Dermatological Tool for Automatically Identifying Skin Cancer

Problem Description

With more than 85,000 cases recorded each year, skin cancer affects 1 in every 6 Canadians [1]. One of the most fatal type of skin cancer is Melanoma that has 7200 reported cases in 2017, 1250 of which resulted in death [2]. Melanoma can extend deep into the body, having the potential to spread to more organs. People with light skin tone and blue eyes, genetic history of melanoma, excessive moles (~50), and who have had frequent Ultraviolet (UV) exposure are found to have a higher risk for developing melanoma. A key factor in improving survival rates of melanoma is early detection. Despite being one of the most fatal types of skin cancer, melanoma is primarily diagnosed visually using features such as mole asymmetry, lesion border irregularity, color, diameter and whether the lesion is evolving. This approach of diagnosis is problematic as monitoring skin lesions isn't always easy because some melanoma lesions are of a similar color to the surrounding skin, and some lesions don't express the abnormalities to the extent of most melanoma lesions. Therefore, this project focuses on building an automatic skin cancer detection tool which will aid the general public in examining skin lesions.

Design Solution

The proposed solution is an intelligent, point-of-care (PoC) mobile application that can examine skin lesions. A mobile application is ideal since most of the population has smartphones and having an application would allow users to monitor their lesions at home; hence, allowing the early detection of malignant lesions. The mobile application prompts users to capture a photo of their lesions. Once the user is content with the captured photo, the image is classified as benign or malignant and the results are displayed on the screen. The app uses machine learning and pattern detection to classify lesions as either benign or malignant. The machine learning classifier is trained on the International Skin Imaging Collaboration (ISIC) dataset. ISIC is an open source and publicly accessible archive of skin lesion images. The dataset includes 1000 images of each condition. A convolutional neural network (CNN) has been used for pattern detection and image classification. The activation function used with this model is a SoftMax function which fundamentally intakes inputs and outputs probabilities of each input with respect to the others. We implemented the classifier using transfer learning by fine-tuning the MobileNet architecture. Single-Fold validation technique was used for validation with a data split of train (70%), validate (15%), and test (15%). The model was trained using a GPU on Google's free cloud service for developers, Google Colab. The mobile application operates on Android and Android Studio is to build the prototype. The app is hosted on Firebase and published on Google Play Store. As the audience is the general public, special attention was given to proper user experience design to ensure the application is simple and intuitive.

Application

The classifier was trained over 10 epochs to obtain a final testing accuracy of 97% with a loss 0.056. The initial loss obtained from the training set starts at 0.2904 and it decreases to 0.0424 over 10 epochs, and the training accuracy increased from 89% to 99%. The accuracy and loss graphs obtained from the validation set follow a similar trend as the training accuracy and loss graphs. The validation accuracy started at 88% and increased to 97% , while the loss started at 0.6918 and decreased to 0.0564. The classifier was further verified on a test data set for which it obtained an accuracy of 97% and a loss of 0.056. This further expresses the generalization of the classifier which obtained similar results on the train, validation and test data sets. Figure 1 below shows the complete flow of the application.

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Figure 1: Complete app flow starting from splash screen and ending with an About Us page.

Implementation

The mobile application is currently deployed on Google Play store and is available to all android users. Furthermore, the app can be improved through the following means to improve the user experience and performance. The addition of an archive will allow the user to store the history of the lesions being monitored. An option for creating a detailed analysis of the lesion and results could be provided which the user can share with his/her physician via email. The machine learning classifier can be improved by augmenting the data used for training. The inclusion of augmented data will account for variations in the images taken through a mobile such as poor resolution, low brightness and contrast, and position translation of the image. The addition of a negative class in the classifier will allow the app to identify a skin lesion before performing analysis. These changes will improve the current working prototype by ensuring the results are correct by taking possible discrepancies into account and providing the user with a pleasant experience.

References:

[1] "About Skin Cancer", Canadian Skin Cancer Foundation, 2018. [Online].Available: http://www.canadianskincancerfoundation.com/about-skin-cancer.html.

[2] "Melanoma skin cancer statistics - Canadian Cancer Society", www.cancer.ca,2018.[Online].Available: http://www.cancer.ca/en/cancerin Formation/cancertype/skinmelanoma/statistics/