COLOR SENSITIVITY OF A CCD CAMERA

Ing. Petr SADOVSKÝ, Doctoral Degree Programme (4)
Dept. of Biomedical Engineering, FEEC, BUT
E-mail: petrsad@feec.vutbr.cz

Ing. Jiří MAJZNER, Doctoral Degree Programme (3)
Dept. of Physics, FEEC, BUT
E-mail: majzner@feec.vutbr.cz

Supervised by: Dr. Jiří Rozman, Prof. Josef Šikula

ABSTRACT

In our research focused on EEG and video monitoring of sleeping patient, we had a problem with monitoring in dark environment. Our camera has a NightShot mode, but we didn't know how to improve the brightness in saved video. We tried some numerical algorithm for brightness improvement, but the better idea is preexposure dark scene with sleeping patient from external panels which consist IR luminary diodes. Before the construction was necessary to know which kind of the IR luminary diodes is the best for this purpose, i.e. which part of lighting wave-length they should generate.

This article contains measurement description of color sensitivity of camera CCD chip SONY TRV 240 in normal mode and NightShot mode and the measurement results.

1 MEASUREMENT METHOD

For light spectral sensitivity measurement is necessary to use the light supply which is enabled to hold up exactly defined light level on varied wave-length of the light.

The instrument which requires above mentioned characteristics is available at Department of Physic at FEEC, BUT. This instrument is used for the light absorbtion measurement of several materials and has signification SPEKOL.

The principle of function of this instrument is very easy. SPEKOL contains white light supply which is generated by a bulb. White light from this light supply is led to a glass cuboid by the lens system. Glass cuboid, which is placed in front of aperture, decomposes the white light to a spectrum. Decomposed light incidents in a inner aperture and pass through the aperture (outside instrument) as the color light, which correspond approximately one wave-length of the light. The glass cuboid is movable and hitched by micrometric screw which is accurately calibrated in the wave-lengths of the light. The

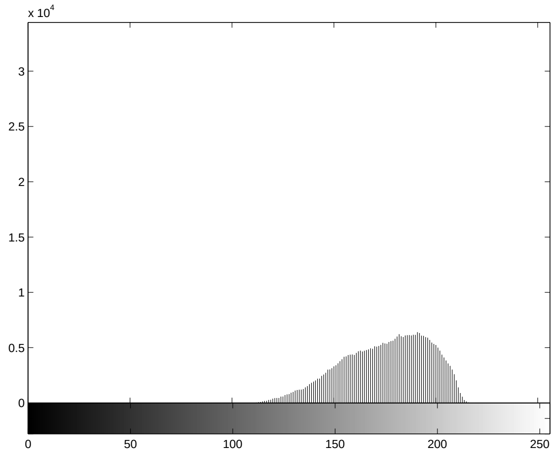

Figure 1: Histogram for green component of color by 550nm wave-length

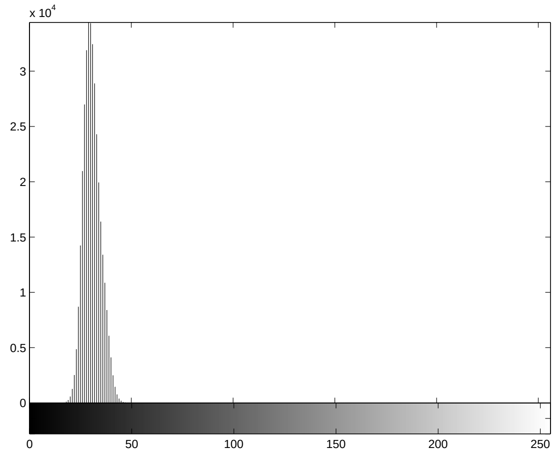

Figure 2: Histogram for blue component of color by 550nm wave-length

setting up of wave-length value on micrometric screw sets up glass cuboid into a position in which the color light incident in a inner aperture, which corresponds to wave-length value set up by calibrated micrometric screw.

The spectral light absorption in glass is approximately identical. Then it is possible to suppose that the light decomposed by the glass cuboid has the same intensity level on all wave-length in whole light spectrum and close areas.

Measurement method is based on the incident of the color light of exactly defined wave-length and the same light intensity level to a camera. The camera records color level in each of the recorded colors (Red, Green, Blue – RGB Color System) in the image. After the measurement through the whole spectrum of light, the result is the dependence on the level of the light for each color in RGB color system to wave-length of the light.

2 THE MEASURING SYSTEM

The measuring system consists of SPEKOL, lenses, a transparent shield and the camera. Because SPEKOL is a special measuring system for a light absorbtion in a transparent materials, it was necessary to make some adaptation for our measuring.

We had to remove a part for light-scan from SPEKOL and all measuring equipment was fixed to avoid any movements, during all the measurement time.

Light of the exactly defined wave-length (set up by the micrometric screw) out of the aperture incident to the transparent shield which disperses the sharp light from a bulb string. The dispersed light incident to the camera CCD chip through the lenses. These lenses enable the camera to shoot the incidence of the light from one point of stripe light placed in the focal point to the major part of the CCD chip.

3 LIGHT SPECTRAL SENSITIVITY MEASUREMENT OF THE CAMERA

Camera is taking a image for each wave-length which is set up by micrometric screw. Every image was analyzed after the measuring. For example in Figure 3 is a green light of

550nm wave-length. In next Figure 4 is a histogram of brightness of the red part of RGB image which was recorded by the CCD camera. It is obvious that red part in this image must have low brightness.

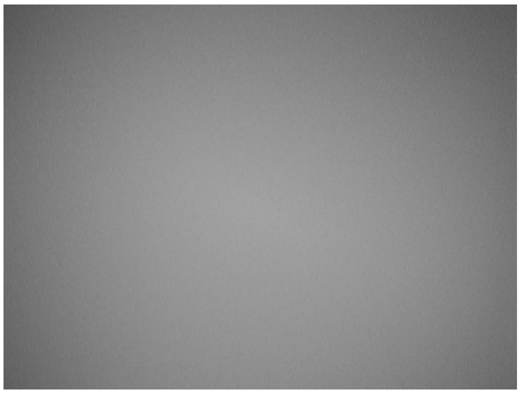

Figure 3: Image taken by camera for light of 550nm wave-length

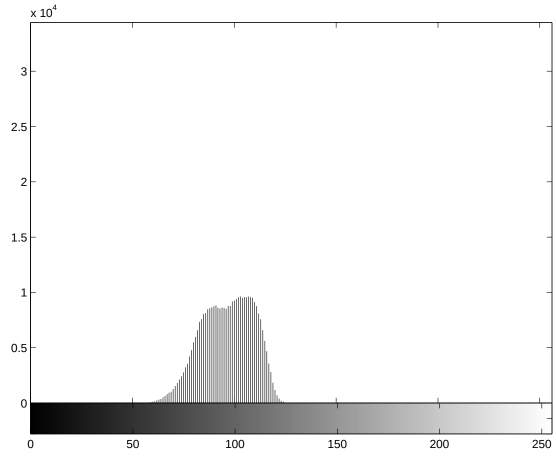

Figure 4: Histogram for red component of color by 550nm wave-length

These attributes are the same for the blue color. The majority of pixels for blue color have very low brightness. That means that they are dark and in histogram are placed in the left side of brightness axis in Figure 2.

On the other hand the brightness of a green color is bigger then the previous ones. This is shown in Figure 1. The histogram for the green color is placed on the right side of brightness axis which corresponds with the brightest light.

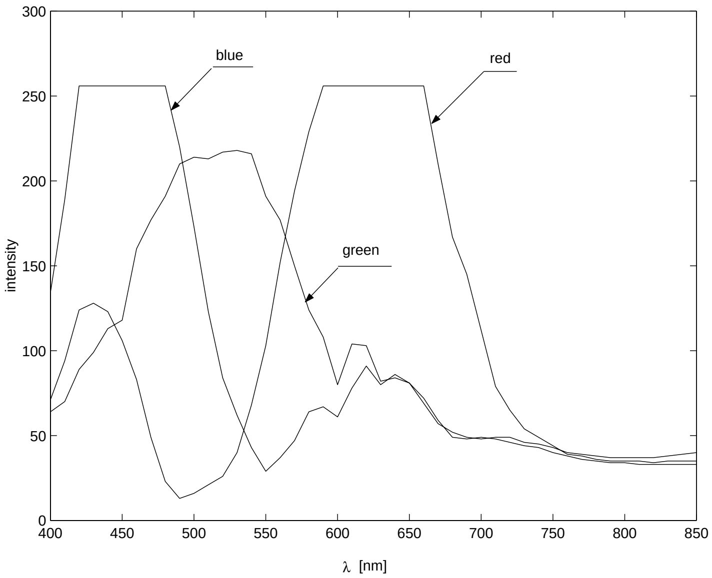

Figure 5: Light spectral sensitivity of the camera. (The RGB color model use 8b for each color – 24b color depth.)

There are a light spectral sensitivities of the camera for each color in RGB color model in Figure 5. This figure is based on 50 analyzed images.

There is a histogram for each color in RGB model computed from every image (every image corresponds with exactly defined wave-length, images were taken through the whole spectrum of the light). Only the parts of histogram which contain the highest amount of pixels, were used for the graf in Figure 5 construction.

The camera uses RGB color model. Then, in the graf in Figure 5, there are three curves for each color (red, green and blue).

There is a light spectral sensitivity of the camera in scotopic vision (Nighshot camera mode) in Figure 6. This figure was obtained the same way like the Figure 5, but the camera was in scotopic vision – Nighshot mode. This figure is based on 25 analyzed images.

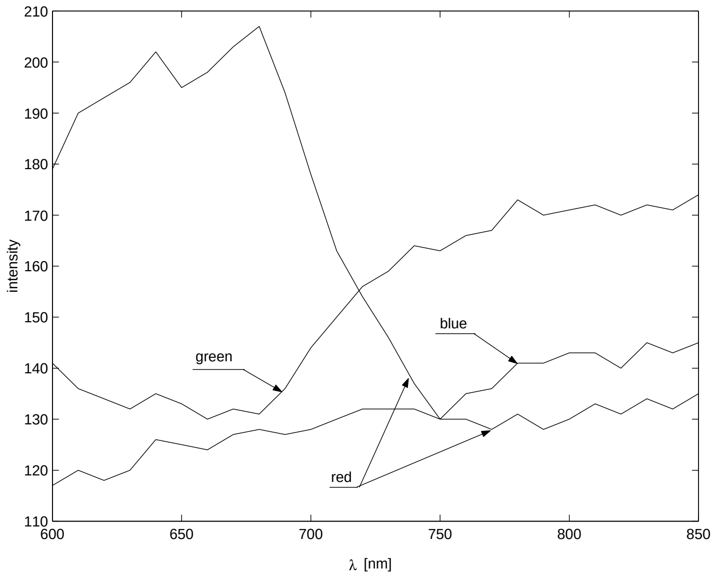

Figure 6: Light spectral sensitivity of the camera in scotopic vision mode. (The RGB color model use 8b for each color – 24b color depth.)

4 CONCLUSION REMARKS

There is showed a light spectral sensitivity of the camera in Figure 5 and a light spectral sensitivity of the camera in scotopic vision in Figure 6. From these images is obvious how brightness in each color in RGB color model depend on wave-length of the light. In the red color part (600 – 700nm) in both figures the brightness is big. In the part about 700nm, the brightness rapidly decreases in both figures. Whereas the brightness of all colors is lowered with decrease wave-length of the light in Figure 5, in Figure 6 is brightness much bigger then previous Figure and brightness increases for each color (especially for the green one).

It is obvious that for preexposure of dark scene is possible to use IR luminary diodes and it is not important which wave-length of the light they emitted, because from 750nm to 850nm the sensitivity of the camera in scotopic vision mode slowly increase.