[Industry-project] Medical Image Recognition

Project Plan

October 3, 2021
1 Background

Keloid is a skin condition involving a scar that is enlarged, firm and raised. A typical scar might be formed on the skin after a skin injury. For a keloid to be developed, the healing process of the skin does not stop and it continues to create additional scar tissue, growing past the borders of the injured skin area into the surrounding normal skin. Compared with a normal scar, keloids can be much larger than the original area of injury. It is also different from hypertrophic scars, another type of scars, which also look similar to keloid with a raised shape but the growth is limited on the damaged skin [1].

An estimated 10% of people with scars experience keloid scarring. Common types of skin injury that could cause keloid scarring includes scratches, acne scars, burns, vaccination sites or surgical incision sites. The most common places for keloid are on the chest, cheeks, shoulder and earlobes, and it can appear on any part of the body. Patients of keloids are usually in their teens and 20s, although it can happen at any age group. Keloids are also more commonly found in patients with darker skin tones or of Asian or Latino descent [2].

2 Motivation

Scarring is a world-wide issue. In developing countries, 100 million new cases happen with scars each year. It is reported that the African population is most prone to keloids, with 6–16% of the population affected. People with darker skin tones or of Asian or Latino descent are more vulnerable to keloids. After an injury, Asian skin tends to have scar formation than Caucasians, although still lower than African and more investigations are required [3].

Although keloids only occur in the skin and do not spread into the body, meaning that they are not cancerous [1], keloids are still undesirable conditions due to its major aesthetic disturbance. The negative effects of keloids are closely related to emotional and financial burden [3]. In addition, some patients may experience itching, pain or soreness when touched. In more serious cases, keloids can become so irritated that they appear to be infected with drainage [1].

Since the mechanism behind excessive scarring is still not well known, there is no ideal way to cure keloids after its maturation. Therefore, early medical interventions on scars are important to its treatment. Early intervention such as treatments and controls at the beginning of scarring could decrease the chance of worsening, hinder scar growth and improve the skin appearance and symptoms. Therefore, objective and reliable methods on scar assessments is one of the focused clinical areas of keloids [4].
Early intervention of scars would require accurate early detection of it on different individuals. The typical identification and diagnosis of keloids are usually by conducting clinical examinations, which is time-consuming. It also requires well-trained dermatologists for accurate diagnosis [4], which is currently the only way for scar classification. Easier and more convenient identification of keloid patients via an automatic keloid analysis system would allow more patients to be identified in a more convenient, quicker and cost-effective way. Such an image analysis system would mean, to many potential patients, more accessible keloid pre-screening, faster diagnosis and the possibility of early prevention of keloids.

3 Previous Work

One research conducted by Pan et al. identified drug compounds for keloids and hypertrophic scars using machine learning techniques such as text mining and DeepPurpose, a deep learning library for drug-target interaction prediction. The study investigated new drug therapies for keloids and hypertrophic scars by machine learning methods.

There was also previous research on skin image related machine learning applications. One instance conducted by Chang worked on image recognition of skin cancer based on deep learning techniques. This involved a segmentation neural network and a deep neural network based on Google inception v3 network. This design could achieve a high level accuracy for skin lesion segmentation and melanoma diagnosis. Another instance also worked on machine learning for skin cancer image classification, which implemented a convolutional neural network applying three neural network architectures (InceptionV3, VGG19, and ResNet) inputting a range of parameters. More than 24,000 skin cancer images were analysed and highly acceptable results were reported. The classification for whether the skin cancer image belonged to benign or malignant was having a diagnostic accuracy of about 86.90% [7]. A research by Soliman et al. implemented an image classification of 4 types of skin conditions including Eczema, Melanoma, Psoriasis and healthy skin with a pretrained convolutional neural network and multiclass support vector machine. It claimed an accuracy rate of 100% with a set of 100 skin images [4].

4 Objective

The goal of the project is to create a model, that takes a single image of a suspected patient, to perform clinic examination. The overall objectives are as follow:

- The initial goal of this project is to detect whether a keloid exists.
- The intermediate goal is to perform image segmentation on the existing keloid.
The ultimate goal is to create a workable web application that can apply the model into real-life situations.

The solution should provide workflow assistance in the clinic that can facilitate the procedure of diagnosis. Therefore, the main focus of the project will be based on two criteria: real-time and accuracy.

We hope that the model will take less than 10 seconds to identify the patient’s situation, including the result whether a keloid exists and a bounding box on the keloid if the keloid exists. This real-time solution will be cost-effective and time-saving on clinical examination.

Second, the solution should provide high sensitivity and high specificity. There should be nearly zero intolerance on false positives and false negatives. As a false positive result may cause unnecessary worry or even panic to the patients, and a false negative result may lead to a miss of the early diagnosis, which is of great significance in the treatment of keloid.

5 Methodology

5.1 Data Pre-processing

Our project will be cooperated with a specialised surgeon. Therefore, we will have access to clinical data for the model training. The data will be a single RGB image of a patient’s skin. However, the data collected will be raw data. Pre-processing will be done on the image before training the model.
As graph 1 presented, we will go through 3 steps:
First, we will use a Generative Adversarial Network (GAN) to create more data for our model. GAN is a machine learning framework suggested by Ian J. Goodfellow [goodfellow2014]. The framework is divided into two parts: the discriminator and the generator. The two parts are trained for competing with each other. The generator is trying to produce a fake image that is as truthful as the original image. Discriminator is acting as a detective to find out any fake image. The purpose of GAN is to create more data for the model.

Second, we will perform augmentation on the image. Augmentation is a technique that creates a new copy of the original data by a slight modification. Simple augmentation including rotation, transformation, cropping and random erasing. The advantage of augmentation is that it can reduce overfitting.

Third, we plan to perform edge detection on the image. Edge detection is a technique that extracts the outline of the image. By looking at the edge image, one can identify the structure and features of the image. After doing edge detection, the output will be a grayscale image. This could be good for the model as it reduces the necessity of lighting requirements when taking the image. However, the color information will be lost which may affect the result of the model.

5.2 Model Selection & Training

![Diagram of model selection and training process]

After doing the pre-processing of the raw image, the data will be used for model training. Deep Neural Network (DNN) will be used. The output of the DNN will be a boolean value that is either true or false. True indicates there is a keloid existing in the image, and vice versa.
The image of the true result will then go through another model that performs image segmentation.

5.3 Model Evaluation

Medical image processing requires a strict and high standard of accuracy. We will evaluate the model using the confusion matrix.

Sensitivity and specificity will be evaluated. We hope our model will reach at least 97% for both matrices.

6 Project Schedule and Milestones

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<td>Project Research &amp; Literature Review</td>
<td>Done</td>
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<td>03 Oct 2021</td>
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<td>Data Collection and Preprocessing</td>
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<td>Model training and Evaluation</td>
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7 References


