# Classification of Eye Diseases Using CNN on Fundus Images


1st M Afif Zain
*School of Computing*
*Telkom University*
Bandung, Indonesia
mafifzainakaenryu@student.telkomuniversity.ac.id

2nd Tjokorda Agung Budi Wirayuda
*School of Computing*
*Telkom University*
Bandung, Indonesia
cokagung@telkomuniversity.ac.id

3rd Febryanti Sthevanie
*School of Computing*
*Telkom University*
Bandung, Indonesia
sthevanie@telkomuniversity.ac.id



***Abstract*— Eye diseases represent a critical global health concern, affecting approximately 2.2 billion individuals with visual impairments or blindness and underscoring the urgent need for accessible screening solutions. Early detection is essential for preventing progressive vision loss; however, limited access to eye care significantly delays timely intervention, as witnessed in Indonesia, where more than 8 million cases of blindness and visual impairment have been reported. Fundus imaging detects abnormalities linked to various eye diseases. This system processes fundus images to classify eye diseases. The author trained models using the labeled ODIR (Ocular Disease Intelligent Recognition) dataset. The author's approach incorporates multi-label classification and preprocessing to improve diagnostic accuracy. The author cropped fundus images to reduce background influence and applied Contrast-limited Adaptive Histogram Equalization (CLAHE) for preprocessing. This study evaluates feature extraction methods, including ResNet152, VGG19, and MobileNetV2, to identify the best-performing backbone for automatic eye disease recognition. The system performance was evaluated using the average value of binary accuracy, micro F1-score, AUC, and Cohen's Kappa. According to the experimental findings, the MobileNetV2 model performed best with an F1 score of 88.05%, an AUC of 87.77%, and a Cohen's Kappa of 44.37% while learning at a rate of 0.001. Fine-tuning this model yielded an F1 score of 87.60%, AUC of 88.65%, and Cohen's Kappa of 44.87%.**



***Keywords*— *Eye Disease Recognition, Fundus Images, Deep Learning, ResNet152, VGG19, MobileNetV2, Classification***


## I. INTRODUCTION

Millions of people worldwide suffer from eye disorders, a serious public health issue. The World Health Organization (WHO) estimates that 2.2 billion people worldwide experience blindness or vision impairment, of which at least 1 billion cases are preventable or untreated [1]. Early detection of eye diseases is crucial to prevent blindness and mitigate severe complications. However, a shortage of ophthalmologists hinders the regular implementation of eye screenings. In Indonesia, the ratio of ophthalmologists to the population is approximately 1:90,743 [2], which is significantly lower than the WHO's recommendation of 1:20,000 [3]. Recent Indonesian data reveal that more than 8 million people experience blindness or visual impairment, highlighting the urgent need for screening solutions tailored to regional contexts [4]. This disparity results in unequal access to eye health services, especially for individuals in remote areas.

Advancements in deep learning technology provide opportunities to develop automated systems for eye disease recognition using fundus images. Fundus imaging captures detailed photographs of the interior surface of the eye, revealing signs of abnormalities associated with various ocular conditions [5]. According to recent studies [6], deep learning algorithms can perform multi-label classification to detect multiple eye diseases simultaneously with high accuracy.

Several deep-learning architectures have been employed in ocular disease diagnosis, including VGG19, MobileNetV2, and ResNet152 [6][7][8]. VGG19, with its deep architecture and strong feature extraction capabilities, remains effective when fine-tuned appropriately, even with limited data availability [6]. The optimal balance between computational efficiency and accuracy is what distinguishes MobileNetV2, rendering it suitable for deployment on devices with restricted computational resources [7]. ResNet152 has proven highly effective in diagnosing retinal diseases, achieving high accuracy in processing ultra-wide-field fundus images [8]. However, a notable gap remains regarding how models with smaller size such as MobileNetV2 can outperform models with deeper layers such as ResNet152 or larger parameter sizes such as VGG19. Specifically, MobileNetV2 is significantly more compact (14 MB), with 3.5 million parameters and a depth of 105 layers, when compared to ResNet152 (232 MB, 60.4 million parameters, 311 layers) and VGG19 (549 MB, 143.7 million parameters, 19 layers) [9]. Further research is required to explore how these differences in size, depth, and parameter counts influence performance in tasks like multi-label eye disease classification.

In this research, the author aim to address these gaps by developing a multi-label eye disease recognition system using the deep learning architectures ResNet152, VGG19, and MobileNetV2 applied to fundus images, with advanced pre-processing techniques such as CLAHE to enhance the visibility of important retinal features. The study compares these designs using metrics such as Accuracy, F1-score, AUC, and Kappa in order to determine which model is better. This comparison seeks to determine which approach yields superior performance for multi-label classification on the Ocular Disease Intelligent Recognition (ODIR) fundus image dataset. Specifically, the research investigates whether superior multi-label eye disease recognition is achieved through deeper architectures, models with a larger number of parameters, or lightweight models optimized for efficiency.

The structure of this document is as follows: Section II offers a thorough analysis of current studies on the use of fundus images to classify multi-label eye disorders. Section III details the methodologies employed, including data preprocessing techniques, model architectures, and performance evaluation metrics. The experimental data are analyzed and the findings are thoroughly discussed in Section IV. Section V wraps up the work and suggests possible avenues for further study and advancement.

## II. LITERATURE SURVEY

In the medical world, accurately and effectively detecting eye illnesses is still a major difficulty. Recent developments