Non-contact dermatoscope system for automated detection of suspicious skin lesions

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Contact dermoscopy is the standard tool for skin cancer screening. We present a prototype of a non-contact dermatoscope system and show the advantages of non-contact examination of suspicious skin lesions compared to the state-of-the-art. As an example for the optimization of the system, a light source with tunable color temperature is demonstrated. The dermatoscope system presented is an important step towards automated detection of skin diseases in future.

1 Introduction

Over the last decades, the number of incidences of skin cancer in Germany has raised significantly, in particular also those for the deadliest form of skin cancer, the malignant melanoma [1]. This results in an increased burden for the dermatologists. To improve this situation, advanced imaging systems with enhanced functionalities to facilitate skin cancer diagnosis are required. To date, suspicious lesions are identified via epiluminescence microscopy, the so-called dermoscopy, and by using scoring systems for optical features such as the ABCD rule. As the skin contact of conventional dermatoscopes leads to unfavorable effects (see Section 3) and cannot be used for automatized screening, we developed a non-contact system with additional features such as tunable color temperature of the illumination.

2 Prototype of a non-contact dermatoscope

Fig. 1 shows the prototype of the non-contact dermatoscope system. It consists of an LED light source with tunable color temperature and a lens system which illuminates the target area (the skin) homogeneously. Cross-polarization is realized to minimize surface reflections. The camera unit detects the light from the target and the images recorded can subsequently be post-processed by a personal computer. The LED light source is realized by a remote phosphor setup which is explained in Section 4. A benefit of this setup is that the color correlated temperature (CCT) of the light source can be changed. If the CCT is high, the blue proportion of the spectrum is larger compared to the red proportion. In turn, if the CCT is lower, the red proportion is larger.

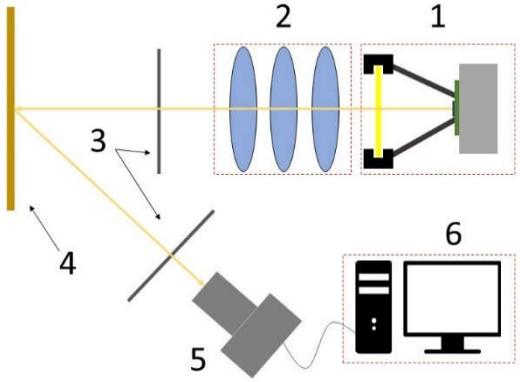

Fig. 1 *1: LED-Light source; 2: Lens system; 3: Polarizers; 4: Target (skin); 5: CCD-Camera unit; 6: Digital image processing*

3 Contact versus non-contact systems

As can be seen from Tab. 1, non-contact dermatoscope systems offer several advantages compared to contact systems, the latter being state-of-the-art technology. For example, contact dermatoscopes often use white LEDs with a high color temperature resulting in unnatural colors. Also, those illumination systems are not optimized for different tissue parts and structures of interest to the dermatologists. Therefore, we constructed an LED source with variable CCT to investigate the optimal light scenario for different diseases and skin types.

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Contact dermatoscope	Non-contact dermatoscope
+ Established	- Not yet established
+ Digitally available images	+ Digitally available images
- May distort geometry	+ No distortion of geometry
- Possibly painful	+ No pain
- Unnatural colors	+ Natural colors
- Small field of view	+ Large field of view

Tab. 1 *Comparison of contact and non-contact dermatoscope systems.*

4 Remote Phosphor LED white light source

LED-based white light sources usually consist of a blue LED-chip which is coated with a fluorescent phosphor such as YAG:Ce (Cerium(III)-doped Yttrium aluminium garnet). The phosphor layer is absorbing the blue light from the LED and converts it to light in the yellow spectral range. The resulting white spectrum depends on the specific phosphor composition.

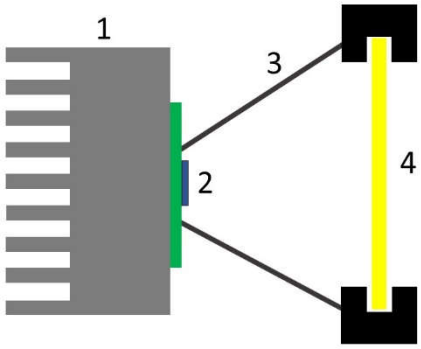

Fig. 2 *1: Aluminium radiator; 2: LED chip; 3: Reflector; 4: Phosphor plate;*

In our system, we use a remote phosphor setup as shown in Fig. 2. In this setup the phosphor and the LED-chip are spatially separated from each other. This allows an easy exchange of the phosphor and, therefore, also an easy variation of the generated spectrum. Furthermore, it enables to test different light sources optimized for different skin diseases in clinical studies.

5 Advantages of a tunable color temperature

For digital image processing algorithms, it is possible to use the different color channels of the CCD camera. For example, it is advantageous to compare the green and the red color channels in order to enhance the blood contrast in a recorded image. If the illuminating spectrum is tuned the signal intensity on the different color channels can be varied, as seen in Fig. 3. This enhances the contrast in the resulting image [2].

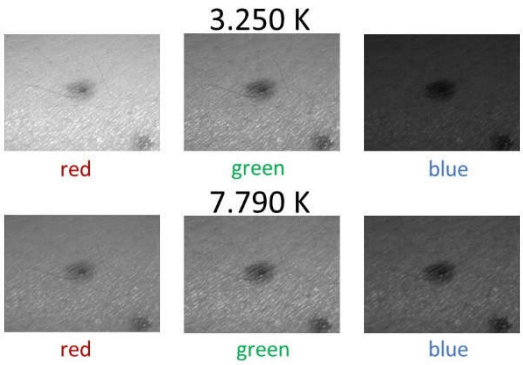

Fig. 3 *Contrast enhancement by choice of appropriate color temperature for the illumination. Images show the three colour cannels of two pictures of the same skin region with a naevus in the centre. Top row: illumination at 3.250 K CCT. Bottom row: illumination at 7.790 K CCT.*

6 Outlook

In this work we present a non-contact dermatoscope which features significant advantages compared to state-of-the-art contact dermatoscopes. It facilitates automatized imaging of patients. Our remote phosohor system allows to easily tune the spectral composition of the light source in order to investigate optimal illumination for different skin diseases and image processing algorithms. In the future, the system aims to automatically scan the skin of patients and perform a skin cancer risk assessment based on parameters such as the ABCD-rule. Thus, it will provide an additional diagnostic support for dermatologists. We also intend to use the polarized light to increase skin structural information at a later stage.

7 Acknowlegement

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