DETECTING DIABETIC RETINOPATHY USING DEEP LEARNING

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GitHub Link

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Abstract

- Diabetic Retinopathy (DR) is a serious eye disease that can cause retinal damage and blindness if left undiagnosed and untreated. Traditional DR screening by ophthalmologists is time-consuming.
- The project aims to automate DR detection using Deep Learning (DL) methods, improving efficiency and accessibility.
- Mobile Net, a lightweight deep learning model, is trained on 3,662 high-resolution fundus images from the APTOS dataset hosted on Kaggle.

Keywords: Deep learning, diabetic retinopathy, MobileNet, Graph Neural Network (GNN), Recurrent Neural Network (RNN), fundus images, hybrid models.

Introduction

- Diabetic retinopathy is a leading cause of vision loss, often with devastating consequences. Early detection is crucial for effective treatment, but current methods are resource-intensive. Utilizing deep learning for automated, accurate diagnosis could revolutionize care, making screenings more accessible and timely, ultimately preserving vision for millions worldwide.

PROBLEM STATEMENT

- The early diagnosis of diabetic retinopathy is crucial for effective treatment, but the existing methodologies are not scalable due to their reliance on specialized medical professionals for manual evaluations. There is also a significant lack of accessibility to regular screenings in underprivileged areas, leading to late-stage diagnosis and, often, irreversible vision loss.

OBJECTIVE

- The primary objective of this project is to develop a deep learning model that can accurately identify signs of diabetic retinopathy from retinal images. The goals are:
- 1.To collect a substantial dataset of retinal images, annotated with the stages of diabetic retinopathy.
- 2.To design and train a deep learning model for classification tasks concerning the severity of the condition.
- 3.To evaluate the model's performance in terms of accuracy, sensitivity, and specificity.
- 4.To create a user-friendly interface where medical professionals can upload retinal images for quick analysis.

SCOPE

- The project aims to leverage convolutional neural networks (CNNs), a specialized class of deep learning models, for the automated detection of diabetic retinopathy through image classification tasks. Geographically, while the technology has the potential for global deployment, initial testing will be localized, using data from partnering healthcare centers. The user scope encompasses healthcare providers, notably ophthalmologists and general physicians, and aims to extend as a tool for community health screenings. Starting with publicly available datasets, the project plans to integrate data from local healthcare partners to improve model robustness. The timeline for project completion is set for one year, which includes phases for data collection, model training, and rigorous testing. Through these concerted efforts, the project aspires to significantly advance early detection and effective management of diabetic retinopathy.

PROPOSED METHOD

Our proposed system for Diabetic Retinopathy (DR) screening integrates MobileNet with advanced neural network architectures to enhance detection accuracy and efficiency. The core model, MobileNet, is trained on 3,662 high-resolution fundus images from the APTOS dataset to classify DR into five stages. To further improve performance, we introduce two hybrid models: MobileNet + Graph Neural Network (GNN) to capture complex spatial relationships in retinal images, and MobileNet + Recurrent Neural Network (RNN) to address sequential dependencies and temporal patterns. These hybrids aim to optimize DR classification by leveraging both structural and sequential data insights.

ADVANTAGES:

- Accurate classification
- Less complexity
- High performance
- Easy identification

IMPLEMENTATION

- **Data Collection**
  - **Source Integration:** Gathered retinal images and metadata from multiple sources including Kaggle and public medical databases.
  - **Anonymization:** Ensured all patient data are anonymized for ethical compliance.
  - **Data Storage**: Utilized a secure and compliant data storage system to hold the collected data.
- **Data Preprocessing**
  - **Image Resizing:** Standardized all images to 224x224 pixels.
  - **Normalization:** Scaled pixel values to the range [0, 1].
  - **Label Encoding:** Transformed textual labels ('No DR', 'DR') into numerical values (0, 1).

MODEL IMPLEMENTATION

- **Data Augmentation**
  - **Rotation:** Applied random rotations to images up to 30 degrees.
  - **Zooming:** Incorporated random zooms ranging from 0.8x to 1.2x.
  - **Flipping:** Performed horizontal flipping on images to augment the dataset.
- **Model Training**
  - **Architecture:** Utilized a Convolutional Neural Network (CNN) with multiple layers.
  - **Loss Function:** Employed Binary Cross-Entropy for the loss function.
  - **Optimizer:** Used the Adam optimizer for weight updates.
  - **Training Parameters:** Batch size set at 32, epochs set at 50.

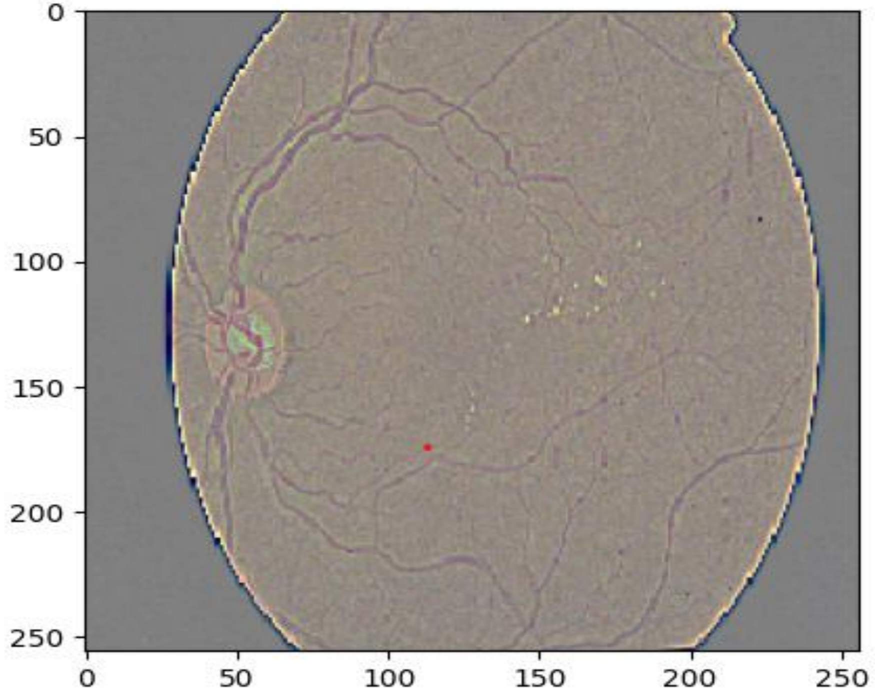
MODEL IMPLEMENTATION

- Hybrid Model: Combines MobileNet's efficient feature extraction with GNNs' relational reasoning to enhance Diabetic Retinopathy (DR) detection.
- Feature Extraction: MobileNet processes high-resolution retinal images, extracting crucial visual features like blood vessels and lesions.
- Graph-Based Analysis: MobileNet's feature maps are converted into graph data, with GNNs capturing complex spatial and contextual relationships between image regions.
- Improved Accuracy: GNNs refine node representations, enhancing DR classification by modeling global patterns and interactions.
- Computational Efficiency: MobileNet's lightweight design ensures feasibility for large datasets, while GNNs efficiently handle graph-based analysis, improving diagnostic accuracy.

MODEL IMPLEMENTATION

- **Hybrid Model:** Integrates MobileNet's efficient feature extraction with RNN's sequential data analysis for improved Diabetic Retinopathy (DR) detection.
- **Spatial Features:** MobileNet uses depthwise separable convolutions to capture detailed visual features from high-resolution retinal images, such as blood vessels and lesions.
- **Temporal Analysis:** RNNs analyze sequences of images over time to track disease progression and detect subtle changes not visible in individual images.
- **Enhanced Accuracy:** The model combines spatial and temporal information, improving DR classification and monitoring disease advancement.
- **Computational Efficiency:** Leverages MobileNet’s lightweight design and RNN’s sequential processing, ensuring efficient and robust DR detection.

Results



Prediction: Moderate

Predicted class: Severe

The image displays two retinal scans with AI predictions; left predicts moderate, right confirms severe classification for diabetic retinopathy.

CONCLUSION

- In conclusion, the application of deep learning in detecting diabetic retinopathy represents a significant advancement in the field of medical diagnostics. This innovative approach has shown promising results in automating the early detection of diabetic retinopathy, thereby enabling timely interventions and reducing the risk of vision loss in diabetic patients. With further refinement and integration into healthcare systems, deep learning models can contribute to more efficient and accessible screening, ultimately improving the quality of life for individuals with diabetes.

REFERENCES

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