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Development of New LED Light Sources for Improved Visualization of Bio-samples

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Abstract— Visual examination is the initial tool used by clinical doctors in all classes of medical diagnostics. Many medical imaging techniques have emerged over the recent years, thereby offering extended "vision" to surgeons and medical doctors. However, immediate visual clarity is still an unresolved issue. Human visual perception can be significantly affected by the spectral power distribution (SPD) of the available light. Though, the diagnostic luminaires are chosen only by taking into account the illumination level, shadow, glare and heating reduction. LED technology allows control over SPD and can, as well, address all above mentioned factors. Simulation programs for predicting the optimal spectral distribution of illuminant, for enhanced color difference between abnormal and normal tissue, has recently been reported successfully [1]. Moreover, exploration of color contrast through computation (NIST color quality simulation program software) according to CIE standards has showed that it is possible to enhance the contrast between color patches typical of tissue color by using special illuminant spectral distribution [2].

In this work, in order to bring into life the simulation work [1, 2], a multi-channel LED lamp was developed. The various channels were allowing modifying the intensities of colored (blue, green, red and cyan) and white LEDs (warm, neutral and cold). The LED light source could provide white light with color temperature ranging from 2700–5400 K, with high color rendering index in the range 90–95. A systematic optimization procedure was followed in order to achieve optimal visual perception of contrast on bio-samples. It was shown that higher color temperatures (above 4500 K) resulted in better visual perception of bio-samples. Furthermore, colored light (mixture of RGBC) resulted in surprisingly better contrast than conventional light sources, but resulted in eye fatigue quicker than white light. Human eye spectral sensitivity combined with reflection measurements of bio-samples, were used as a guide for selecting the optimal spectral power distribution of the colored light. Human acceptance, for the proposed spectral power distributions, and preference over conventional light sources was statistically recorded (population: 35 participants).

A first step towards statistical validation of the human preference for the proposed optimal light source over conventional light sources was done, though confirmation in medical practice is still critical for the implementation of the method. Moreover, the universality of the success of the method for varying bio-samples needs still to be tested, and is of fundamental importance. It is believed that the prospect of improving visual perception of doctors and clinical practitioners by using highly energy efficient and environmentally friendly light sources, as LEDs, could improve the lifecycle of hospitals and benefit medical society.

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