Anemia Detection using Conjunctiva Images

Manas Satish Bedmutha, Jainish Nileshkumar Chauhan, Siddhant Saoji

I. INTRODUCTION

Anemia is a condition where the blood has insufficient Hemoglobin (Hb) concentration to effectively carry oxygen to all parts of the body. It affects 1.62 billion people globally. Anemia can be detected via Hb level and other data of the patient such as gender, age etc. The only gold standard for testing anemia is through blood tests which are not practically possible at scale. Medically the conjunctiva of the eye acts as a good indicator of the Hb level. With increasing research interest in digital eye images, we aim to develop an automated system that can predict the Hb level as well as classify anemic patients using deep learning. We also aim to validate our findings by visualizing the network attention maps to explain the physical correctness of the model.

II. DATASET

We will be using Eyes-defy-anemia dataset for our task. It is a collection of data from a series of studies, [1], [2] and [3]. This dataset contains 218 images of eyes, in particular conjunctivas, which can be used for research on the diagnosis and estimation of anemia based on the pallor of conjunctiva.

The dataset also contains segmentation masks of conjunctiva and the exposed parts of the sclera and iris. This can be used to study semantic segmentation well. The dataset contains the laboratory standard values of measured Hemoglobin (Hb) levels. It also has other details about patients such as their agem, sex and location (India or Italy).
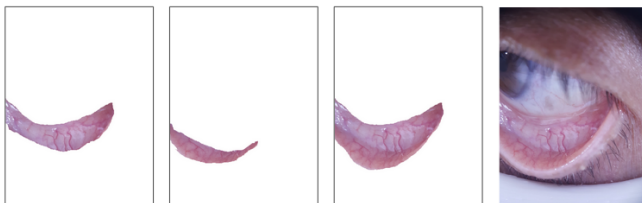

Fig. 1. The figure shows a representative sample from the image. The images are the palpebral, forniceal, total conjunctiva and original image in the left to right order.

For sake of uniformity all of the images were captured with a Samsung S6 smartphone with standardized white LED lighting to eliminate the influence of ambient light. The dataset can be accessed here

III. PROPOSED METHOD

A. Visualization of data

We will first perform exploratory analysis of given data. We will try to visualize the data using different plotting tools and come up with some useful insights related to the data which will help us later in the deep learning model development.

B. Anemia detection

We are planning to use mainly two approaches for the task of anemia detection:

1) Prediction of Hb level from the conjunctiva images using deep learning and then using predicted Hb level and other metadata such as age and gender to detect anemia by rule-based method or ML modes like Random Forest, SVM, XGBoost etc. For the task of Hb level prediction we will first take CNN based pretrained models like VGG or Resnet and fine tune them on our chosen dataset for the regression task. Another approach for Hb level prediction that we are planning to try is using conjunctiva images to train a CNN based model for Semantic Segmentation of different parts of the eye and then try to fine tune that CNN model for the regression task of Hb level prediction.

2) Detection of Anemia using a deep learning framework trained on conjunctiva images as well metadata such as age and gender. Here we are planning to employ a multitask learning approach. We will have Hb level prediction from conjunctiva images as the primary task and prediction of Age and Gender from conjunctiva as the auxiliary task.

We will mainly focus on the first approach but if time permits we will also try out the second approach.

C. Visualize the layer outputs of the model to validate the physical correctness of the model

To understand the physical implication of our model, we want to understand the features that the CNNs are trying to extract to get the classification. We aim to use a gradient class activation map (GradCAM) based saliency visualizations for segmentation. These can help us correlate the network's learning with known physical information and hence, validate and verify our approach.

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