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Smartphone-Based Hyperspectral Imaging - Low-Cost Application for Telemedicine

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Abstract. In this paper we outline a cost-effective design for the improvement of telemedicine applications through a two components concept. A normal smartphone is equipped with a small device containing different filter options, which provide particular spectral information for the identification of skin lesions. By merging the measured spectra, a higher data density and more information can be obtained using an ANN to improve an early diagnosis of skin lesions through telemedicine applications in remote areas.

Keywords. telemedicine, artificial intelligence, hyper spectral imaging, smartphone-based application

1. Introduction

Telemedicine allows virtual contact with medical staff or AI-based interpretation of input data. Its benefit is to make medical care independent of location and care options with a local separation between patient and medical staff [2]. In this regard, smartphone-based applications have proven to be highly useful in the area of early detection of diseases and quantitative monitoring after treatments. Furthermore, multi- and hyperspectral imaging has great potential in digital pathology, diagnosis and disease detection [3]. Spectral information, as opposed to RGB imaging, is better suited for detecting different biological compositions [4]. Combined with a suitable artificial neural network (ANN) it can achieve better results in the classification of skin lesions [5].

2. Novelty and Contributions, potential application and design

The envisaged system integrates hyperspectral imaging with low-cost hardware and an AI algorithm to improve continuous monitoring and enable a higher standard in economically depressed and remote areas. In [4] the operability of the working principle has already been demonstrated. A modular hardware is intended to be attached to the smartphone, which is used to record certain spectral information in the form of specific wavelengths. This allows special color information about skin lesions to be generated, which is usually lost due to the low spectral resolution and low versatility of RGB images [4]. The spectral information is then combined into a spectral image cube. An ANN (e.g. similar to the Yolov5 in [5]) can then be used to classify the content of the acquired

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spectral images. The envisaged system consists of a mountable device (cf. Figure 1), which can be put in front of the rear camera of most new-generation smartphones. Users are guided via app to take color photos with different filters and at monitored light conditions to maintain high image quality. An AI-based algorithm then uses the captured images to classify skin lesions of interest into different categories, based on which a physician can make treatment recommendations. The collected patient data is managed securely and will be provided to medical professionals via digital platforms.

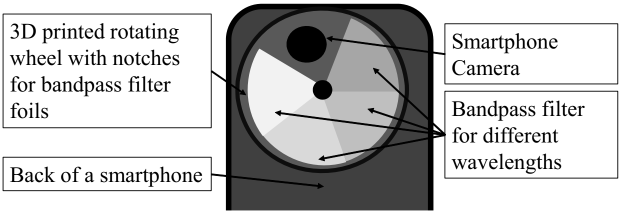

Figure 1. Illustration of the mountable device.

3. Conclusion, expected results and challenges that need to be overcome

Particularly in times of physician shortage in rural regions, mobile, cost-effective and user-friendly systems contribute to substantially improve medical care. Our envisaged system could help to classify skin lesions at an early stage and thus achieve sustainable savings in treatment and care. By generating a spectral image cube from different wavelengths on the basis of smartphone hardware in a cost-effective manner, more versatile spectral information on skin lesions can be generated. In addition, the use of this image data in the context of an ANN can improve the classification and thus the predictability of skin lesions in their early stages. Potential challenges in the context of our project include illumination of the skin lesion of interest, especially for different skin tones. Secondly, the great variability of the designs and CMOS sensors of smartphones may also pose an obstacle.

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