THE POSSIBILITIES OF THE COLORIMETRIC MEASUREMENT OF THE COMPUTER MONITORS' PRIMERS WITH PHOTODETECTOR

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Abstract: *Generally, the large precision colorimetric characterization of the monitors occurs with spectrophotometers. However, because of the application costs of the spectrophotometers the spread of the monitor calibration makes heavier. But, the last few years the monitor calibration devices are current by the application target which requires smaller measuring precision. In this application segment, our aim is to prepare an instrument which has got more precise colorimetric calculation method and cost-effectively sensitive unit than the currents. As the first stage, we examine the possibility of the detector's measurement without spectrophotometers and the potential variants of the calculating methods.*

Keywords: *gamma-curve, channel-characteristics, colorimeter, calibration device*

1. INTRODUCTION

The modern CAD and DTP applications require true-colour visualization of the computerized monitors during planning and manufacturing. The insurance of the true-colour stage occurs with the help of the monitor calibration. For this, the first step is to measure the instrument's colorimetric parameters and then to create the ICC colour-profile [1,2] file from the measured data which help to provide the calibrated state.

2. MONITOR CALIBRATION

There are several opportunities onto calibrate the display device. The easiest method is to calibrate a device instrumentally [3]. In this case, the monitor is investigated by a device (Fig.1.) which was made for that purpose; the necessary parameters are measured then as a function of the given results, the software of the device creates the display's colour-profile file.

Fig.1. Calibration devices which are available currently on the market

The advantage is that we can make much more correct result with help of the instrumental calibration but the price of the device needed is very high.

The other solution is the visual calibration [4] which applies subjective photometry. At that time, the user measures and configures the correct parameters of the device with the help of the different test-figures (Fig.2.) and the software which was made for that purpose. The method's advantage is the low price but during the calibration we use our eyes, so the given result is not such perfect as if we carried out it with the device.

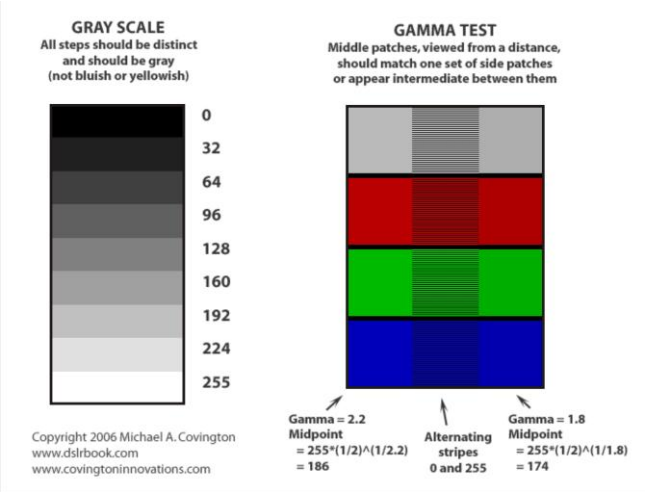

Fig.2. Test-figures used in visual calibration

The colorimeter [5], which is the new device of the calibration, is developed or began to spread in the last time for the purpose to eliminate the above-mentioned inaccuracies. The colorimeter is a cheaper and low-tech structure device; its sensitivity matches the eye's sensitivity [6]. This method reduces in the large measure the process of the right colour-settings, but the essential condition for the operation is the opportunity of the visual calibration on each displays.

With the visual calibration method [7] good scores are made in the case of the CRT displays. Mostly, it is due to that the gamma and spectral characteristics of the CRT monitors are fixed with large precision in the case of the devices of different age and production, too (Fig.3.). The equity of the spectral characteristics curves is led back to the spectrum-production of the CRT technology.

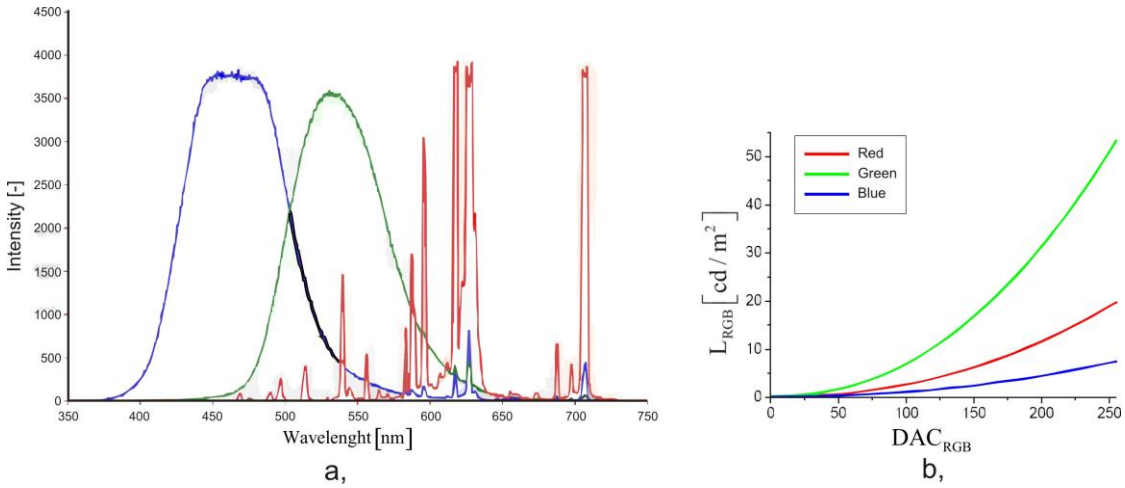

Fig.3. a, The spectral-characteristics of the CRT and b, the gamma-curves of the CRT

3. THE MEASURING OF THE LCD MONITOR' PARAMETERS

The development of the display device took a new direction in the early 2000's, and the LCD displays [8] began to take over the CRT monitors positions. The technology and the imagery of the Liquid Crystal Displays (LCDs) are totally different than the CRT's [9].

The visual calibration became totally unsuitable with spread of the LCD monitors, because the RGB filters of the appeared LCD monitors deviated from the different manufactures and the difference of the applied backlight were damaged for the conditions, too.

A research was started in the Department of the Mechatronics, Optics and Applied Informatics of the University of Budapest Technology and Economics to measure the characteristics of the LCD monitors available on the market currently. With the aim of knowing these, the development of newer methods in the area of the visual and instrumental calibration should become possible. During the measurements, we examined 60 different monitors from different manufactures [10].

One of the tasks was to determine the channel characteristics of the monitors. These characteristics show what kind of connection appears between the palette values of the monitor and the measurable colour-stimuli quantities on the monitor in the case of the red, green and blue colour-stimuli. Every single case of the measure on the monitors, we set the brightness to 100 per cent and the colour-temperature to 6500K. To determine the channel characteristics, we raised the DAC values from 0 to 255 with 10 DAC values steps in the case of all three colour-channels, while we measured the given light-intensity in each steps. We didn't change the palette-value of the other two channels at the given channel examination, those put 0 value. The given light-intensity values, represented as a function of the DAC (palette) values (Fig.4.), we can receive a property channel-characteristics graph from the given display (gamma-curve, [11]).

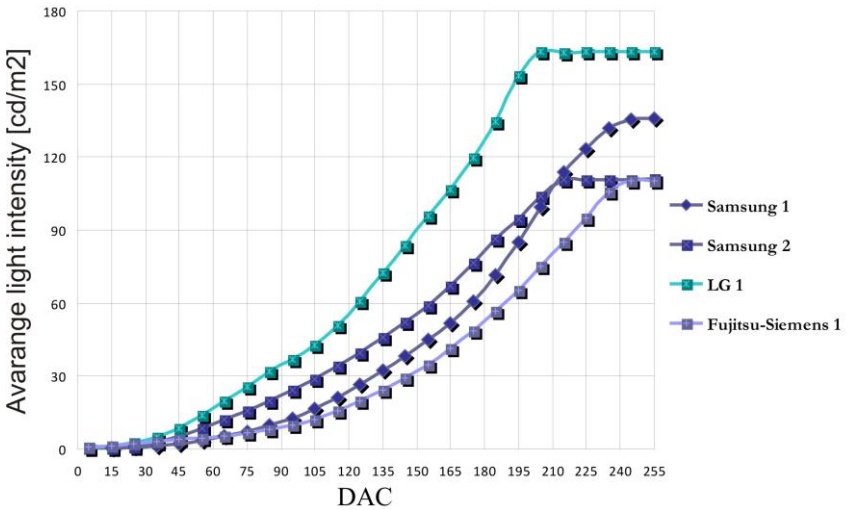

Fig.4. The gamma-curve

The characteristics of the graphs are equal onto all of the three colours. It might be observed that with the exception of one or two characteristics, the curves are not as the same as the CRT monitor's gamma-characteristics those adapt the best way for the human eyes gamma-curves. But instead, we can observe the bend wards of the LCDs' curves those are usually not taking up the maximal value at the 255 DAC value, but a little bit sooner. The scale of the bending is various and this presents the sigmoid (S-shaped) characteristics which

are representative for the LCD displays. These characteristics make heavier the spread of the visual calibration in a large way, too.

In the other hand, we measured the spectral transmission of the displays with spectrophotometer in 100 per cent brightness. We represented the measured RGB values by the side of the wavelength, like this, we got the spectral distribution of the displays (Fig.5.).

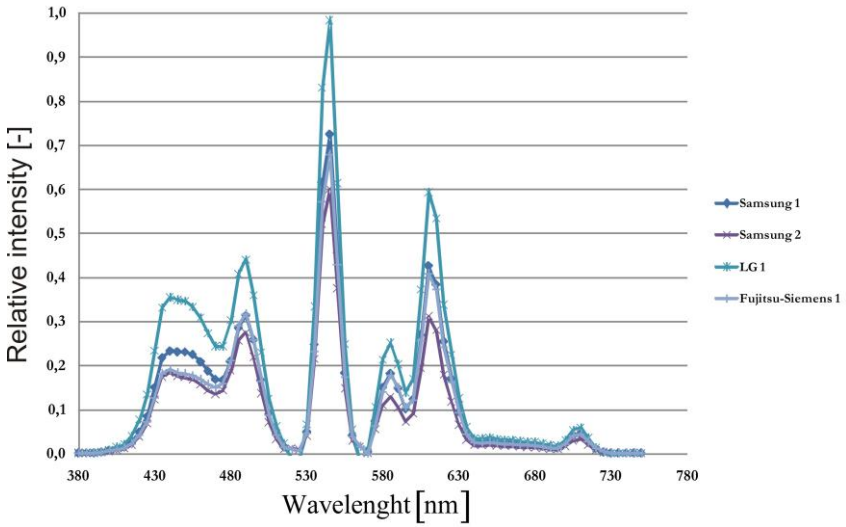

Fig.5. The channel-characteristics

After we evaluated the results; we can see that the spectral characteristics of the different panels fixed in the case of the increment of the colour saturation, too, only a margin of difference appears between them.

The given results show it well that the manufacturing technologies occurred to boil (became simplified or optimized) in the past time; the different panels are similar in visualize parameters and it progressed in the direction of the favorable from the point of calibration. This makes it possible the application of the visual calibration or that moved for the application of the calibrate instrumental which contents for a one detector. Hereby, it may be attained for the fraction of the price of the calibration device that is obtainable on the market.

4. THE COLORIMETER

We would like to design a very precise, well functioning and economically producible device so it is necessary to examine more design shaping. The different constructions may vary in the number of detectors or in the usage of the colour-filters applied, namely, the values of the single RGB colours may be determined different ways [12].

Like this possible constructions are for example: colorimeter with

- 3 colour-filters and 3 detectors

The detectors are silicon-based photodiodes; the sensitivities of them must cover the wave-length interval emitted by the LCD monitors. The input light into the sensors are filtered by the colour-filters which characteristics suitable for CIE colour-matching functions.

- built together 3 colour-filters and an RGB detector

Here, the photodiodes content the colour filters (RGB) thereby it is not necessary to use extra filters.

- 3 colour-filters and 1 detector

Here, the aim was to minimize the number of detectors. It is possible to attain that the 3 colour-filters are needed to build into a plate, so its planar motion is controlled by a stepper-

motor. Each of colour-filters are obliged a position that to control at measuring of the given colour.

- 1 detector without colour-filter

The above-mentioned measuring results show that there is a possibility to develop such colorimeter which goes without colour-filters. In this case, there is an opportunity to measure and calibrate the monitor's colours with a help of one photodiode (only one primary colour may be measured at the same time) and a convenient process.

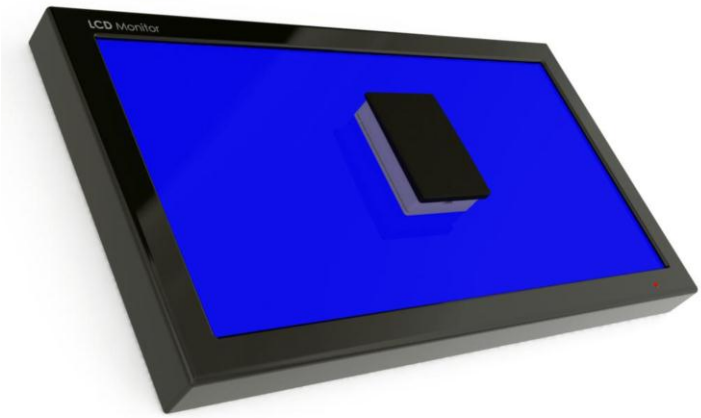

Fig.6. The planned colorimeter

Naturally, each device possesses advantageous and disadvantageous features, too. For instance, the more complicated housing-frame or the additional charges because of the colour-filters.

To design the different types of devices, I considered the following aspects: to reach the convenient measuring precision, to manufacture and operate ergonomically, to provide heavy-duty structure and easy assembling and not an inessential aspect: the ergonomically design and aesthetic aspect, either.

5. CONCLUSION

Thanks to the research, it is possible to establish that the most of the LCD monitors produce the bending-phenomenon about one of the base colour-stimuli and the characteristics are S-shaped curves. This shape involves difficulty in terms of the calibration. On the other hand, thanks to the similar spectral characteristics, there is a possibility that further on to development measuring method which contents one detector device just as well ignore a spectrophotometer.

The usage of the planned colorimeter without colour-filters will be a newer step on the spread of the calibration possibility of the LCD monitors. The method waiting for development in the future and the implemented device will help such applications where the colour-correct visualization is important.

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