NSF Proposal: A Healthcare Setting for Early Stage Skin Cancer and Skin Disease Diagnosis

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A Healthcare Setting for Early Stage Skin Cancer and Skin Disease Diagnosis

I. PROJECT SUMMARY

Skin cancer is the most common form of cancer in United States. In 2012, there are 5.4 million cases of nonmelanoma skin cancer, including basal cell carcinoma and squamous cell carcinoma, diagnosed in 3.3 million people in the United States. Melanoma, the deadliest skin cancer, attributes more than 9000 deaths in America in 2015. On average, one American dies from melanoma every hour. The number of new cases of skin cancer is fast increasing. Researchers estimates that nearly 20% of Americans will develop a skin cancer in their lifetime.

![Incidence of malignant melanoma and other skin cancer](image1)

**Figure 1:** Incident of malignant and other skin cancer.

Early-stage skin disease diagnosis is the most important and efficient way of preventing skin cancer. Research shows that 98% of people achieved a five-year survival rate if melanoma is detected and treated before it spreads to the lymph nodes. Another two most common forms of skin cancer, basal cell and squamous cell carcinomas are highly curable when they are found and treated in early-stage. Each year $8.1 billion are spent in the US to treat skin cancer. While, less than 15% of cancer funding goes to early-stage detection and screening.

![Cost of Cancer Care by Phase of Care, Melanoma, All Ages, Male and Female, in 2010 Dollars](image2)

**Figure 2:** Cost of care by phase of care.

The American Academy of Dermatology encourages people to perform self-exams to check for signs of skin cancer and get a skin exam from a doctor. However, early-stage skin disease detection and screening in clinic is inconvenient and costly. In most of the cases, it is not always possible for people to go to hospital for their early-stage skin disease that seems not a big problem. Even if they go to a hospital, the traditional screening process is often costly and time consuming. Besides, even the most trained human professionals are not able to give an accurate and fast diagnosis.
The goal of this project is to design a handy healthcare setting for early-stage skin disease diagnosis. With the help of smart camera and using computer vision and machine learning technologies, this project aims to assist patients completing their own diagnosis at home. This computer aided healthcare setting will provide both patients and doctors useful diagnosis information to guide later treatment. By using big data technology, the project will link patients’ diagnosis results with their personal healthcare history and nearby dermatology hospitals which will help patients to get a better and in time treatment.

II. PROJECT DESCRIPTION

Research Plan

This project is completed in the following phases.

1. Collect labeled skin images for a variety of skin disease.

Our goal is to do diagnosis for basically most of the major skin diseases. This will require us to obtain a variety of skin disease images. Based on preliminary research, there are currently three image datasets: DermNet, DermWeb and OLE. These datasets contains more than 30,000 images for 23 classes skin diseases. However, due to their disparity and most of the images are not labeled very well, we need human professions’ help for labeling. We may also need some skin disease images from hospitals if the current resources is not enough for certain type of skin disease.

![Figure 3: Sample images from datasets OLE.](image)

2. Design a skin disease classification system using computer vision and machine learning technologies.

Computer vision and machine learning has a wide-range of applications on medical imaging. In years of development, some computer vision and machine learning theories become mature in several areas, e.g retina imaging, and yields lots of excellent research results. However, the research on skin disease classification is still on going. The human skin is complex. skin texture may varies depend on body location, subject’s age and gender, lighting and camera, which makes it very hard to do skin recognition. In terms of the skin disease, current researches are usually focusing on one or several skin diseases. The approach of a broader range of skin diseases has only done by very few researchers. In this project, an innovative solution will be presented for multiclass skin disease classification. First, several state-of-art skin texture feature extraction and skin image segmentation algorithms will be proposed and implemented. Second, a series of advanced object classification algorithms (CNN, AdaBoost, BayesNet, J48, MLP, NaiveBayes) will be test and implemented. We will choose the best classifier from these classification algorithms.

3. Build a healthcare setting for skin disease detection and screening.

This project wants to provide the most convenient way for early-stage skin disease diagnosis. The goal is to help patient complete the skin disease screening at home and get the needed medical service immediately. The healthcare setting consists of two products and one service. First, a skin disease scanner will be designed. The scanner has a smart camera with an embedded skin disease classifier system. It can diagnosis the skin diseases in seconds. This scanner an be used by both the patient and the doctor. Second, a mobile app will also be designed. The app will make use of the smart phone’s camera and do the diagnosis the same way as the scanner. However, a mobile app will increase the availability of the healthcare setting. Third, healthcare info center will be set up. This info center uses big data technologies to collect dermatology hospital and doctor information from...
Internet and provide suggestions to patient's diagnosis. Patient can use the scanner or the mobile app to access the suggestions.

4. Test the healthcare setting on patients and compare its performance with human professionals.

A series of experiments will be conducted to test the performance of the healthcare setting. Since the skin disease classification will mainly be conducted based on existing dataset on-line, this step is crucial. Besides, several comparison experiments will also be performed. It would be very valuable if the healthcare setting can achieve similar or better performance than human professionals.

**Required resources**

1. **Buy skin disease images**
   
   As mentioned above, if the existing datasets on-line don't satisfy the requirement of the classifier system. It is required to buy skin disease images from other sources, such as hospital.

2. **Buy required software resources for App development**
   
   The mobile app may require the developer to obtain a license for development and publish.

3. **Hire patients and human professionals for experiments**
   
   To perform the experiments for the healthcare setting, it is necessary to have enough funding for hiring the participants.

**References**


