DermFollow: Better Diagnosis & Treatment of Skin Cancer

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Introduction

- The curability of skin cancer is as high as **92%** [1] if the cancer is detected **early**.
- Current standard-of-care for diagnosis is **in-person care** in a dermatologist's office.
- Results in **unmonitored growth** of potentially cancerous lesions over time.
- **DermFollow** allows patients to upload pictures of skin lesions over time using their smartphone or computer outside the clinic.
- The system uses knowledge learned from several thousand images via **deep residual and convolutional neural networks** to compute risk assessment of uploaded images for physician.
- The application also presents most **similar images** to provide a useful explanation to the doctor.

Approach

- An intuitive and easy to use **web app** with separate patient (Fig. 1) and provider (Figs. 2, 3, 4, 5) interfaces (built with **Ruby on Rails, Python, Bootstrap, d3, AWS**).
- Interactive user interface uses **d3** to allow provider to see **lesion images superimposed on patient body** in 2D space (Fig. 3).
- Model: Ensemble of **VGG-16** [2], **Inception** [3], **ResNet** [4].
- VGG-16 and Inception models fine-tuned (**Tensorflow**).
- ResNet trained from scratch over 2-day period (**Caffe**).
- Training images **augmented 50-fold** by series of scale transformations, blurs & rotations.
- Dynamically (over time) compute **risk score for patient** based on:
  - Model analysis of patient images
  - Patient demographics/medical history

Data

- Training data: **~3400 high-res dermoscopic images (~9GB)** of benign and malignant skin lesions from the International Skin Imaging Collaboration Archive [5].
- Images had **100% histological (microscopic) verification** of benign/malignant.
- Augmented training data to **169k images** through transformations.
- Initially explored data through feature extraction (asymmetry, border irregularity, color variation, diameter).

Experiment/Results

- Model: Accuracy of **89.1% in binary classification** (benign/malignant) for **10-fold cross validation** from ensemble.
- User studies: **12 patients** and **1 physician** tested application.
- Participants filled out post-experiment Likert-scale (1-5) surveys.
- Mean patient rating of **4.50** on usability, **4.4** on improvement of care, and **4** on raising awareness of health (5 pt scale).

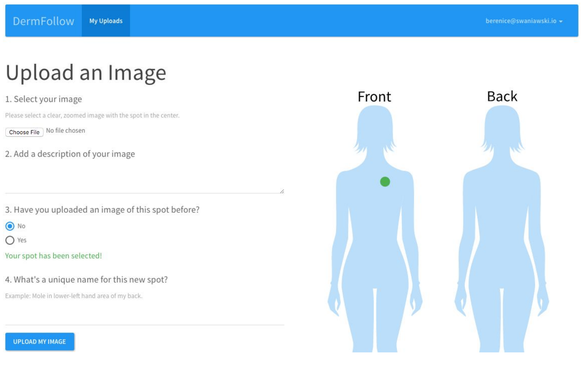

Figure 1. Patient interface. The patient can easily upload images for his/her physician, selecting the location of the skin lesion on an interactive body map.

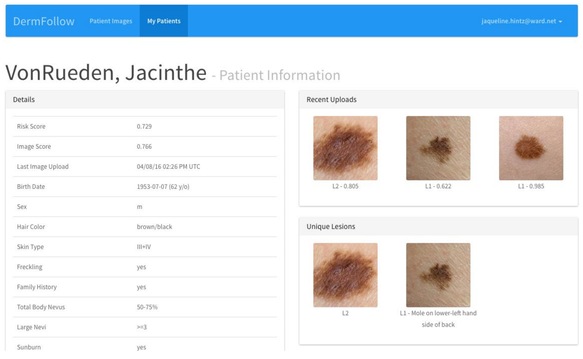

Figure 2. A page for each patient, which is viewable only by the patient's provider, shows the risk score, information about the patient, and the images of various lesion groups.

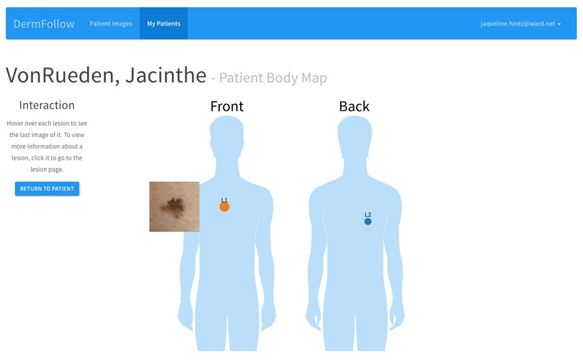

Figure 3. Body map feature which allows interaction with patient images and lesions superimposed on a 2D body.

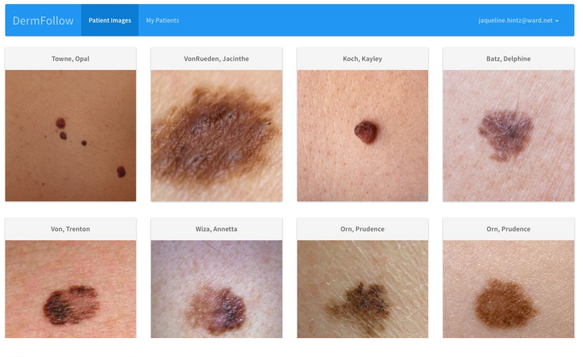

Figure 4. A provider can easily see all uploads from his/her patients.

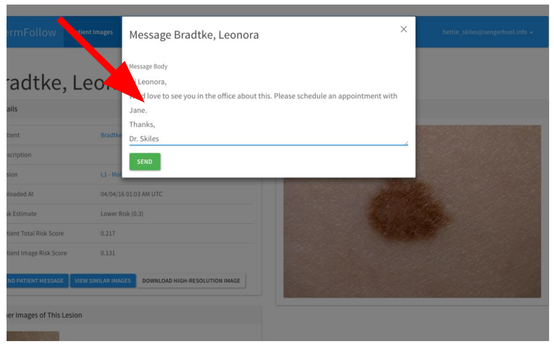

Figure 5. The provider can easily send the patient a message regarding their image.

Bibliography

[1] P. G. B. e. a. U. Leiter. Prognostic factors of thin cutaneous melanoma: an analysis of the central malignant melanoma registry of the german dermatological society. Journal of Clinical Oncology, 2004.

[2] K. Simonyan and A. Zisserman. Very deep convolutional networks for large-scale image recognition. arXiv preprint arXiv:1409.1556, 2014.

[3] C. Szegedy, W. Liu, Y. Jia, P. Sermanet, S. Reed, D. Anguelov, D. Erhan, V. Vanhoucke, and A. Rabinovich. Going deeper with convolutions. In CVPR 2015, 2015

[4] K. He, X. Zhang, S. Ren, and J. Sun. Deep residual learning for image recognition. CoRR, abs/1512.03385, 2015.

[5] https://isic-archive.com/