GR-104 Diabetic Retinopathy Detection Without Pre-Processing

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Abstract

This Diabetic retinopathy is an eye condition that can lead to vision loss and blindness in people who have diabetes. To detect DR is a time-consuming and manual process that requires a trained clinician to examine and evaluate the color fundus images of retina. Pre-processing for retinal images is important for DR detection to achieve higher accuracy but, it might require domain knowledge for doing such standard pre-processing steps. Our goal is to develop automated detection system for 5 DR stages 0-No DR, 1-Mild, 2-Moderate, 3-Severe,4-Proliferative DR without pre-processing steps.

Introduction

Diabetic retinopathy is an eye condition that can lead to vision loss and blindness in people who have diabetes. The US Center for Disease Control and Prevention estimates that 29.1 million people in the US have diabetes and WHO estimates that 347 million people have this disease worldwide. Diagnosis of DR is an intensive process, which involves a lot of clinical study and requires time, resources and money.

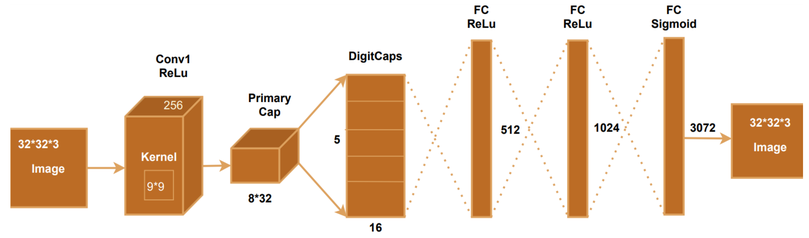
Research Question(s)

1. In medical field, DR detection is time consuming, and it requires appropriate equipment.
2. The expertise and equipment required are often lacking in areas where the rate of diabetes in local populations is high and DR detection is most needed.
3.Pre-processing techniques are heavily dependent on domain knowledge with high computation time.
4.Early detection of DR through regular screening is a key to prevent blindness and preserve good vision in diabetes sufferers.
5. Goal is to develop automated detection system for multistage DR detection without pre-processing step.

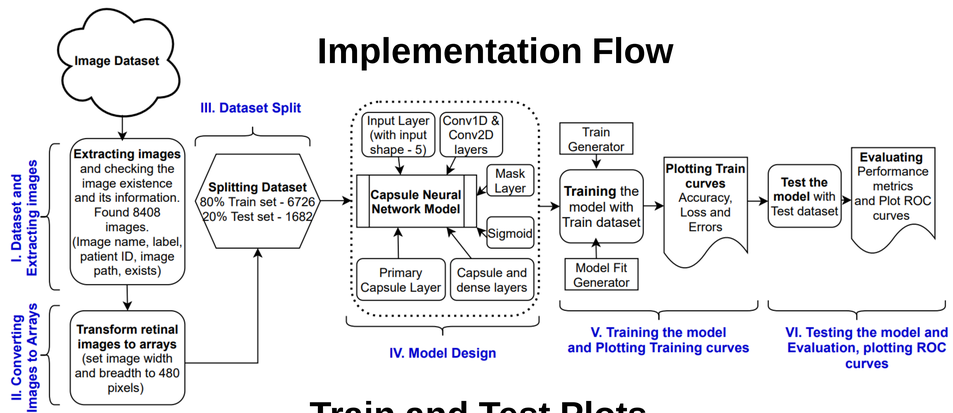
Materials and Methods

A large set of high-resolution retina images are taken under a variety of imaging conditions of EyePACS[1] dataset from Kaggle Diabetic Retinopathy Detection - Identify signs of diabetic retinopathy in eye images. We omitted all the pre-processing techniques as it is heavily dependent on domain knowledge with high computation time. We use Capsule Neural Network (CapsNet) which adopts the concept of capsules to address the weakness in existing algorithms. Capsule neural network helps to perform the functions of a CNN with improved architecture and with for more robust classification.

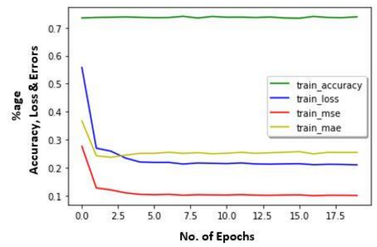
CapsNet Model Architecture

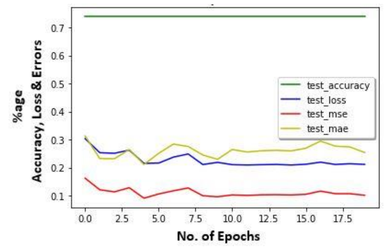


Implementation Flow



Train and Test Plots





Metrics	Train	Test
Loss	0.22	0.28
Accuracy	0.79	0.76
Mean Squared Error (MSE)	0.12	0.15
Mean Absolute Error (MAE)	0.31	0.35

Results

Classification Report				
Metrics	Precision	Recall	F1-Score	Support
Class 0	0.76	0.63	0.84	1229
Class 1	0.75	0.65	0.75	113
Class 2	0.74	0.70	0.77	269
Class 3	0.76	0.65	0.82	42
Class 4	0.77	0.62	0.74	29
Accuracy	-	-	0.76	1682
Macro avg	0.15	0.20	0.17	1682
Weighted avg	0.53	0.73	0.62	1682

Performance Metrics	
Metrics	Percentage %
Accuracy	76.54
Precision	63.35
Recall	75.99
F1-score	65.69

Conclusions

Without doing any pre-processing techniques on retinal images is a cost-effective strategy to solve the problem of multistage DR detection. As Pre-processing techniques are heavily dependent on domain knowledge with high computation time.
Using CapsNet (Capsule Neural Network) model, we achieve the average accuracy (76%) without pre-processing techniques with reduced computation time.
The dataset used for our experiment is unbalanced for 5 class distribution. If we use an improved dataset, then the results can be improved.

Acknowledgments

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