# UNIVERSITI TEKNOLOGI MARA

# ROBUST OPTIC DISC LOCALIZATION USING FAST RCNN AND AGGREGATE CHANNEL FEATURES (ACF) WITH GENERATIVE ADVERSARIAL NETWORK (GAN) SYNTHESIZED FUNDUS IMAGE

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# ABSTRACT

Recent advancements in artificial intelligence (AI) hold promise in addressing the challenge of blindness, particularly through accurate and non-invasive early detection of Diabetic Retinopathy (DR). Among the prominent symptoms of DR, exudates play a crucial role. Detecting these symptoms in fundus images is intricate due to the visual resemblance between the optic disc (OD) and exudates. Hence, discerning the OD before detecting exudates bears significance. This study aims to develop OD detection systems using both Deep Learning (DL) and non-deep learning (non-DL) methods. The proposed model was trained and evaluated using various publicly available fundus image datasets, including Kaggle, DIARETDB, DRIMDB, and Messidor. Pre-processing techniques were applied to enhance the image quality, involving color normalization through the Reinhard method, OD labeling, image resizing, and dataset expansion. To ensure the robustness of DL-based techniques, which rely on extensive examples, a Generative Adversarial Network (GAN) based on the Lightweight GAN architecture was introduced to synthesize fundus samples for AI training. Subsequently, the DL model Fast Region-based CNN (Fast RCNN) with transfer learning and the non-DL model, Aggregate Channel Features (ACF), were trained and assessed using the processed and GAN-generated datasets. The trained GAN network proficiently generated high-resolution samples of normal and diseased fundus images. The OD detection achieved an average confidence score above 90% for training, testing, and validation datasets for both methods. Performance evaluation indicated that Fast RCNN exhibited the highest average precision (AP), specifically 80.79%, 84.67%, and 90.22% for the test, validation, and GAN datasets, respectively. Meanwhile, the ACF method achieved AP of 75.3%, 79.1 and 80.12% for the respective datasets. Although Fast RCNN outperformed ACF across all dataset categories, it's worth highlighting that ACF's detector still delivered a commendable performance, with minimum rate of correct detection achieved 75% and maximum of correct detection approximately 90%. These outcomes highlight the effectiveness of the proposed approaches in handling multi-sourced datasets characterized by non-standard colour, illumination, quality, location, and acquisition devices.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 Research Background

According to the World Health Organization, the number of people affected by diabetes mellitus (DM) worldwide is currently 422 million [1]. and this figure is expected to reach 300 million by 2025 [2]. DM is characterized by elevated blood glucose levels and is categorized into two main types: Type 1 diabetes mellitus (T1DM) and Type 2 diabetes mellitus (T2DM), with faulty insulin secretion or action being the primary causes [3].

Patients with DM, particularly T2DM, are at risk of developing diabetic retinopathy (DR), a progressive condition that often shows no early signs of visual impairment and is a leading cause of blindness [4]. In Malaysia, statistics indicate that 36.8% of diabetes patients experience DR [5], and it contributes to 10.4% of blindness in senior individuals, as observed in the National Eye Survey (NESII) [6], compared to 34.6% worldwide [7]. The primary cause of DR lies in the damage to the blood vessels due to diabetes [8]. Among the pathology's characteristic of DR, the presence of exudates is a crucial symptom, representing the initial signs of retinal distortion caused by the leakage of lipids from blood vessels [9].

Retinal fundus images provide essential information regarding the pathological changes associated with local ocular diseases, such as diabetes, hypertension, arteriosclerosis, cardiovascular disease, and stroke [10]. These images are typically captured using a fundus camera [11], also known as a fundoscopy camera [12]. A comprehensive understanding of retinal images is essential for ophthalmologists when evaluating eye conditions such as glaucoma and hypertension. Proper assessment and timely treatment of these conditions are crucial to prevent the risk of blindness and visual impairment [13]. The medical imaging community has been actively involved in developing automated tools to improve the analysis of retinal images [14].

A significant feature in fundus images is the optic disc (OD), a bright, round region from which blood vessels emerge. The OD has a similar brightness and colour range as exudates [15] and is considered a crucial landmark in the human retina's coloured image [16]. Accurate localization of the OD is an essential step in the