Some Aspects of Formation Knowledge Base Information on the Basis of Use Optical-Electronic Devices of TV and MM Paths

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***Abstract*—This paper considers algorithms of visual information in the application of multimedia and television problems. Looks at the application of data of visual information in their spectral composition. Attention is drawn to the fact that the color with particular characteristics may be represented by different spectral components. It presents one of the way to optimize the obtained spectral data and simplify the detection of the same color in different spectral distribution.**

***Keywords*—Base data, color appearance models, models of color vision, spectral distribution, TV, MM.**

I. INTRODUCTION

Task of correct perception and transformation of visual information is important in systems of machinery vision, in the television devices (TV), in multimedia devices (MM). Correct information about light transformation is reduced to quality of converting sensors, cameras matrix and elements of path and for forming and transmission optical energy. All mentioned above system nodes in bring their own errors and noise, special attention should be paid to the elements of conversion "light-signal". The latter work on the principle of averaging spectral energy in the visible range of the human eye. Analytical expressions describing the operation of the converter shown in the paper [1]. Expressions do not allow to take into account the spectral distribution which in result of energy computation give the same value. The latter may cause the system to identify one color, and in other conditions will give as a result a completely different color, which will lead to a false perception, in a self-learning systems to increase the knowledge base. These and other questions will be addressed in this paper.

II. OPTICAL-ELECTRONIC DEVICES (OED) TV AND MM PATHS AS A MEANS OF OBTAINING KNOWLEDGE

The main feature of the progress of television systems and other video applications is the trend of transition to new levels of image quality and creation of new system functionality. Thus the special place is occupied by the fidelity of the rendering, depending on the colorimetric characteristics of the systems as a whole and their components, defining the colorimetric image quality. When it comes to colorimetric quality, it should be based on evaluation of color fidelity in a through path "from light to light" [1-3], as the main color irregularity occurs on the transmitting and receiving sides, namely, they arise due to possible imperfections in the spectral the composition of the source of studio lighting and radiation due to possible imperfections in the spectral characteristics of the camera, as well as colorimetric errors introduced by the playback device, and errors which may make a digital image processing at the transmitting and receiving sides.

One of the most critical factors is the imperfection of the spectral characteristics of the sensitivity channel of camera primary colors. This means that when assessing true color reproduction one can not move away from the spectral reflection characteristics of objects in the scene and to operate only with their color coordinates. That is why paper [1] focuses on the spectral composition of objects and given a comparison of distortion of color reproduction of optimal colors and an example of real colors in the form of a combination of Gaussian functions from length of the radiation wave, and is shown that there may be some inconsistency with a metamerism.

In order to quantitatively judge the trueness of colortransmission of TV cameras, one must have the opportunity to compare the characteristics of real cameras with the characteristics of an ideal cameras, and spectral characteristics of the R, G, B channels. primary colors of which would provide an undistorted colortransmission regardless of the spectral composition of objects.

In the present study determined the spectral characteristics of the ideal in terms of colorimetry CIE 1931 standard camera television (SDTV) and high (HDTV) and ultrahigh (UHDTV) definition, as well as for UHDTV system in terms of colorimetry CIE 2006 and there are examples of error estimation of colortransmission due to views difference about undistorted colortransmission. Also examples of distortion assessment for a set of colors, Color Checker, that optimally configured to a "standard" SDTV camera in relation to the ideal.

The difference of these characteristics leads to the error of colortransmission, which makes the camera in which feature colorimetry of 1931, in relation to the camera, which has a more advanced colorimetry 2006 year. Where $\alpha_R(\lambda)$, $\alpha_G(\lambda)$, $\alpha_B(\lambda)$ the vectors of spectral characteristics of the sensitivity of the channels of the primary colors of the TV camera. Index F marked affiliation colorimetry 2006 year.

Colors different in brightness and respectively belong to different levels of lightness of the image. For the set of Color Checker the signals of primary colors do not go beyond the

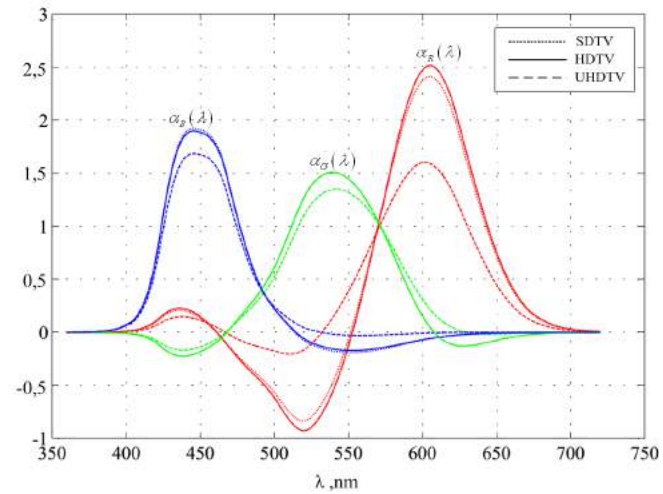

Figure 1. Comparison of the spectral characteristics of the sensitivity of the channels of the primary colors is ideal from the point of view of colorimetry, the CIE 1931 SDTV cameras, HDTV, UHDTV

boundaries of the interval $\overline{0,1}$, i.e. they can be transmitted by UHDTV system. For a set of optimal colors for some colors the basic colors exceeds a single level, so in their brightness was introduced normalization, in which signal levels were limited by interval $\overline{0,1}$. Points of colors of both sets are presented in Picture 3.

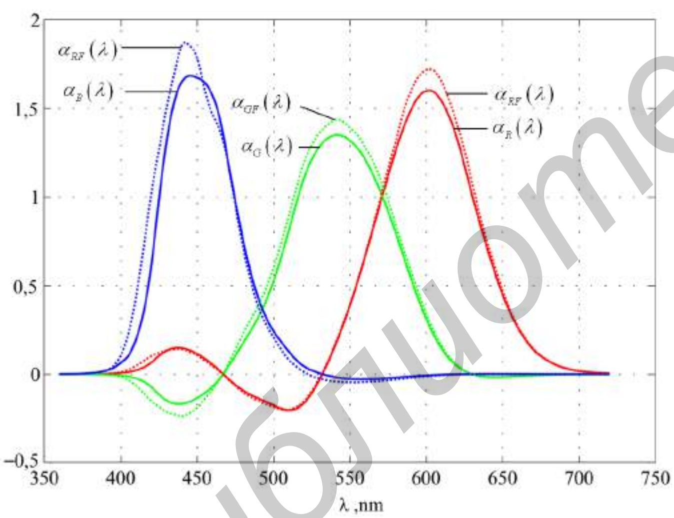

Figure 2. A comparison of the spectral characteristics of the sensitivity of the channels of the primary colors of the UHDTV camera, ideal from the point of view of colorimetry, the CIE 193 the CIE and 2006

Evaluation of distortion of color transmission of the “standard” camera when compared to the ideal. In TECH 3355 [4] introduced an assessment of true color transmission for "standard camera", the characteristics of which were obtained as a result of averaging modern cameras SDTV, picture 3. For the "standard camera" [4] were calculated the resulting spectral characteristics, taking into account the linear matrix that approximates the resulting spectral response, as far as possible to the ideal, and made evaluation of color shift with respect to the original colors for the two models-linear, i.e. excluding gamma transformation, and non-linear, i.e. taking into account the gamma transformation. However in [4] color shifts have its place due to the imperfection of the spectral characteristics of the camera, together with a non-linear transformation, and for compensation applied optimization of the matrix.

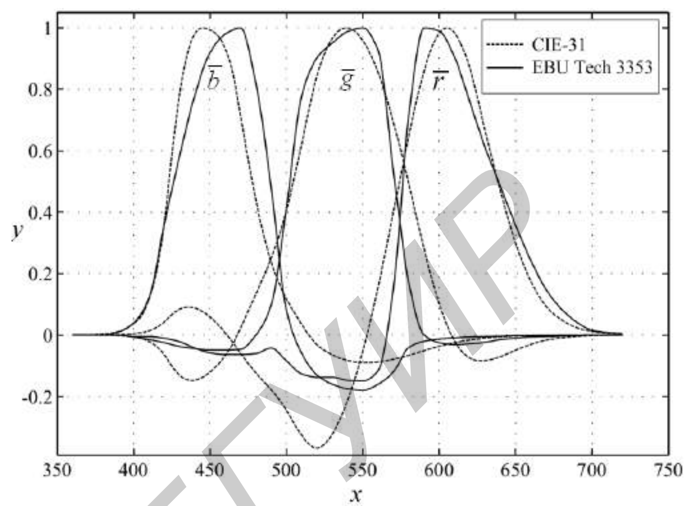

Figure 3. Spectral characteristics of reference and a real camera (EBU Tech 3353)

In the present work adopted for the baseline a different approach, consisting in the fact that the successive gamma conversion from $\gamma_1 = 0.45 = \frac{1}{2.2}$ on the transmitting side and $\gamma_2 = 2.4$ on the receiving side result in the reproduction of colors and brightness tones, perceived by observers as the best. Therefore, as a criteria of true color transmission is preferable to estimate the color shift in relation to colors specified in case of use of ideal camera and the use in series of both non-linear gamma transformation. Using the camera with the characteristics of a "standard" camera with a linear matrix [4, Pictures 11] provides a virtually undistorted color reproduction.

This conclusion can be extended to the HDTV system, given the proximity of colorimetric systems, standardized for SDTV and HDTV systems, and are consistent with the data of [4] for UHDTV system. The paper presents a study of the spectral characteristics of the camera standardized in ITU-R SDTV systems, HDTV and UHDTV in terms of their effect on the colorimetric image quality as one of the major factors.

III. ONE COLOR AND DIFFERENT LIGHT SOURCES – DIFFERENT COLORS

The desire to improve the quality of the TV picture or MM causes engineers to integral actions-control and measurement parameters through television tracts. For this purpose there have been developed a technique of subjective and objective quality control, testing a variety of materials and measuring equipment. And if there more tools for assessing the quality, the greater the likelihood that the solution to enhance the image quality will be solved. A neglect of one of the factors affecting the quality, leads to imperfection video transmission system. Since there are many point in the path, in which there is a likelihood of distortion, lets pay attention to the distortions associated with the use in the D65 light studio but different spectral distribution and characteristics of cameras which differ

Table I. RESULTS OF THE EVALUATION OF THE INFLUENCE OF VARIOUS SOURCES OF LIGHTING ON COLOR REPRODUCTION OF THE SCENE

Y	Light source	*R*	*G*	*B*	*Ye*	*C*	*M*
0.25	FL3.15	2.3	1.8	0.6	3.2	0.5	0.8
	FL1	6.1	3.1	2.4	3.1	4.1	2.0
0.75	FL3.15	2.8	2.2	0.7	3.9	0.6	0.9
	FL1	7.3	3.7	2.9	3.8	4.9	2.4
1.00	FL3.15	3.0	2.3	0.7	4.1	0.7	1.0
	FL1	7.6	3.9	3.0	3.9	5.1	2.5

Table II. THE AMOUNT OF CHANGE OF VECTOR OF COLOR USING CAMERA EBU TECH 3353 [4] AND THE LIGHT SOURCES WITH RESPECT TO AN IDEAL CAMERA, ICE IS EXPRESSED IN UNIT

Y	Light source	*R*	*G*	*B*	*Ye*	*C*	*M*
0.25	D65	4.1	2.0	3.7	13.5	0.5	7.9
	FL3.15	3.8	1.8	4.6	13.6	0.2	7.6
	FL1	3.5	4.8	10.0	11.8	3.1	10.4
0.75	D65	4.9	2.4	4.5	16.3	0.7	9.5
	FL3.15	4.5	2.1	5.6	16.4	0.2	9.2
	FL1	4.1	5.8	12.4	14.1	3.8	12.4
1.00	D65	5.2	2.5	4.8	17.1	0.7	9.9
	FL3.15	4.7	2.2	5.9	17.2	0.2	9.6
	FL1	4.4	6.2	13.1	14.7	4.0	13.0

from the idealized characteristics of standardized CIE-31. As for the camera, then not having the spectral characteristics of the latter it is not possible to judge the colorimetric capabilities of cameras, since, at this stage, this information is hidden in nature were used standardized characteristics cameras EBU Tech 3353.

As for the metrics and thresholds used in the calculations was used analysis represented by authors in paper [5]. For evaluation of effect of mentioned factors was used equally contrasted system CAM02-UCS [6].

Table 1 shows the value of the color differences in lighting of scene at the transmitting side of an idealized (reference) light source D65, and on the receiving side fluorescent light source type F3.15 and F1, with different brightness of the playback scene and brightness adjustment equal to 50 cd/m^2. The shaded area shows the most critical values of color distortion that will be visible to ordinary viewers.

The table results are presented in terms of the CIE, which expressed a long vector in three-dimensional color space. Its length refers to the distance between the studied colors and can be used for quantitative assessments. The criterion of length of the vector estimation is presented in [5]. Since the assessment carried out in uniform color space chromaticity point which are placed evenly over the entire area of the color it gives the right to assert that the proposed criterion is valid for any of the chromaticity diagram.

As for the camera, the camera's spectral characteristics are shown in Fig. 3. Studies conducted using the real camera in the same scene brightnesses and brightness adjustment are shown in Table 2. Assume that the ideal camera is the one that standardized CIE-31.

These results were obtained using artificial spectral characteristics which closer to the idealized and produced by mathematical modeling, more detail can be found in the literature of [8]. These colors are made up of a set of basic and additional colors, all other colors are not quantify but some

Table III. EVALUATION OF COLOR RENDERING ON THE EXAMPLE OF USING THE STANDARDIZED SPECTRAL DISTRIBUTIONS IN [7]

Research options	Value	
1. Optical sample illuminated by natural light, 2. Optical pattern illuminated light source D65, the,camera [8]	1.69	2.90
1. Optical sample illuminated by natural light, 2. Optical pattern illuminated light source A, the,camera [8]	11.03	15.94
1. Optical sample illuminated by natural light, 2. Optical pattern illuminated light source D65, the camera [4]	5.69	10.10

issues are reflected in [10].

According to the data presented in the Table. 2 it can be argued that there is a color for which distortion accept invalid values, and there are those for which the distortion in the normal range, or not visible. But because the studies have not been conducted on the full and artificially generated spectral distributions advisable to conduct research on the actual spectral distributions. Data spectral distributions has been taken to achieve the last of the ISO/IEC standard [7]. In this standard, a wide range of spectral distributions of actual colors. The results of three studies of the possible embodiments were chosen, namely:

- an option when the color is perceived by the system which is equivalent to the average human eye and there is no distortion of the optical the machine or inverter "light to signal" (OTF – optical transfer function) or the distortions insignificant are small;
- an option when using the same system, but the artificial lighting, namely light source type A and D65;
- An option when using a real camera [4] and artificial lighting.

As can be seen from the results shown in the table appear as distortions only artificial lighting has excellent spectral distribution from natural sunlight and when the actual camera used different from the spectral characteris-tics shown in Fig. 1 and 2.

These data indicate unacceptable distortion, distortion of this kind can be reduced or eliminated through the use of adaptive models [9], but even the simplest model of color correction will not work without the second pa-rameter vector direction. The direction can be varied, as shown in the example in Figure 4.

IV. METAMERISM IN THE APPLICATION OF MULTIMEDIA AND TV SYSTEMS

Understanding about the concept of metamerism in optics indicate the ability to create the same visual sensation of a stimulus by the person in different spectral distributions. The spectral distribution was noted in some earlier works, e.g. [1]. An example of metamerism is shown in pictures 4.

On the pictures shows two different spectral distribution (example 1 and example 2), which in the end give the same result the same values of color coordinates, namely $x = 0.2353$, $y = 0.1667$, $y = 0.5978$. The coordinates obtained using the spectral characteristics of the sensitivity of the camera shown

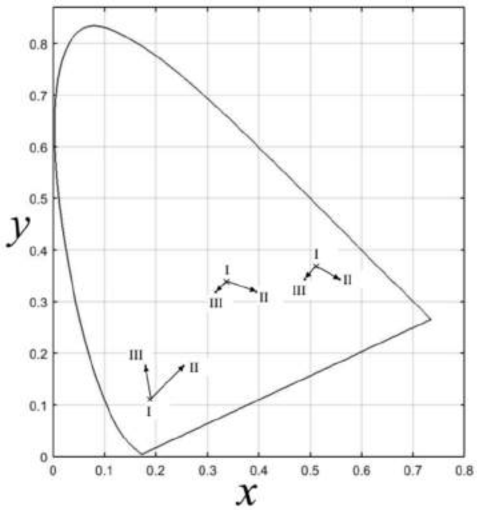

Figure 4. The character changes color point depending on the lighting and the different spectral characteristics of the cam-era's sensitivity to the example of the use of the spectral characteristics of a real object (I - the spectral distribution of the optical sample under natural light, II - for the variant using the camera with the characteristics [4], III - for option using the camera with the characteristics [8])

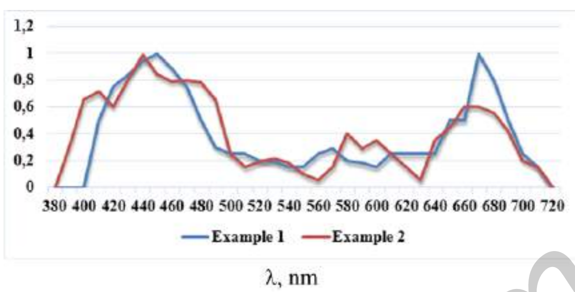

Figure 5. Is the spectral distribution of the color stimulus

in Fig.3, and the optical stimulus was illuminated by the light source type D65.

V. Conclusions

From the presented data we can draw the following conclusions. Given that the magnitude of change are presented in table. 1 and 2 in some cases reaches unacceptable values (more than 7 units) in the future, it is advisable to take into account the parameters of the light sources in the design of new TV and MM systems, in particular the adaptive television.

The spectral distribution of the sensitivity characteristics, standardized EBU camera brings distortions, and the use of other cameras in machine vision, and systems capable of accumulation of knowledge makes them not universal. That is, the use of the same conditions, different cameras leads to a duplication of the same the knowledge and most importantly, that the stored data is different, although the optical parameters of the observed object were original, and when they are compared in a common database leads to a lack identity between them which results in the desired increase in volume has not retained the knowledge. Similarly explained by the influence of other light sources.

One possible exception of this phenomenon may be the use of adaptive spectral sensor data obtained correction pattern. The use of the latter can be implemented in combination with the use of color patterns, such CAM02-UCS.

Questions metamerism require further research, since existing methods do not allow to eliminate this phenomenon is due to the design features of converters "light signal", as well as the absence of analytical methods for the determination and elimination of metamerism.

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НЕКОТОРЫЕ АСПЕКТЫ ФОРМИРОВАНИЯ БАЗ ДАННЫХ НА ОСНОВЕ ИСПОЛЬЗОВАНИЯ ОПТОЭЛЕКТРОННЫХ УСТРОЙСТВ ТЕЛЕВИЗИОННЫХ И МУЛЬТИМЕДИЙНЫХ ТРАКТОВ

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В работе рассматриваются алгоритмы обработки визуальной информации в прикладных мультимедийных и телевизионных задачах. Рассматривается вопрос различия визуальной информации на основании спектрального состава излучения. Акцентируется внимание на том, что цвет с одними спектральными характеристиками может быть представлен разными спектральными составляющими, что увеличивает. Представлены оценки метамеризма при воздействии источников освещения, спектральной чувствительности камеры и т д. Представлен возможный вариант оптимизации полученных данных и упрощение детектирования одного цвета по разным спектральным распределением.