Handheld Multispectral Imaging Device Designed to Aid Skin Cancer Detection

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Dermoscopy is an instrument-aided procedure used for the examination of skin lesions with the help of a dermatoscope with relatively wide field-of-view and high resolution. Digital dermoscopy also includes image processing techniques where a specialized digital camera allows a digital record and analysis of the structures. The most commonly use of digital dermoscopy is for early stage melanoma detection. In this project, we develop a prototype of a new generation digital dermoscopy device which is based on multispectral imaging technology.

CSEM multispectral imaging strategy is to provide application-specific solutions from both a hardware and software perspective. This strategy contrasts with general purpose hyperspectral imaging. The advantage of dedicated solutions is that they are optimized in many aspects such as data rate, physical size, accuracy and cost. To this end, CSEM provides multispectral imaging systems with diverse technologies such as spectral filtering on the image sensor or using multispectral illumination.

The SpectroX system combines multispectral imaging and deep learning in order to provide instant predictions about the risks of the underlying skin conditions. During a pre-study phase, the suitable specifications for the dermoscopy application, such as the central wavelength and bandwidth of the spectral bands, spatial resolution, field of view, cube acquisition rate and so on have been obtained (Table 1).

Table 1: Specifications of the multispectral imaging device.

Characteristic	Value
Number of spectral bands	14
Wavelength range (nm)	400 – 970
Spatial resolution (pixel)	1096 x 1096
Field of view (mm)	20 x 20
RGB display frame rate (1/s)	16
Total cube acquisition duration (s)	2.0
Camera interface	USB 3.0

Based on these investigations, a multispectral imaging device has been designed and implemented using the multispectral illumination strategy. The device is constructed using off-the-shelf components in order to optimize the cost and delivery time and then packaged using 3D printing technology (Figure 1).

Figure 1: Two views of the SpectroX device designed and produced by CSEM.

Once the camera is on, a color image of the target is displayed in the software. After pointing at the region of interest, by pressing the button on the device, a multispectral image of this region will be saved on the computer. The design is centered around ease-of-use for medical doctors and also potentially for general public in the future. It has a single USB 3.0 connection for both power delivery and data transfer and a single button to trigger the acquisition. Some sample slices of an acquired multispectral hypercube are shown in Figure 2.

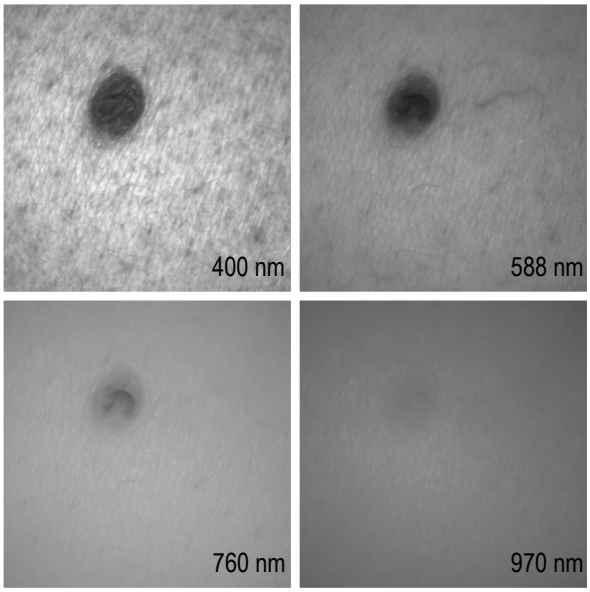

Figure 2: Samples of taken images at 400 nm, 588 nm, 760 nm and 970 nm, respectively from top-left to bottom-right.

In combination with deep learning algorithms, this system is expected to be able to detect melanoma and other skin cancer conditions (like basal cell carcinoma) much earlier than existing dermoscopy systems. Such early stage diagnosis increases the success rate of the treatment, reduce the medical and insurance costs, providing a benefit for the society as a whole (it is known that skin cancer can be an aggressive metastatic form of cancer).

Thanks to these innovative features, SpectroX system expected to be able to penetrate the market since (i) it will be more effective and accurate than current systems, (ii) it minimizes the need for repeated examinations, saving time and costs and (iii) it can be scaled as a screening device by non-experts for the massive examination of a larger portion of the population. By enabling digital dermoscopy for consumer applications out of the close-boundaries of skin healthcare professionals, a new market will be created [1].

[1] S. Blanc, P. Pad, L. A. Dunbar, "A fast, simple to use and inexpensive multispectral camera to detect skin conditions", submitted to conference on Photonic Instrumentation Engineering VII, part of SPIE OPTO (2020).