OcuScan: Multi-Disease Detection from Fundus Images

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1. Introduction

This project aims to develop OcuScan, an automated deep learning system for detecting multiple ocular diseases from fundus images. It uses advanced image analysis and patient metadata to improve early diagnosis and support ophthalmologists.

2. Motivation

Ocular diseases like diabetic retinopathy, glaucoma and cataracts affect millions of individuals worldwide often leading to irreversible vision loss if not detected early. Timely diagnosis is essential but frequently delayed due to a shortage of ophthalmologists, particularly in rural and under-resourced areas. To address this critical gap in healthcare accessibility, we are motivated to develop OcuScan, an automated deep learning-based system designed to detect multiple eye diseases from retinal fundus images. This project aims to enhance early screening and assist clinicians by providing accurate, scalable and accessible diagnostic support.

3. Current Line of Thought

3.1 Data Collection

We plan to utilize the ODIR-5K dataset, a publicly available benchmark for multi-label ophthalmic disease classification. The dataset comprises left and right eye fundus images for each patient and the metadata such as age, sex and visual acuity. Each sample is annotated with diagnostic labels for eight ocular conditions making it well-suited for developing and evaluating multi-disease classification models.

3.2 Data Preprocessing

To ensure compatibility with deep learning models and improve training performance, we plan to apply a series of preprocessing steps to both the image and metadata components of the dataset:

- **Image and Label Preparation:** Fundus images are resized, normalized and augmented.The disease labels are multi-hot encoded for multi-label classification.

- **Metadata Processing:** Continuous features (e.g., age) are normalized and categorical ones (e.g., sex) are one-hot encoded for model input.

3.3 Model Construction

- **Model Architecture:** We plan to build a convolutional neural network (CNN) tailored for multi-label classification of fundus images. The architecture may utilize proven backbone networks such as ResNet or EfficientNet to extract robust image features. These will be combined with fully connected layers to integrate patient metadata, enabling the model to leverage both image and clinical data. The final layer will output probabilities for each ocular disease using a sigmoid activation function to support multi-label predictions.

- **Model Training:** The model will be trained on preprocessed images and metadata to learn patterns associated with multiple ocular diseases and improve classification performance through combined visual and patient information.

- **Model Evaluation:** Model performance will be evaluated using metrics appropriate for multi-label problems, including the area under the receiver operating characteristic curve (AUC-ROC), precision, recall, and F1-score for each disease class.

3.4 User Interface

To make OcuScan clinically usable and accessible to non-technical users, we propose to develop a lightweight graphical user interface (GUI) using **Streamlit**, a Python-based framework for deploying interactive machine learning applications.

4. Expected Outcome

The expected outcome of this project is to build an accurate automated system that can detect multiple eye diseases from fundus images using deep learning. The model will be able to identify conditions like diabetic retinopathy, glaucoma and cataracts through multi-label classification. By combining image data with patient information, the system aims to improve diagnosis accuracy. This tool is intended to help ophthalmologists with early detection, especially in areas where specialist access is limited, ultimately supporting better screening and clinical decisions.

5. References

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