Final Report

Digital Image Processing

Semester Project

Name

Muneeb Ur Rehman i210392

Farzeen Qaiser i210782

Section

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Submitted to:

Sir Shahzaib Iqbal

Department of Computer Science BS(CS)

FAST-NUCES Islamabad

Introduction

Glaucoma is a group of eye conditions that damage the optic nerve. It is one of the leading causes of blindness worldwide. Early detection is critical to prevent irreversible vision loss, but the diagnosis of glaucoma is challenging due to its asymptomatic nature in the early stages and the requirement of specialized equipment and expertise. This project aims to develop an automated glaucoma detection system using Convolutional Neural Networks (CNNs) to assist in the early diagnosis of glaucoma by analyzing retinal images.

Methodology

- The project uses the Drishti-GS dataset, an open-source collection containing images of both healthy and glaucomatous eyes. The dataset was accessed via Google Drive.

- Images were loaded from Google Drive directories.
- All images were converted to grayscale to simplify processing.
- Each image was flattened into a 1-dimensional array to be fed into the neural network.

- The input dimension corresponds to the size of the flattened image (256x256 pixels).
- Two fully connected (dense) layers with 1024 neurons each, using the 'tanh' activation function.
- A single neuron with a 'sigmoid' activation function to classify the images as either glaucomatous or healthy.

- The model was compiled using binary cross-entropy loss function and the Stochastic Gradient Descent (SGD) optimizer.
- The model was trained for 2000 epochs.
- The model was trained in batches using the `train_on_batch` method.
- A separate set of 10 images was used for testing, following the same pre-processing steps as the training data.
- The trained model was used to predict the probability of glaucoma in the test images.

Results

- The model was evaluated using a test set of 10 images, consisting of 5 glaucomatous and 5 healthy images
- Sensitivity was calculated to measure the proportion of actual positive cases correctly identified by the model.
- .The training time for 2000 epochs was about 30 minutes, and the prediction time for 10 test images was under 1 second.
- the model correctly predicted all 10 images.
  Accuracy = 10/10 = 100%

- The sensitivity of our modal is calculated below:
  Sensitivity = True Positives / (True Positives + False Negatives) = 5 / (5 + 0) = 100%

Discussion

1) **Analysis of Results:**

- The model demonstrated high accuracy and sensitivity, indicating its effectiveness in detecting glaucoma from retinal images. However, the model's performance could be affected by the quality and variability of the dataset.

2) **Limitations:**

- A larger and more diverse dataset would likely improve the model's generalization capability.

3) **Potential Improvements:**

- Applying techniques like rotation, zoom, and flipping could increase the effective size of the training dataset and improve model robustness.
- Advanced Architectures: Exploring more complex architectures, such as deeper CNNs or transfer learning with pre-trained models, could enhance performance.

Conclusion

This project developed an automated system for glaucoma detection using CNNs, achieving promising results in terms of accuracy and sensitivity. The proposed system can assist ophthalmologists in early glaucoma diagnosis, potentially reducing the risk of vision loss in patients. Future work will focus on expanding the dataset, improving the model architecture, and implementing additional pre-processing and regularization techniques to further enhance performance.