Design of a Mobile Imaging System for Early Diagnosis of Skin Cancer

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***Abstract*— This project aims to research a mobile imaging system for early diagnosis of skin cancer. Our system computes visual features from a user-captured skin lesion image, and analyzes them to estimate the likelihood of malignancy, using an off-the-shelf smartphone. We investigate new resource-constrained image analysis algorithms and user-friendly software design for this application. Our research advances knowledge concerning best design practices for disease diagnosis systems using smartphones and imaging algorithms.**

I. Background

Increasingly, mobile phones are equipped with multi-core CPUs and high resolution image sensors. All this creates the opportunity to use a mobile phone to analyze a captured image for disease diagnosis and self-screening. In this project, we research a novel mobile imaging application for early detection of skin cancer (Fig. 1(a)).

Skin cancer is one of the most common cancers in Caucasians [1]. In Australia, 1 in 17 will be diagnosed with skin cancer. It is also one the fastest growing cancers globally, with steadily increasing incidence over the past 30 years. In Singapore, there is a trend towards more advanced disease staging at presentation due to lack of patients' awareness and delayed or missed diagnosis by primary care physicians [2]. There is a pressing need for an accessible and accurate prescreening solution to improve the general awareness.

II. Methodology

Our project focuses on two main areas. First, we research image processing and analysis techniques to compute the morphological and chromatic features in the skin lesion image captured by the phone. Based on these features, our system mathematically estimates the likelihood of skin cancer. Our research advances state-of-the-art and proposes new low-complexity image analysis algorithms suitable for power-constrained mobile devices. Specifically, we develop low-CPU-usage, low-memory-footprint image segmentation to localize the skin lesion region. We compute novel visual features useful for skin cancer diagnosis, namely shape asymmetry, border irregularity, color variation and texture characteristics of the lesion (Fig. 1(b)). Using these features, we perform support vector machine (SVM) based classification to estimate the malignancy.

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Secondly, as many skin cancer patients are elderly, we research user-friendly mobile software design for this application in older individuals, who may have visual, physical and cognitive issues. Our research applies the principle of User-Centered Design [3] to identify and address the needs, expectations and limitations of older users. We investigate various topics relevant to mobile app usability for the elderly, ranging from multi-modal feedback, gesture limitation to augmented functionalities. As an example, we propose a novel image CAPTCHA technology to facilitate the use of our system in older patients.

III. Results and Conclusion

We have obtained promising preliminary results based on a dataset provided by NSC: 80% sensitivity, 77% specificity. Details of the system design, the experiment setup and a prototype running on an Android smartphone will be shown in the poster session.

Our project combines computation, biology, design, medical science and healthcare research expertise. Our holistic and inter-disciplinary approach is crucial for this important healthcare problem. Our work also advances knowledge concerning best design practices for mobile diagnosis systems potentially applicable to other diseases.

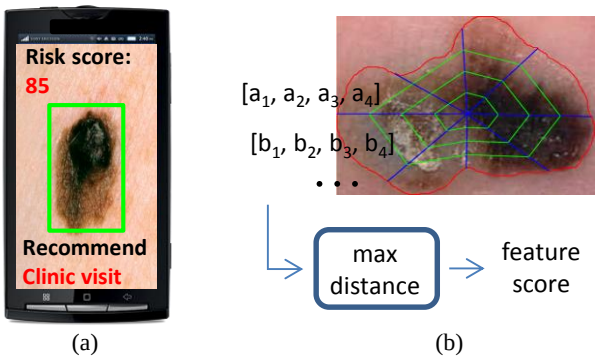

Figure 1. (a) Mobile imaging system for early diagnosis of skin cancer running on an off-the-shelf Android smartphone. (b) Our proposed feature to quantify color variation of a skin lesion.

References

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