Feature Engineering Approach to Detect Retinal Vein Occlusion Using Ultra-Wide Field Fundus Images

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2023 4th International Conference on Artificial Intelligence and Data Sciences (AiDAS) | 979-8-3503-1843-2/23/$31.00 ©2023 IEEE | DOI: 10.1109/AIDAS60501.2023.10284639

***Abstract*—Retinal Vein Occlusion (RVO) symptoms can be identified through analysis of fundus image capturing the retinal area of an eye. One of the symptoms associated with RVO is haemorrhage lesions due to rapture or damage of blood vessels in the retina. This paper investigates the feature values associated with haemorrhage symptoms in wide-angle fundus images. The feature values are used to construct a classifier to label an image into RVO or non-RVO. A total of 80 feature values are extracted based on various image properties. Four classifiers are built by using the feature vectors to compare their performance. A total of 87 wide-angle images are used in the evaluation. It is found that shape- and colour-based features are useful for separating the RVO images from non-RVO images with a sensitivity of 0.80 and specificity of 0.85. Given the accuracy rate of 0.90, specificity of 0.92, and sensitivity of 0.88 on RVO detection, SVM performed best compared to other classifiers. The traditional feature-based approach can achieve performance levels close to the deep learning approaches using UWF images for haemorrhage prediction.**

Keywords—Ultrawide-field fundus images, Classification, Retinal Vein Occlusion, Feature Engineering

I. INTRODUCTION

Retinal Vein Occlusion (RVO) is a retinal disease caused by a formation of obstruction or blood clot in the retina. RVO is the second most common retinal disease after diabetic retinopathy, and experts claim that over 16 million people are suffering from this disease globally. In Malaysia, it is estimated to affect more than 100000 people [1] and mostly affects people who are 50 years old and above, as well as young people suffering from hypertension, diabetes, and arteriosclerosis [2].

According to the location of the occlusion, RVO can be categorised into Central Retinal Vein Occlusion (CRVO) and Branch Retinal Vein Occlusion (BRVO). Occlusion of the CRVO occurs when there is a blockage at or posterior to the optic nerve head. In contrast, Occlusion of the BRVO occurs when there is a partial or total obstruction of a tributary or branch of the central retinal vein [3]. Ophthalmologists diagnose the RVO based on anomalies more visible in fundus photography. Common signs of CRVO (Central Retinal Vein Occlusion) that are visible in fundus photography are more extensive retinal haemorrhages with dilated and tortuous veins in all quadrants. While in BRVO (Branch Retinal Vein Occlusion), the presence of haemorrhages, cotton wool spots, and dilated and tortuous veins in one or two quadrants are characteristic findings [4]. This retinal disease might cause permanent visual loss; therefore, it is important to diagnose it earlier.

Fundus photography is a visual record that captures the retina, blood vessels, optic disc, and macula using a fundus camera. Fundus photography includes standard and ultra-wide views for diagnosing retinal diseases such as diabetic retinopathy [5] and glaucoma [6]. Traditional fundus photography provides a limited assessment of the posterior pole up to 30 to 50 field of view including macula and optic disc only. The inability to view the far peripheral retina causes anomalies outside the posterior pole and cannot be established accurately. Over time, ultra-widefield fundus imaging by Optos camera is introduced because of its broader field of view. The ultrawide field fundus images can capture an area covering more than 80% of the retinal surface [7].

Automated RVO detection can be broadly divided into two categories of machine learning-based methods and deep learning-based methods [8]. Machine learning is a branch of artificial intelligence that focuses on creating algorithms that are capable of pattern recognition with minimum input [9]. Traditional machine learning techniques need an additional process called feature engineering. Feature engineering is an essential step in the machine learning pipeline to extract features from raw input data with optimal feature selection such as Principal Component Analysis [10].

From prior research, we observed that machine-learning techniques have been applied in retinal disease detection [11], and optic disc and cup segmentation [12]. [13] proposed a Completed Local Binary Pattern (CLBP) feature extraction technique and neural network classification to detect RVO. The study includes image acquisition, preprocessing, feature extraction, and classification. A total of 400 regular fundus images from STARE database were collected for feature extraction, training, and testing. Finally, the ANN classifier

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