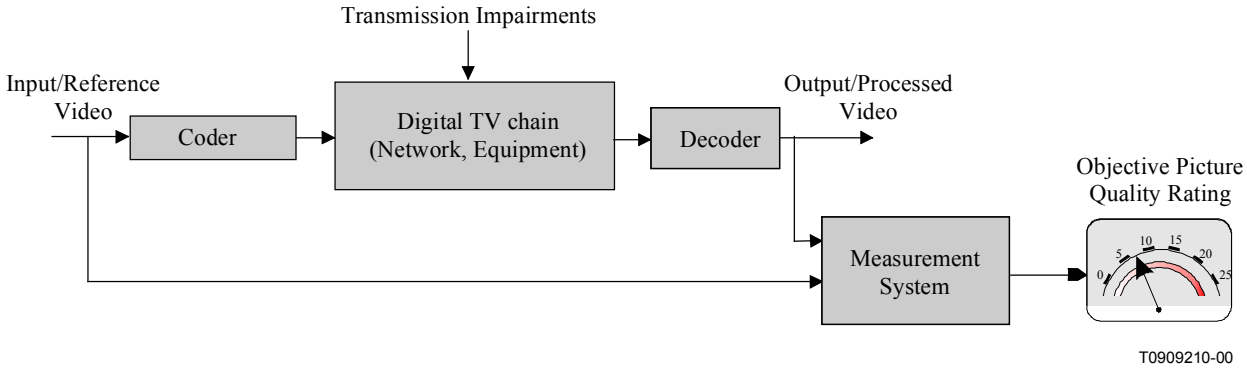

Figure I.2/J.143 – Objective picture quality rating for testing a transmission chain

To measure a transmission chain using the same double-ended methodology, a decoder may be fed from various points in the transmission chain. The decoder could be located at a point in the network, as in Figure I.2, or directly at the output of the encoder.

A digitally transparent transmission path makes measurement of objective picture quality rating at the source equal to measurement at any subsequent point in a transmission chain.

It is generally accepted that the "double ended" method using full reference video information described in this clause, provides the best accuracy for Objective Picture Quality rating, and the method has proven to have the potential for high correlation with subjective assessments made by the DSCQS method described in ITU-R BT.500.

I.2 Methodology using reduced reference information

A different type of "double ended" approach uses measurement systems at points A and B in Figure I.3.

Specific parameters are extracted from both the reference and the processed signals.

Reference data relating to these parameters at point A is signalled to the measurement system at point B to enable a comparison between the parameters at each end of the chain.

This, together with knowledge of the output video, can provide an indication of signal quality. Parameters can include blockiness, spatial and temporal signal information and noise.

Specific impairments such as freeze frames and loss of picture can also be detected.

This methodology offers potential for use where the decoder and encoder are physically separated for instance by a transmission chain.

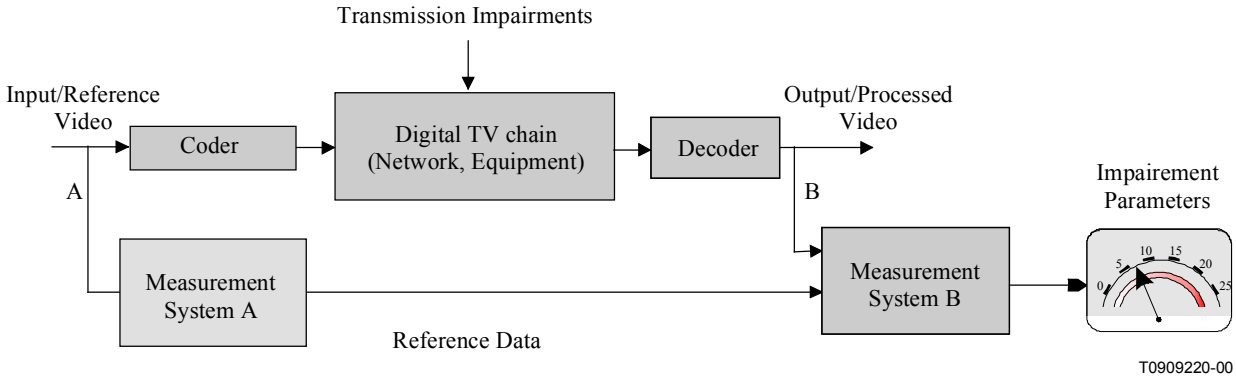

Figure I.3/J.143 – Parameter monitoring with reduced bandwidth reference path

I.3 Methodology using no reference signal

A third approach, known as "single ended" (Figure I.4) uses no reference signal.

Parameters similar to those described in the preceding clause are measured.

Lack of a reference means that the measurement may be subject to errors caused by picture content resembling the specific impairment parameters that are being detected.

An example of this would be a picture that includes elements resembling the blocking structure used within MPEG-2 coding.

As with the technique using reduced reference information, the measurements concern parameters that indicate picture impairments, but do not correlate directly with objective picture quality ratings.

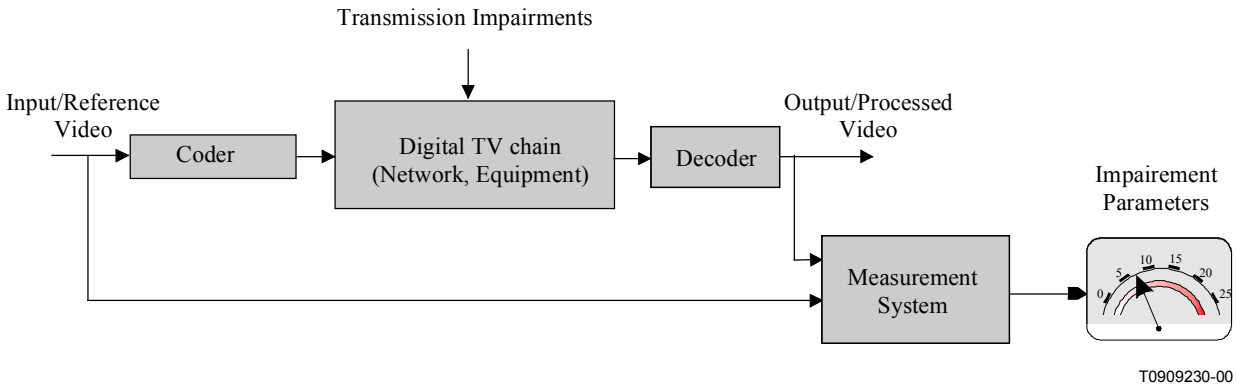

Figure I.4/J.143 – Parameter monitoring with no reference

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Geneva, 2001