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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Broadband, triple-play and advanced multimedia services – Advanced multimedia services and applications

Scenarios, framework and metadata for digitalized artwork images display system

Recommendation ITU-T H.629.1

ITU-T H-SERIES RECOMMENDATIONS

AUDIOVISUAL AND MULTIMEDIA SYSTEMS

CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	
General	H.200–H.219
Transmission multiplexing and synchronization	H.220–H.229
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	H.260–H.279
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	H.300–H.349
Directory services architecture for audiovisual and multimedia services	H.350–H.359
Quality of service architecture for audiovisual and multimedia services	H.360–H.369
Telepresence, immersive environments, virtual and extended reality	H.420–H.439
Supplementary services for multimedia	H.450–H.499
MOBILITY AND COLLABORATION PROCEDURES	
Overview of Mobility and Collaboration, definitions, protocols and procedures	H.500–H.509
Mobility for H-Series multimedia systems and services	H.510–H.519
Mobile multimedia collaboration applications and services	H.520–H.529
Security for mobile multimedia systems and services	H.530–H.539
Security for mobile multimedia collaboration applications and services	H.540–H.549
VEHICULAR GATEWAYS AND INTELLIGENT TRANSPORTATION SYSTEMS (ITS)	
Architecture for vehicular gateways	H.550–H.559
Vehicular gateway interfaces	H.560–H.569
BROADBAND, TRIPLE-PLAY AND ADVANCED MULTIMEDIA SERVICES	
Broadband multimedia services over VDSL	H.610–H.619
Advanced multimedia services and applications	**H.620–H.629**
Ubiquitous sensor network applications and Internet of Things	H.640–H.649
IPTV MULTIMEDIA SERVICES AND APPLICATIONS FOR IPTV	
General aspects	H.700–H.719
IPTV terminal devices	H.720–H.729
IPTV middleware	H.730–H.739
IPTV application event handling	H.740–H.749
IPTV metadata	H.750–H.759
IPTV multimedia application frameworks	H.760–H.769
IPTV service discovery up to consumption	H.770–H.779
Digital Signage	H.780–H.789
E-HEALTH MULTIMEDIA SYSTEMS, SERVICES AND APPLICATIONS	
Personal health systems	H.810–H.819
Interoperability compliance testing of personal health systems (HRN, PAN, LAN, TAN and WAN)	H.820–H.859
Multimedia e-health data exchange services	H.860–H.869
Safe listening	H.870–H.879

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T H.629.1

Scenarios, framework and metadata for digitalized artwork images display system

Summary

Recommendation ITU-T H.629.1 identifies the typical application scenarios (e.g., museum, art gallery, home, etc.) of digitalized artwork images display system; it identifies metadata for the content provider, the display terminal and the digital artwork in the digitalized artwork images display system; it identifies the specifications of electro-optics for the display terminal in the digitalized artwork images display system; and it provides the measurement methods and evaluation guidance for electro-optical parameters. A digitalized artwork images display system can provide users of artwork images convenience, an authentic experience and digitalization preservation of artwork images.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Digitalized artwork images, framework, metadata, scenarios.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Table of Contents

Recommendation ITU-T H.629.1

Scenarios, framework and metadata for digitalized artwork images display system

1 Scope

This Recommendation defines typical application scenarios and metadata for the Digitalized artwork Images Display System (DRIDS), and also to specify the electro-optical parameters for digitalized artwork displayed in DRIDS. In order to address the above-mentioned issues in more detail, the following four aspects have been defined and specified:

– Define the typical application scenarios for the digitalized artwork display system; analyse user behaviours, environmental contexts and common requirements for display devices. The typical scenarios include but not limited to museums, art galleries, and homes.

– Define the basic hardware specifications of a display terminal (DT) for digitalized artwork, in order to guarantee high-quality visual effects for various types of display devices.

– Define the content provider metadata, DT metadata, digitalized artwork metadata and the relevant descriptions.

– Specify the electro-optical performance of digitalized artwork DT(s) and detail the measurement and evaluation guidance of the electro-optical performance parameters.

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; 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. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[IEC 61747-30-1] IEC 61747-30-1:2012, *Liquid crystal display devices – Part 30-1: Measuring methods for liquid crystal display modules – Transmissive type.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 colour depth [b-ISO/IEC TR 29170-1]: Known as bit depth, number of bits of precision of colour channels (or components) of an unencoded image.

3.1.2 contrast ratio [b-IEC 62341-1-2]: Ratio of white luminance to black luminance of the image, including light reflected from the display.

3.1.3 luminance [b-IEC 60107-1]: Luminance in a given direction is the luminous intensity per unit of projected area of any surface, as viewed for that direction. The luminance value is expressed in candela per square meter (cd/m^2).

3.1.4 luminance uniformity [b-IEC 62341-1-2]: Deviation of luminance produced by different areas of the organic light emitting diode display.

3.1.5 reflectance [b-IEC 60050-845]: Ratio of the reflected radiant or luminous flux to the incident flux in the given conditions.

3.1.6 viewing angle range [b-IEC 61747-1-2]: Range of viewing angular direction over which the visual specification is satisfied.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 accuracy of brightness gradient: Standard deviation of brightness gradient, which represents the statistical results of all the brightness gradients deviating from ideal values.

3.2.2 accuracy of greyscale luminance: A display device's ability to reproduce greyscale luminance while trying to match the ideal luminance curve.

3.2.3 brightness gradient: Ratio of relative brightness difference between two adjacent grey scales to their ideal relative average brightness.

3.2.4 brightness gradient range: Deviation range between the actual brightness gradient and the ideal brightness gradient.

3.2.5 greyscale luminance range: Deviation range between actual greyscale luminance and the ideal greyscale luminance.

3.2.6 rate of change for luminance with viewing angle: Luminance change rate with the viewing angle change.

3.2.7 technical frame: Subset of members' organizational frames that concern the assumptions, expectations and knowledge they use to understand technology in organizations.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Program Interface
APP	Application
CP	Content Provider
DRIDS	Digitalized Artwork Images Display System
DT	Display Terminal
DUT	Device Under Test
HTTP	Hypertext Transfer Protocol
IoT	Internet of Things
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LMD	Luminance Measuring Device
MAC	Media Access Control
MC	Management Cloud
OLED	Organic Light Emitting Diode
QLED	Quantum dot Light Emitting Diode
REST	Representational State Transfer
URL	Uniform Resource Locator

5 Conventions

In this Recommendation:

– The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

– The keywords "is prohibited from" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

– The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

– The keywords "is not recommended" indicate a requirement which is not recommended but which is not specifically prohibited. Thus, conformance with this specification can still be claimed even if this requirement is present.

– The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Introduction

Following the rapid development of information technology, the industries of music, movies and books have been well developed and digitalized. However, the artwork industry has not been fully digitalized yet. The digital system for artwork contains two parts: digital data acquisition and digitalized artwork images display.

The digitalized artwork images display system (DRIDS) is a special system for digitalized artwork displaying that can meet demands for high visual quality of digitalized artwork with the specification of electro-optical performance and system metadata. This Recommendation focuses on the digitalized artwork images display part, to define application scenarios and specify the DRIDS.

6.1 Necessities of technical specifications of DRIDS

1) Global trend of traditional artwork digitalization

Artwork is an essential part of cultural heritage. The importance of the protection, inheritance and propagation for cultural heritage has been reflected through the advocacy of the United Nations Educational Scientific and Cultural Organization (UNESCO).

DRIDS will minimize the frequency of use of the physical originals of artwork; it will also prevent the physical originals from the erosion of age, damages, and other losses, as far as possible. It will promote the wide use of the Internet of things (IoT) systems for digital artwork exhibitions. Therefore, the digitalization of artwork and DRIDS will become the global trend in the artwork field.

2) Demands for high visual quality of digitalized artwork

Digitalized artwork is stricter with the performance of display terminals (DTs) than for how daily graphs or pictures are displayed. In order to achieve a high quality of digitalized artwork images display, basic electro-optical parameters for DTs and software factors need to be specified; these include *inter alia* luminance, contrast ratio, colour depth and metadata.

6.2 Significance of the new Recommendation proposal

This Recommendation includes, but is not limited to, the following significant points:

1) Through application scenario research, this Recommendation will provide a standard reference for all the scenarios where the display of digitalized artwork images is needed.

2) This Recommendation will provide general guidelines for display manufacturers producing special DT(s) for digitalized artwork exhibition purposes.

3) This Recommendation will provide general references for optimal display settings for digitalized artwork.

4) This Recommendation will greatly promote the cultural heritage and propagation of artwork in the global sphere by digitalizing traditional artwork, while also protecting the physical pieces of artwork. It overcomes the limitations to artwork accessibility seen in more conventional approaches.

5) Ultimately, this Recommendation will ensure users acquire the best visual experience when viewing artwork in different conditions, while retaining maximum authenticity from the original pieces.

7 Scenarios for DRIDS

The scenarios for DRIDS include museums, art galleries, home and other relevant scenarios such as schools, hotels and restaurants, without losing generalities. The application scenarios for DRIDS include *inter alia* the scenarios described in the following subclauses.

H.629.1(19)_F7-1

Figure 7-1 – Typical scenarios for DRIDS

7.1 Museum

A museum is one of the typical scenarios for digitalized artwork display. Displaying digital versions in a museum will greatly help reduce the physical erosion of the original artwork. High authenticity, local detail and ambient lighting effects are common concerns when considering this application scenario.

7.2 Art gallery

An art gallery is another typical scenario where digitalized artwork is often needed. Artwork created by young artists are shown in galleries for exhibition and sale purposes. Digitalized display systems in galleries will greatly reduce the workload of installations and uninstallations, and make the exhibition planning and execution much easier than the traditional approach.

7.3 Home

Personal homes are another typical scenario for displaying artwork. More and more families appreciate artwork in private. Digitalized artwork will reduce the cost and enrich the quality and type of artwork. Displaying digitalized artwork at home will greatly reduce the time and cost of visiting museums or galleries, and provide family users with much more choice than physical locations.

8 DRIDS framework

The framework of a digitalized artwork display system with three units is shown in Figure 8-1. One end is for the content provider (CP) to upload their digitalized artwork, while at the DT end users view the digitalized artwork via various kinds of display devices. At the management cloud (MC) end, algorithms need to be developed to automatically match the content from the upload terminal with the DT.

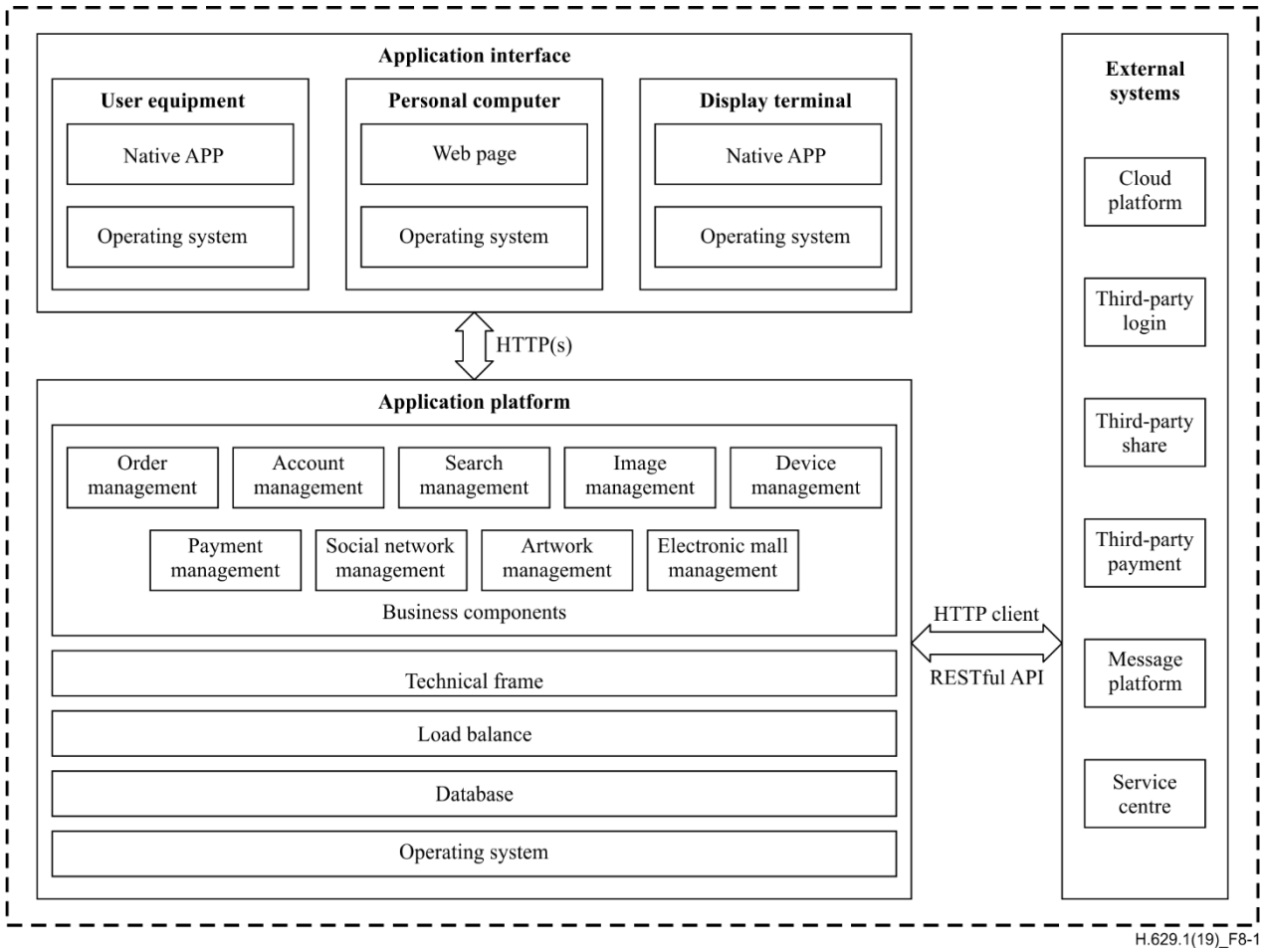

Figure 8-1 – DRIDS framework

9 Electro-optical performance for DT of DRIDS

In order to achieve the realistic effect of digitalized artwork images, the electro-optical performance for DT of DRIDS is specified in Table 1.

Table 1 – Electro-optical performance

Items		Values		Units	Measurements and evaluations
		Min	Max		
Colour gamut		72	–	%	Annex A.1
Luminance		230	–	cd/m^2	Clause 6.1 of [IEC 61747-30-1]
Contrast ratio		1200	–	–	Clause 6.2 of [IEC 61747-30-1]
Colour depth		8	–	bit	–
Reflectance		–	6.0	%	Clause 6.8 of [IEC 61747-30-1], the light source shall be the collimating light source.
Viewing angle Range		85	–	degree	Clause 6.4 of [IEC 61747-30-1]
Uniformity of luminance		75	–	%	Annex A.2
Colour uniformity	Δx	–	0.03	–	Annex A.3
	Δy	–	0.03	–	
Rate of change for luminance with viewing angle		–	6	%	Annex A.4
Accuracy of greyscale luminance		–	2.5	%	Annex A.5.4.1
Greyscale luminance range		−25	25	%	Annex A.5.4.2
Brightness gradient range		−30	30	%	Annex A.5.4.3
Accuracy of brightness gradient		–	7.5	%	Annex A.5.4.4

10 Metadata for DRIDS

10.1 Content provider metadata

The content provider is the one who uploads the digitalized artwork to the application platform. Before uploading, the following information metadata should be required.

Table 2 – Content provider metadata specifications

Fields	Type	Mandatory (Y/N)	Description
Content	TEXT	N	Brief introduction of the author and image
Email	VARCHAR	Y	Contact e-mail address
Phone_num	VARCHAR	N	Contact phone number
Nick	VARCHAR	Y	Nickname of account user
Identity_num	VARCHAR	N	Legal ID number of user
Password	VARCHAR	Y	Login password
Sex	VARCHAR	N	Gender of the user
User_type	INT	Y	The type of content provider: unauthorized artist, authorized artist, art museum, art institution, etc.
User_avatar	STRING	N	Uniform resource locator (URL) of user's avatars
Interest_label	STRING	N	The keywords of the content provider's interest

10.2 DT metadata

With the need of a matching mechanism, the metadata of DT is defined as in Table 3.

Table 3 – DT metadata specifications

Fields	Type	Mandatory (Y/N)	Description
User_ID	INT	N	User's identity information
Class_num	INT	Y	Number of the terminal group
L_time	VARCHAR	N	Loop time value of the image display
Mac_id	VARCHAR	Y	Media access control (MAC) address of the DT hardware
Net_status	INT	Y	DT's network status: whether it is online or offline
Switches	INT	Y	DT's display mode: power on, power off or sleep mode
DT_type	INT	Y	The type of DT's display technology: LED, LCD, OLED, QLED, etc.
S_type	INT	Y	The DT display orientation: vertical or horizontal
Has_BT	BOOL	Y	Whether DT hardware has Bluetooth or not
Voice_switches	INT	Y	Whether DT hardware has voice interaction or not

10.3 Digitalized artwork images metadata

As the basic information for the digitalized artwork, the metadata should be specified; what's more, the metadata is necessary for the matching mechanism. This is defined in Table 4.

Table 4 – Digitalized artwork metadata specifications

Fields	Type	Mandatory (Y/N)	Description
Author_info	VARCHAR	N	Information of the original author
Class	INT	Y	Classification of the artwork
Content	TEXT	Y	Brief introduction of the artwork
Created_at	INT	Y	The original creation time of the image
Height	VARCHAR	N	Height of the original artwork
Width	VARCHAR	N	Width of the original artwork
Art_type	INT	Y	The artwork type
View_direc	INT	Y	Orientation of the artwork: vertical or horizontal
Theme	VARCHAR	N	Theme of the artwork
Title	VARCHAR	Y	Title of the artwork
Price	VARCHAR	N	The price of the digital artwork

Annex A

Measurement and evaluation guidance for electro-optical performance parameters

(This annex forms an integral part of this Recommendation.)

This annex describes a series of suggested measurement and evaluation methods for some electro-optical parameters.

A.1 Colour gamut

A.1.1 Measurement equipment

The details of the measurement equipment can be referred to clause 6.3.2 of [IEC 61747-30-1].

A.1.2 Measurement method: photoelectric tri-stimulus colorimetry

The details of the measurement equipment can be referred to clause 6.3.3 of [IEC 61747-30-1].

A.1.3 Measurement method spectrophotometric colorimetry

The details of the measurement equipment can be referred to clause 6.3.4 of [IEC 61747-30-1].

A.1.4 Definition and evaluations

Colour gamut is all the colours the device under test (DUT) is able to display, the percentage in the colour space:

$$P = \left| \frac{\left(x_R - x_{\mathrm{B}}\right)\cdot\left(x_G - x_B\right) - \left(x_G - x_{\mathrm{B}}\right)\cdot\left(x_R - x_B\right)}{2} \right| \times \frac{1}{0.1582} \times 100\%$$

where $x_{\mathrm{B}}, x_{\mathrm{G}}, x_{\mathrm{R}}$ have been defined and explained in clause 6.3.5.3 of [IEC 61747-30-1].

A.2 Uniformity of luminance

A.2.1 Measurement equipment

A luminance measuring device (LMD), a driving power supply, and a driving signal generator for liquid crystal display devices and a temperature control device (e.g., climatic chamber) are used for these measurements.

A.2.2 Standard measuring conditions

The measurements are performed in the standard measuring conditions; see Annex A of [IEC 61747-30-1-2].

A.2.3 Measurement method

Firstly, position the DUT.

Then, supply the value of the input signals to the DUT to achieve the full white condition to the full active screen area.

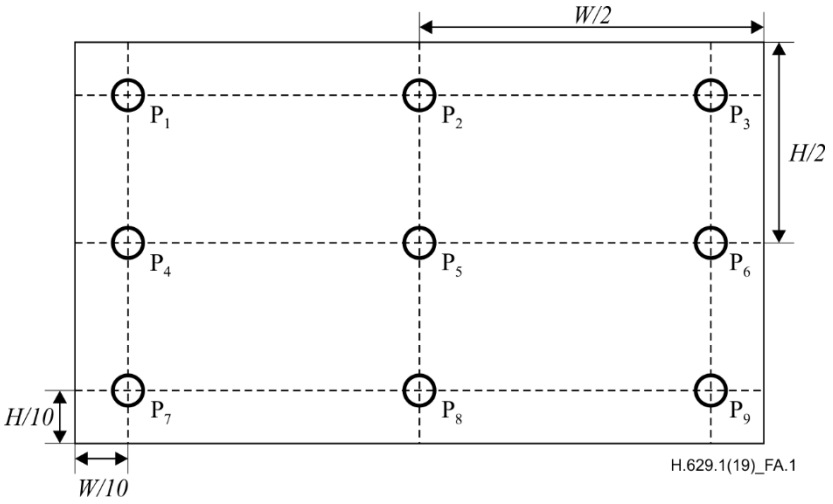

Figure A.1 – Standard measurement positions are at the centres of all rectangles P_1-P_9

Finally, measure the luminance of DUT at positions P_1, P_3, P_5, P_7 and P_9 respectively, and the measurement positions are shown as Figure A.1.

A.2.4 Definition and evaluations

The uniformity of luminance is:

$$L_U = \frac{L_{\min}}{L_{\max}} \times 100\%$$

where L_{min} and L_{max} are respectively the minimum and maximum luminance values.

A.3 Colour uniformity

A.3.1 Measurement method

The details of the measurement method can be referred to clause 6.7.5.1 of [IEC 61747-30-1].

A.3.2 Definitions and evaluations

The chromaticity corresponding to the measurement at position *(i)* is defined by the colour coordinates $x_{c(i)}$, $y_{c(i)}$ as:

$$x_{c(i)} = \frac{X_{c(i)}}{X_{c(i)} + Y_{c(i)} + Z_{c(i)}}, \qquad y_{c(i)} = \frac{Y_{c(i)}}{X_{c(i)} + Y_{c(i)} + Z_{c(i)}}$$

Deviations from the chromaticity at position *(i)* from the chromaticity at the display centre are defined as colour differences in an "approximately uniform colour space", e.g., as defined in the CIE 1976 UCS system [b-CIE 015].

$$\Delta x_c = \left| x_{c(i)} - x_{0(i)} \right|, \qquad \Delta y_c = \left| y_{c(i)} - y_{0(i)} \right|$$

A.4 Rate of change for luminance with viewing angle

A.4.1 Measurement equipment and measurement method

The details of the measurement equipment and measurement method is the same as the luminance measurement; see clause 6.1 of [IEC 61747-30-1].

A.4.2 Definition and evaluations

Rate of change for luminance with view angle is luminance change rate with the viewing angle change.

$$R_c = \frac{2 \times \left| L_{\theta_{n+1}} - L_n \right|}{\left(L_{\theta_n} + L_{\theta_{n+1}} \right)}, \quad \left| \theta_{n+1} - \theta_n \right| = 1$$

where R_c is the rate of change for luminance with the viewing angle and Θ_{n+1} and Θ_n are the measure angles which are adjacent to each other and with one-degree angle difference.

A.5 Greyscale luminance

A.5.1 Standard ambient conditions

Measurements shall be carried out, after sufficient warm-up time for illumination sources and DUTs under the standard environmental conditions, at a temperature of 15℃ to 35℃, at a relative humidity of 25% to 75%, and at atmospheric pressure of 86 kPa to 106 kPa. When different environmental conditions are used, they shall be noted in the detailed specification.

A.5.2 Measurement equipment

An LMD, a driving signal generator for DT devices and, if required, a temperature control device for the DUT (e.g., climatic chamber) are used for these measurements. The distance between the DT device and LMD is recommended as three times that of the DT's height.

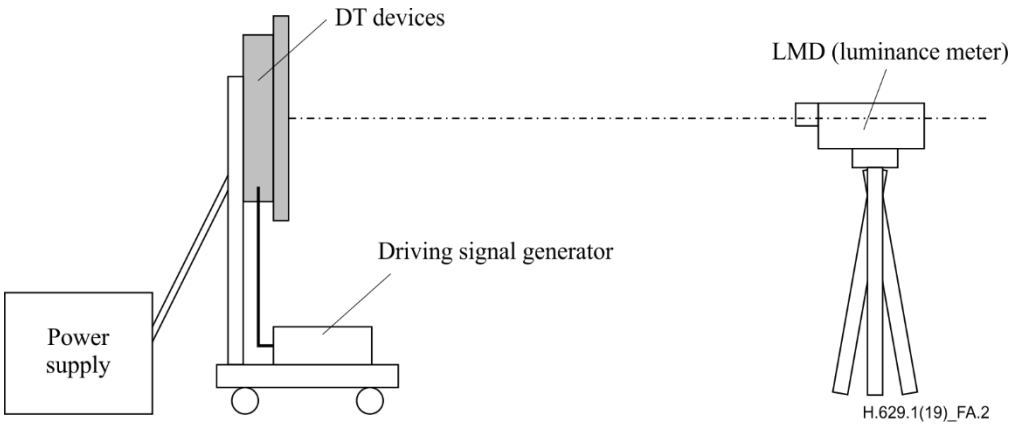

Figure A.2 – Example of equipment for measurement of greyscale luminance

A.5.3 Measurement method

The measurements are performed in the standard measuring conditions; see Annex A of [IEC 61747-30-1].

Use the measurement circuit system as Figure A.2 shows.

a) Input grey scale full field signal whose value is n $(n = 0,1,2, \ldots, n_{max})$, from 0 to n_{max}, respectively.

b) Then measure the greyscale luminance L_n in the centre of DT's screen.

NOTE – L_n has a minimum value at n = 1 and a maximum value when $n = n_{max}$.

A.5.4 Definition and evaluations

A.5.4.1 Accuracy of greyscale luminance

The accuracy of greyscale luminance reflects the deviation range of greyscale luminance actual measuring values. And the accuracy of greyscale luminance is:

$$D = \sqrt{\frac{\sum_{n=0}^{n_{max}} (j_n - j_{av})^2}{n_{max} + 1}}, \qquad j_{av} = \frac{\sum_{n=0}^{n_{max}} j_n}{n_{max} + 1}$$

where n is the grey scale value of the DT's screen and j_n is the deviation range of greyscale luminance.

A.5.4.2 Greyscale luminance range

The greyscale luminance range is the deviation range of actual greyscale luminance from the ideal greyscale luminance.

$$j_n = (\frac{L_n}{L'_n} - 1) \times 100\%$$

where n is the grey scale value of the DT pixel display, L_n is the actual measured brightness value of the n-th grey scale, and L'_n is ideal brightness value of the n-th grey scale.

A.5.4.3 Brightness gradient range

The brightness gradient range is the deviation range of the actual brightness gradient from the ideal brightness gradient.

$$k_n = (\frac{L_{n+1} - L_n}{L'_{n+1} - L'_n} - 1) \times 100\%$$

where n is the grey scale value of the DT pixel display, L_n is the actual measured brightness value of the n-th grey scale, and L'_n is ideal brightness value of the n-th grey scale.

A.5.4.4 Accuracy of brightness gradient

The accuracy of brightness gradient is the standard deviation of brightness gradient deviation, which represents the statistical results of all the brightness gradients deviating from ideal values.

$$E = \sqrt{\frac{\sum_{n=0}^{n_{max}} (k_n - k_{av})^2}{n_{max} + 1}}, \qquad k_{av} = \frac{\sum_{n=0}^{n_{max}} k_n}{n_{max} + 1}$$

where

n is the grey scale value of pixel display of DT.

k_n is brightness gradient range.

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Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
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Series F	Non-telephone telecommunication services
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Series J	Cable networks and transmission of television, sound programme and other multimedia signals
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Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
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Series S	Telegraph services terminal equipment
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