

G21.39

T84

Pyliavskiy V.V., Gofaizen O.V.,
Osharovska O.V., Patlayenko M.O.,
Solodka V.I., Makoveenko D.A., Siden S.V.

TRENDS

IN TELECOMMUNICATIONS

AND MULTIMEDIA SYSTEMS



Volodymyr V. Pyliavskiy

PhD, senior researcher of O.S.Popov Odesa National Academy of Telecommunications (ONAT), authors more than 60 science article field science interesting: image processing, colorimetry, broadcasting systems, adaptive systems



Oleg V. Gofaizen

ScD, professor of O.S.Popov Odesa National Academy of Telecommunications (ONAT), authors more than 400 science article, field science interesting: image processing, digital processing, telecommunication systems, broadcasting system, colorimetry, mathematics



Olena V. Osharovska

PhD, Associated professor of O.S.Popov Odesa National Academy of Telecommunications (ONAT), authors more than 100science article, field science interesting: image processing, digital processing, 3D mesh



Mykola O. Patlayenko

Engineer of O.S.Popov Odesa National Academy of Telecommunications (ONAT), authors more than 60 science article, field science interesting: image processing, digital processing, image compression



Valentina I. Solodka

PhD, Engineer of O.S.Popov Odesa National Academy of Telecommunications (ONAT), authors more than 50 science article, field science interesting: image processing, 3D mesh, image compression



Dmytro O. Makoveyenko

PhD, Associated professor at O.S.Popov Odesa National Academy of Telecommunications (ONAT), authors more than 90 science article, field science interesting: Telecommunication systems, network planning, electromagnetic compatibility



Serhij V. Siden

researcher at the O.S.Popov Odesa National Academy of Telecommunications, author more than 40 scientific works, fields of interest: 5G, adaptive antenna arrays, wireless communication systems



Ministry of Education and Science of Ukraine
O. S. Popov Odesa National Academy of Telecommunications

V. V. Pyliavskiy, O. V. Gofaizen,
O. V. Osharovska, M. O. Patlayenko,
V. . Solodka, D. A. Makoveenko, S. V. Siden

TRENDS

IN TELECOMMUNICATIONS

AND MULTIMEDIA SYSTEMS

Monograph

Kyiv
Publishing Lira-K
2020

UDC 621.397
P32

Recommendation to print
Academic Council of ONAT n.a. O. S. Popov
(Protocol 1 of 26 August 2020)

Reviewer:

Douglas Lee Hall, Ph.D., Chair (Retired), Computer Science
Dept., St. Mary's University, San Antonio, Texas

Pyliavskiy V. V., Gofaizen O. V., Osharovska O. V. and other
Trends in Telecommunications and Multimedia Systems :
monograph. Kyiv: Publishing Lira-K, 2020. 248 p.

ISBN 978-617-7910-68-7

The monograph provides comprehensive information on modem trends in telecommunication and multimedia information transmission systems. The modem aspects of the development of individual elements of the complete data transmission path are presented. The monograph consists of 9 chapters, in which modem issues of light-to-signal conversion are considered in detail, taking into account external light sources, encoding and compression of multimedia information, as well as features of reproducing devices. In addition, the main characteristics of the radio interface of the 5th generation of mobile communications, as well as its main technologies, are considered.

The results presented in this monograph can be useful for scientists, engineers interested in the current state of telecommunication systems for transmitting multimedia information, as well as for graduate students and students of higher educational institutions in the field of telecommunications and radio engineering.

ISBN 978-617-7910-68-7

© ONAT n.a. O. S. Popov, 2020
© Publishing Lira-K, 2020

CONTENT

INTRODUCTION	8
1. COLOR RENDERING IN END POINTS OF TELECOMMUNICATIONS AND MULTIMEDIA PATHS	13
1.1 Use of a color appearance model for video applications.....	13
1.1.1 Requirements for color perception models.....	13
1.1.2 Curriculum current status.....	14
1.1.3 The cone and the mesopic vision.....	15
1.1.4 Accounting geometric dimensions of color details.....	16
1.1.5 Objectives of adaptive video systems its prospects and problems.....	17
1.2 Used Color temperature line in correction video signal.....	18
1.2.1 Establishing the temperature relationship with the coordinate system xy	20
1.2.2 The region of existence of coordinates color temperature.....	20
1.2.3 Equation of Planck temperature line.....	22
1.2.4 Isotropic line (correlated temperature).....	22
1.2.5 Forward model. Determination of chromaticity coordinates in a known color temperature.....	23
1.2.6 The inverse model. Determination of the color temperature of the chromaticity coordinates of the known.....	23
1.2.7 Using the equation in the models of color.....	23
1.2.8 Discussion	24
1.3 An error of transmission a color by video path after use of random a spectral distribution of type light and end-path device.....	25
1.3.1 Factors influencing the through foute using the adaptive model.....	26
1.3.2 Construction of a radial grid.....	27
1.3.3 Error measurement algorithm.....	29
1.3.4 Modeling results.....	30
1.4 Development of the algorithm of video image adaptation to spectral power distribution of illuminants.....	32
1.4.1 Materials and methods of the study on the implementation of the adaptive video communication system.....	33
1.4.2 The algorithm of adaptation to the spectral power distribution of the illuminant.....	34
1.4.3 Determination of test color parameters.....	36
1.4.4 Assessment of color rendering on the basis of real spectral color distribution.....	43
1.4.5 New steps in the metrological support of multimedia and media paths.....	44
1.4.6 Color correction in image transmission in multimedia path.....	45
1.4.6.1 Definition of a colors set.....	46
1.4.6.2 Color rendering criteria.....	46
1.4.6.3 Color Set.....	47
1.4.6.4 Find the optimal spectra for the given color coordinates.....	48
1.4.6.5 Effect of different light sources on color rendering.....	48

1.4.6.6	Determination of correction coefficients.....	49
1.4.7	Results of studies of the algorithm of adaptation to the illuminant and color perception properties.....	51
1.4.8	Discussion of the results of the study of the proposed adaptation algorithm.....	53
1.5	Conclusions.....	55
2.	A COMPLEX ALGORITHM OF IMAGE WAVELET COMPRESSION -A POSSIBLE WAY OF PROGRESSINS DIGITAL IMAGE PROCESSING.....	56
2.1	Image quality measure.....	56
2.2	Test Images.....	57
2.3	Dependence of image signal values from numbers of decomposition levels.....	59
2.4	Clipping minimum level of decomposition levels sub-band signals.....	60
2.5	Quantization of subband signals of decomposition levels.....	60
2.6	Prediction of subband signals of decomposition levels.....	62
2.7	Prediction of subband bit planes signals of decomposition levels.....	63
2.8	Complex algorithm of wavelet-compression.....	63
3.	POTENTIALLY ACHIEVABLE IMAGE QUALITY IN VIDEO APPLICATIONS.....	65
3.1	Introduction.....	65
3.2	MTF of Light-to-Light TV Path.....	65
3.3	Image definition criterion that estimated in two dimensions.....	69
3.4	Correction of Modulation transfer function.....	70
3.5	Conclusion.....	73
4.	IMAGE SPECTRA WITH DIFFERENT TRANSFORMATION KERNELS.....	74
4.1	Formulation of the problem.....	74
4.2	Analysis of recent research and publications.....	74
4.3	Purpose of the study.....	75
4.4	Statement of the main research material.....	75
4.4.1	Fourier Analysis of the Texture of High-Definition Images.....	77
4.4.2	Discrete cosine transformation and constraint of coefficients.....	80
4.5	3D Compression Methods. Images Based on Hilbert and Riesz Transformations.....	94
4.5.1	Instantaneous frequency and instantaneous phase.....	94
4.5.2	The phase information in the spaces of higher dimension.....	95
4.5.3	Hilbert's Transformation.....	98
4.5.4	Monogenic signal.....	99
4.6	Gabor Filters for Threshold Selection of Objects.....	101
4.6.1	Spatial and Spectral Characteristics of the Gabor Filter.....	101
4.6.2	Image Phase Characteristics at the Output of Gabor Filters.....	103
4.6.2.1	The two-dimensional Gabor transform.....	104
4.6.2.2	Experiment results.....	104
4.7	Conclusions.....	107

5. TEST SIGNALS FOR ASSESSMENT IMAGE QUALITY IN HD AND UHD TV VIDEO PATH.....	108
5.1 Introduction.....	108
5.2 Color bar composition.....	108
5.3 Parameters of color bar luminance signal in digital active line.....	110
5.4 Parameters of color difference signals in digital active line.....	110
5.5 Test signal for measurement two dimensional MTF of through video path.....	114
6. VIDEO INFORMATION COMPRESSION ALGORITHM AT FIXED IMAGE QUALITY.....	117
6.1 Method of Data Submission for Subsequent Transmission of Data through the Channel with Variable Capacity.....	117
6.2. Quality Video Sequence Analysis of Loss Depending on the Wavelet Transformation Used in the Coding Process.....	120
6.3 Research on the Efficiency of Using EQM Metrics on Video Codecs Based on Wavelet Transformation.....	122
6.4. Video Comcode Image Compression Ratio Using Wavelet Conversion.....	124
6.5 Results of Modeling In-Frame Compression with Implementation of the Developed Coding Method.....	131
6.6 Results of Interface Compression Simulation Work with Implementation the Developed Coding Method.....	141
7. 2D AND 3D VIDEO OBJECTS WAVELET COMPRESSION.....	148
8. OVERVIEW OF THE 5G RADIO INTERFACE TECHNOLOGY.....	173
8.1 Development trend of mobile communication systems.....	173
8.2 5G Scenarios and services	174
8.3 Spectrum for 5G.....	179
8.4 Overview of Radio Interface Technologies.....	182
8.4.1 RITE-UTRA/LTE.....	183
8.4.2 RITNR.....	193
8.5 Aspect of planning coverage for FR2 5G NR.....	202
8.6 The protection of humans exposed to 5G electromagnetic fields.....	215
9. USE OF ADAPTIVE ANTENNA ARRAYS TO REDUCE INTERFERENCE IN THE E-UTRA/LTE NETWORK	218
9.1 The principle of adaptive data transmission systems in mobile networks.....	218
9.2 Mobile network model.....	222
9.3 Adaptive antenna system.....	224
9.4 Capacity simulation using an adaptive antenna system.....	228
Reference.....	233