Department of Electronics Engineering, AMU

Problem Presentation of UG Project

Biomedical Image Processing

"Retina Disease diagnosis using Retinal OCT Images"

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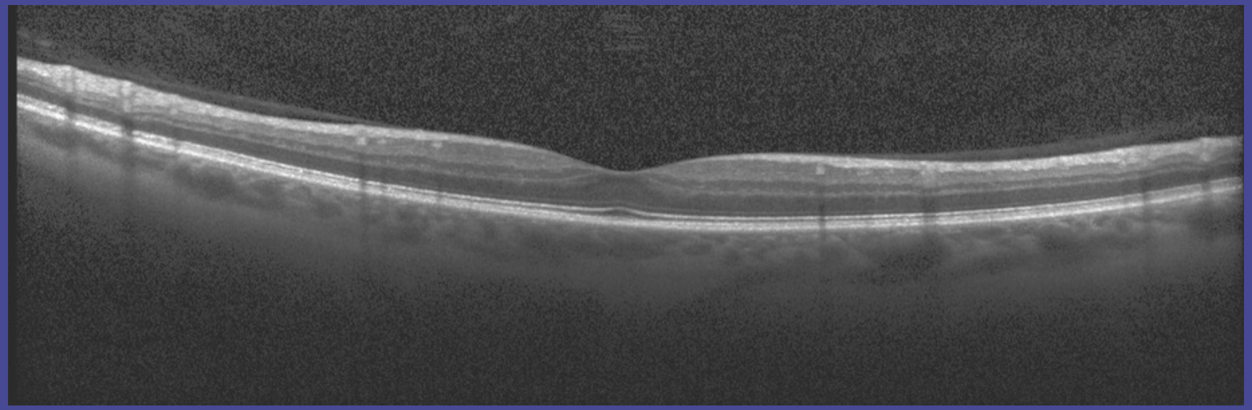
"We affirm that we will not copy the project work and shall be completing all tasks without any unethical help, and all work in this project will be our own"

Why OCT ?

Motivation

OCT can provide means for early detection for various types of diseases because morphological changes often occur before the physical symptoms of these diseases.



The OCT is a non-invasive imaging modality mainly used in ophthalmology to visualize retinal layers. Information about all the retina layers can be inferred from OCT images, useful in detecting and diagnosing retinal disorders.

Around 6.9 million people have glaucoma, 3 million people have diabetic retinopathy, and 2.75 million people have AMD and Duren. All these people will be at risk of developing diabetic macular edema.

With such massive numbers, detecting retinal disorders manually by ophthalmologist is a strenuous task.

FLOW OF THE PROJECT

- Literature Review
- Finding Region of interest
- Denoising of OCT Images
- Segmentation of Retinal Layers
- Deep Learning Model for Automated Detection of Retinal Disease

Literature Review

Paper	Algorithm	Dataset	Results	Limitations
"Diagnosis of retinal disorders from Optical Coherence Tomography images using CNN" [1] *-by Nithya Rajagopalan , Venkateswaran N., Alex Noel Josephraj, Srithaladevi E*	In this work the author develops a CNN architecture for detection of retinal disorders using OCT images. The proposed CNN Architecture contains five Convolution Layers (CL) and two fully connected Layers (FL). The images were resized into uniform size to enable extraction of the features. Filtered for speckle noise reduction.	Mendeley database consists of around 84,000 OCT images are categorized into four types namely Diabetic Macular Edema, Drusen Macular Degeneration, Choroidal Neovascularization and Normal.	The CNN architecture effectively classified urgent referrals like CNV, DME, and DMD from the normal retinal OCT images with a testing accuracy of 97.01%. The proposed network has achieved a sensitivity of 93.43% and a specificity of 98.07%.	The architectural complexity is less in these two networks similar to the developed model. The work can be further extended to develop a single flexible CNN architecture.

Literature Review

Paper	Algorithm	Dataset	Results
"Deep learning-based automated detection of retinal diseases using optical coherence tomography images" [2] *-by Feng Li, Hua Chen, Zheng Liu, Xue-dian Zhang, Min-shan Jiang, Zhi-zheng Wu, and Kai-qian Zhou*	Approach used an ensemble of four classification model instances each of which was based on an improved ResNet50. The improved ResNet50 mainly consisted of convolutional layers, pooling layers, and fully connected layers.	Conducted a retrospective study and collected a total of 21,357 retinal OCT images from 2,796 adult patients from the Shanghai Zhongshan Hospital and the Shanghai First People's Hospital between 2014 and 2019.	The proposed approach achieved 97.3% classification accuracy, 96.3% sensitivity, and 98.5% specificity.

Literature Review

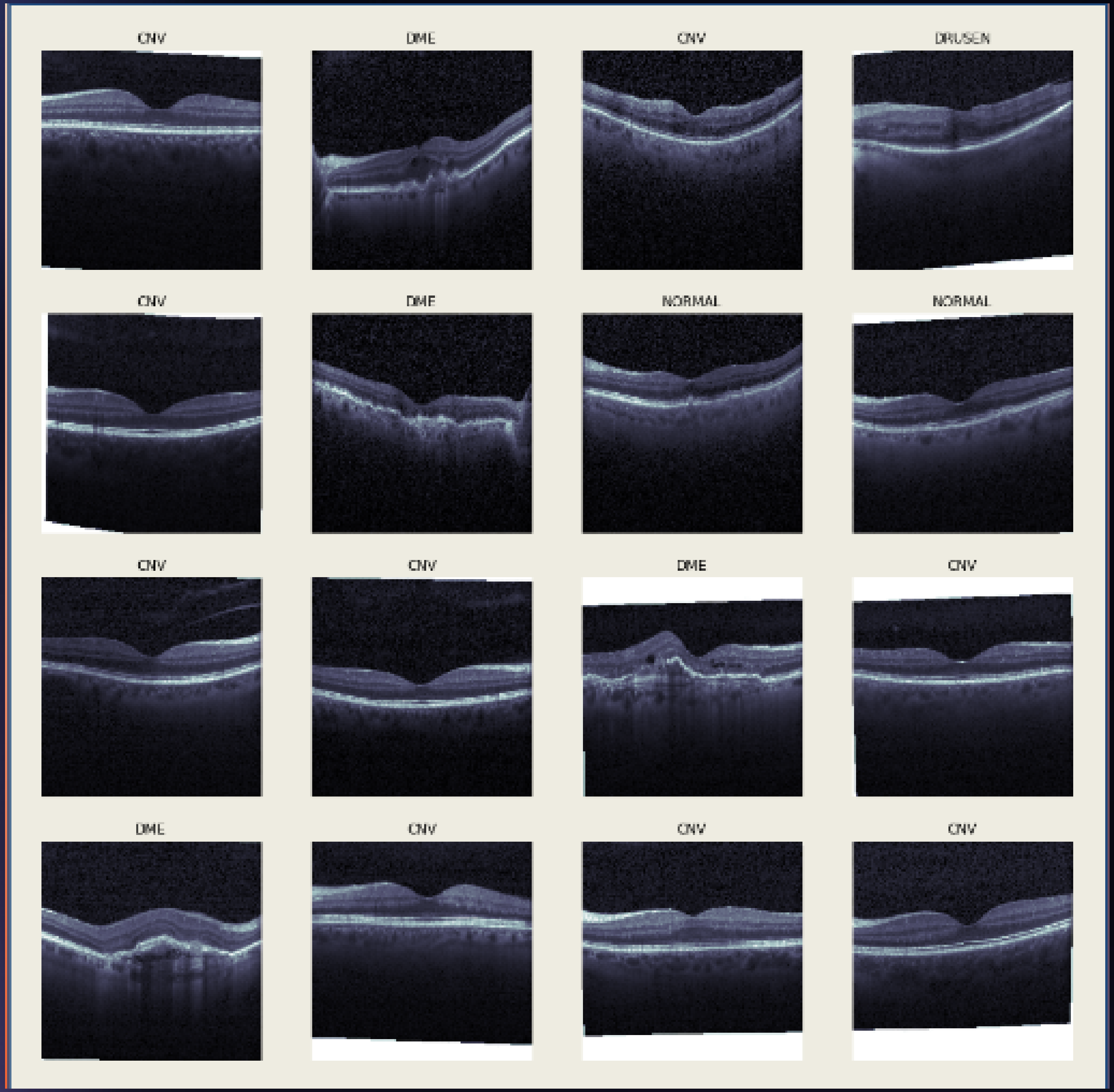
Paper	Algorithm	Dataset	Results	Limitations
"Statistical model for OCT image denoising" [3] *-by Muxingzi Li, Ramzi Idoughi, Biswarup Choudhury, and Wolfgang Heidrich*	The proposed method is founded on a numerical optimization framework based on maximum-a-posteriori estimate of the noise-free OCT image. It combines a novel speckle noise model, derived from local statistics of empirical spectral domain OCT (SD-OCT) data, with a Huber variant of total variation regularization for edge preservation.	retinal OCT images	The approach exhibits satisfying results in terms of speckle noise reduction as well as edge preservation, at reduced computational cost.The proposed method achieves a balanced performance in speckle reduction and structure preservation. It also preserves a high contrast for structural details, e.g. air bubbles in the upper region	K-SVD performed better and has higher efficiency for sufficiently large images.

Literature Review

Paper	Algorithm	Dataset	Results
"Denoising Optical Coherence Tomography Images Using Conditional Generative Adversarial Networks" [4] *-by Dewei Hu; Yigit Atay; Joseph Malone; Yuankai Tao; Ipek Oguz*	• To develop a cGAN that can be generalized to OCT images of both healthy and pathological anatomy without having to re-train specifically for pathology. • To generalize the relativistic cGAN, we introduce horizontal and vertical edge loss functions for our generator to improve edge preservation in any orientation	-	Successfully preserve edges and fine-level details of the anatomy while reducing speckle for both healthy and pathological anatomy.

Literature Review

Paper	Algorithm	Dataset	Results
"Speckle denoising in optical coherence tomography images using residual deep convolutional neural network" [5] *-by Neha Gour & Pritee Khanna*	The proposed method adapts residual Gaussian denoiser by Zhang et al. [56]. The proposed architecture is trained on natural images with added speckle noise following gamma distribution. The trained denoising model is further used on OCT image for removal of speckle noise present in it.	The proposed denoising algorithm is tested on widely used OCT databases, namely, Duke and Topcon. Duke is a SD-OCT database, while Topcon is a 3D-OCT database	The trained architecture is finally used on two landmark OCT denoising databases, i.e., Duke and Topcon. Visual and parametrical analysis shows that the proposed approach performs better as compared to other state-of-the-art methods from literature.



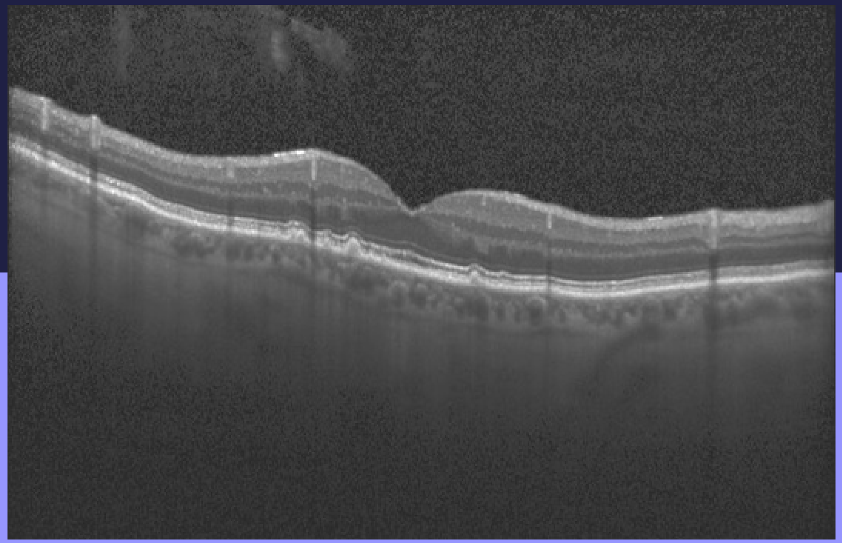
DATASET

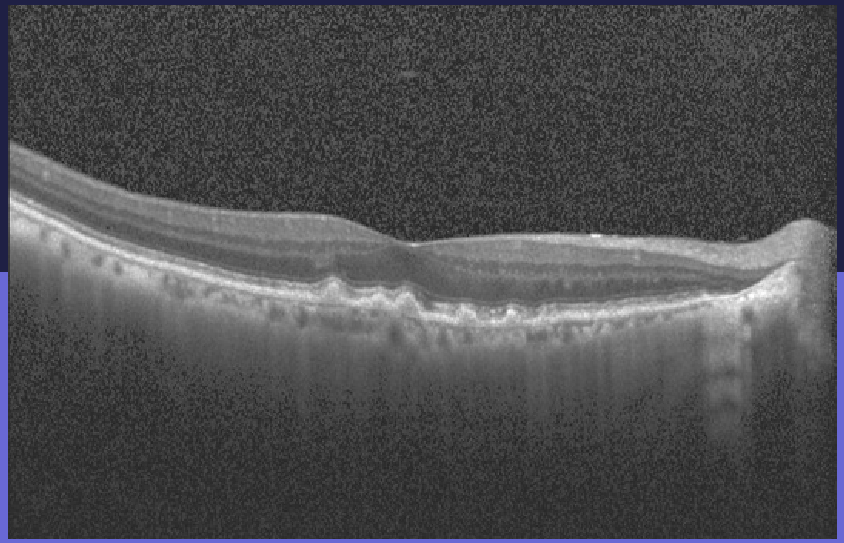
"RETINAL OCT IMAGES" - KAGGLE [6] 4 CLASSES

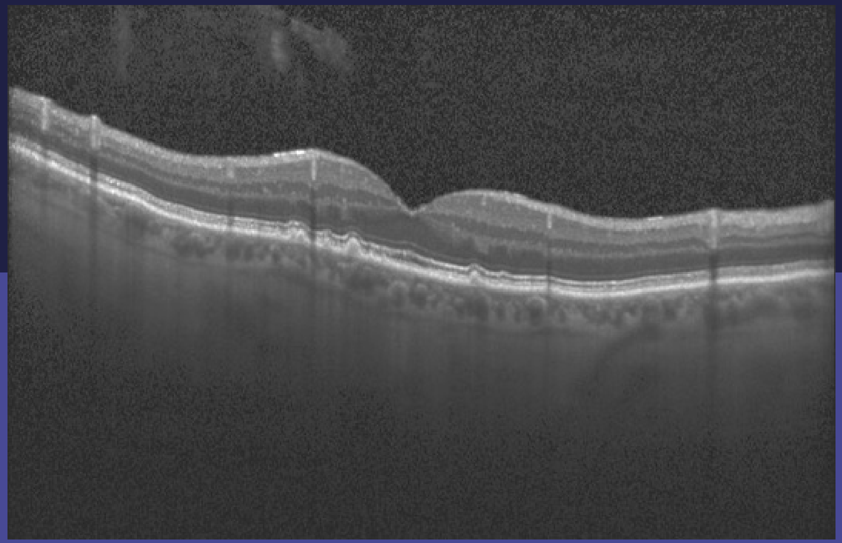
- Normal
- Drusen
- Choroidal Neovascularization (CNV)
- Diabetic Macular Edema (DME)

IMAGE ANALYSIS

DRUSEN







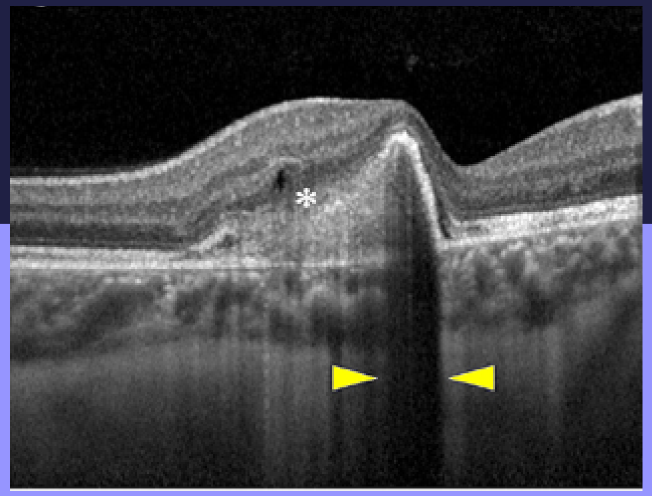
Drusen is the earliest AMD sign that is detected clinically in fundus examinations. On OCT, drusen appear as RPE deformation or thickening that may form irregularities and undulations

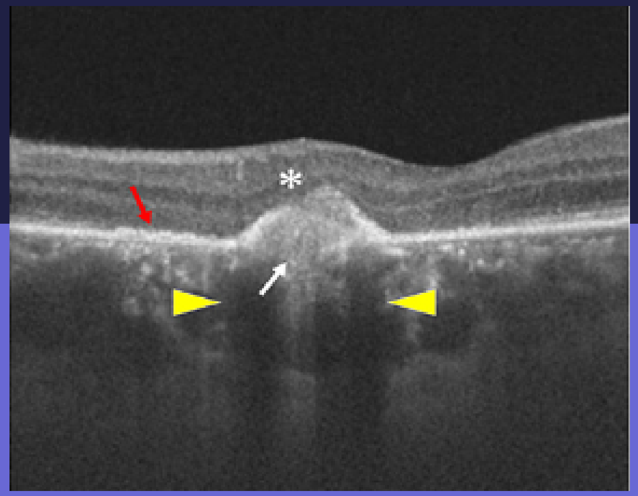
It is difficult to detect the posterior border of drusen on OCT because the resolution decreases as depth increases and the hyperreflective anterior surface of ODD causes a shadowing effect.

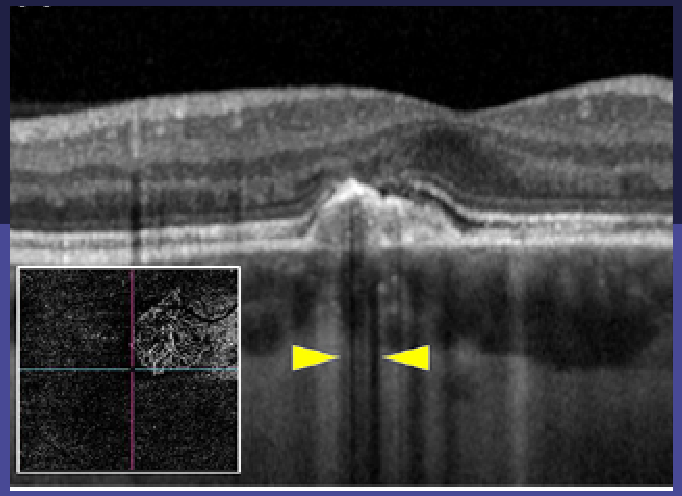
Disc drusen are composed of small proteinaceous material that become calcified with advancing age. These deposits can be considered small tumors that develop within the optic nerve head, and may lead to an elevated disc.

IMAGE ANALYSIS

CNV







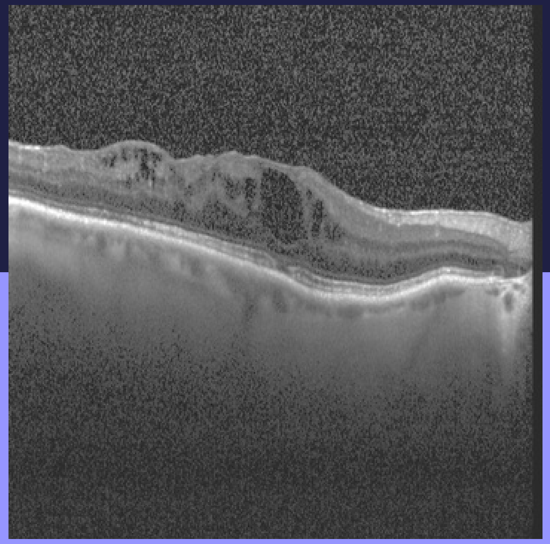
Choroidal Neovascularization (CNV) is a major cause of vision loss and is the creation of new blood vessels in the choroid layer of the eye.

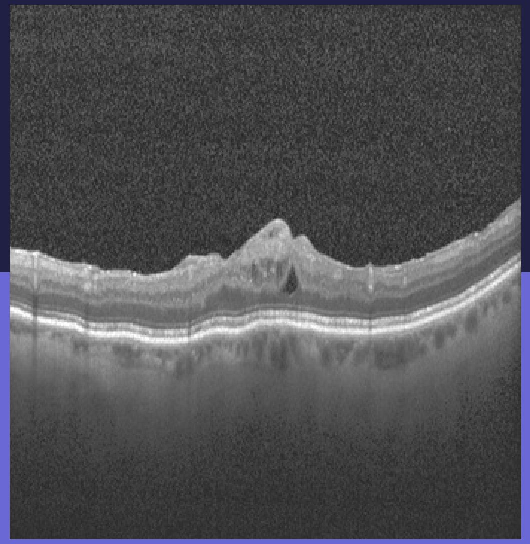
In case of normal OCT the RPE layer is smooth with minimum distortions whereas in the OCT image of a patient suffering from CNV, the extra growth of capillaries can be seen in the RPE layer.

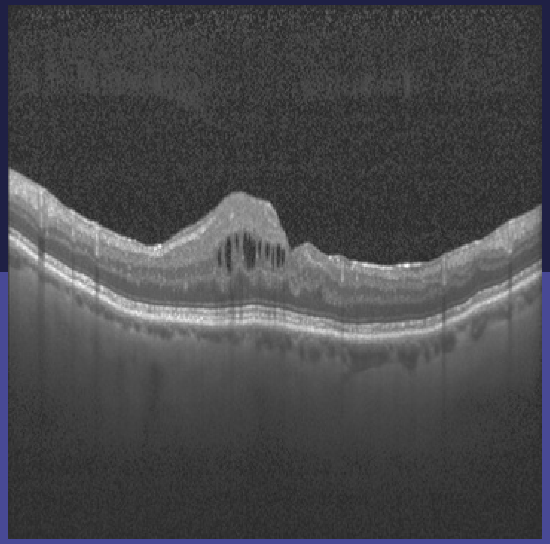
The OCT scan shows hypo-reflective choroidal back-shadowing. OCT scan shows outer retinal fuzziness (white arrow), disruption of the ellipsoid zone (red), a small intraretinal cystoid space, disruption of the BM, and hypo-reflective choroidal back-shadowing (yellow).

IMAGE ANALYSIS

DME







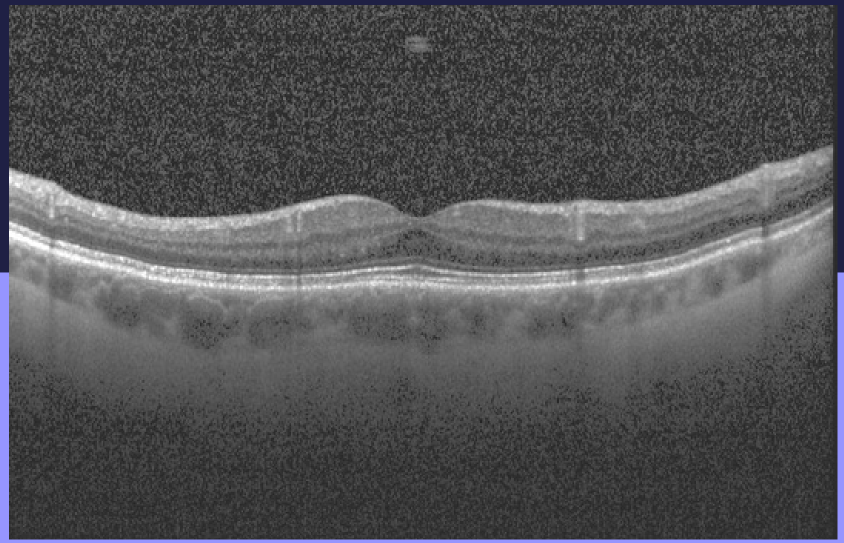
Focal or diffuse oedema first appears as a reduction in the reflectivity of the tissue and as increased retinal thickness.

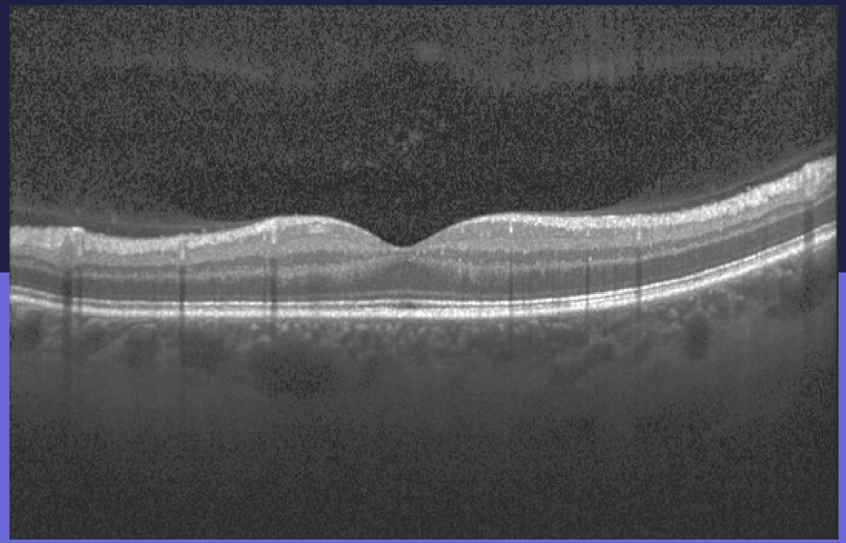
Later the retina appears ‘spongy’. CME includes the accumulation of intraretinal fluid in well-defined spaces

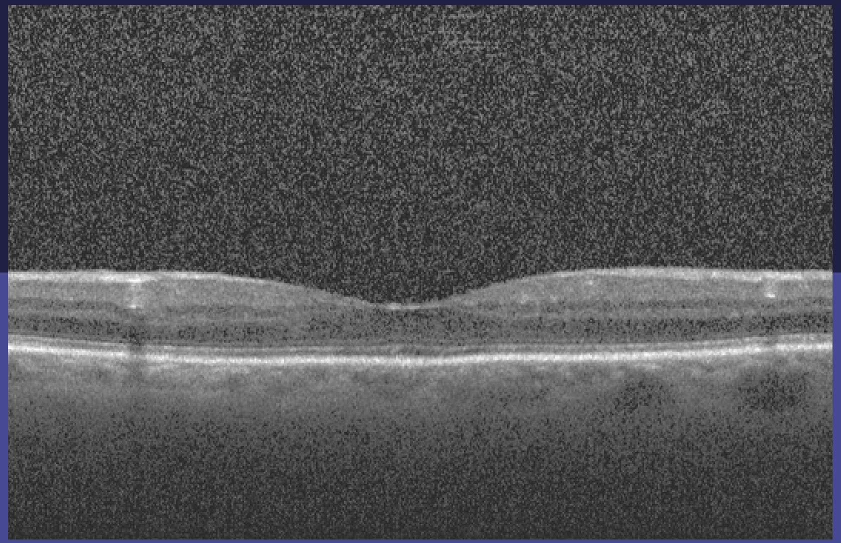
Macular thickening with or without hard exudates may be seen. Retinal swelling, cystoid macular edema, and subretinal fluid. Disorganization of the retinal inner layers.

IMAGE ANALYSIS

NORMAL







OCT Baseline

Work done till now

Phase 1

Literature Review
OCT disease detection and Denoising Research papers

Phase 2

Manual Inspection for detecting morphological changes.

Phase 3

Denoising Autoencoder based Speckle noise denoising

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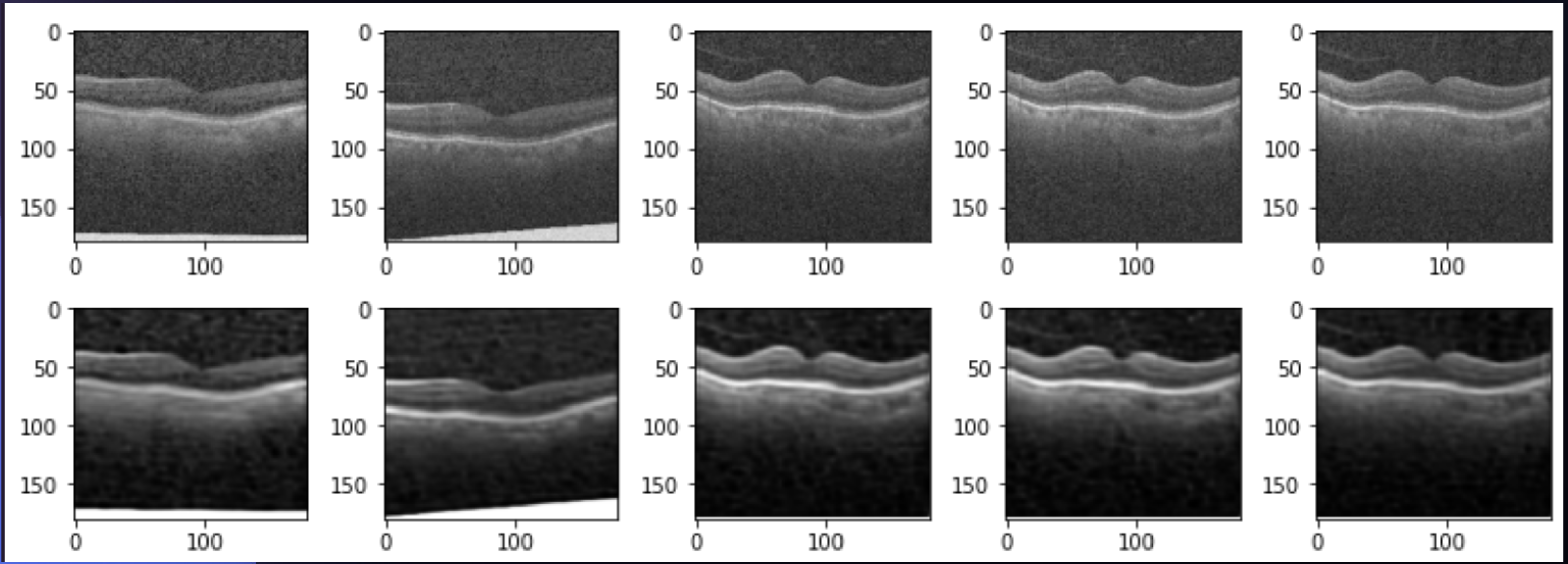
Denoising

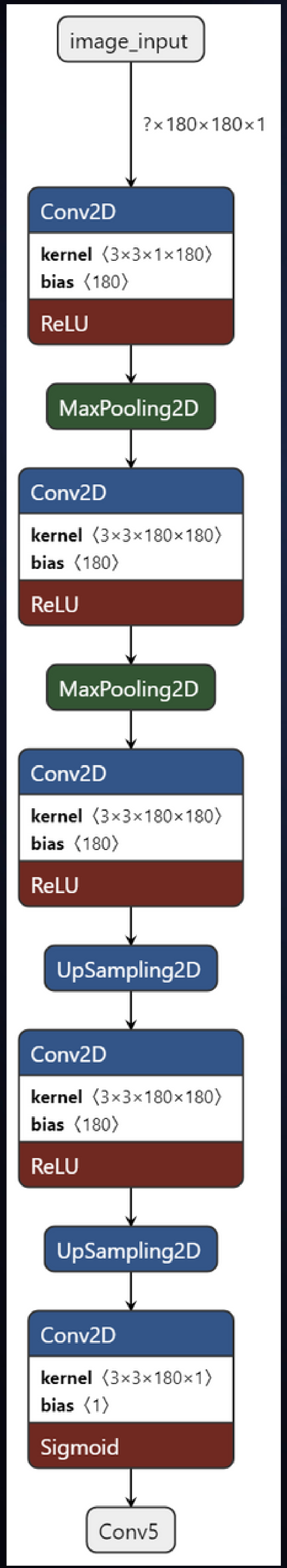
Denoising Autoencoder (DAE) approach is based on the addition of noise to the input image to corrupt the data and to mask some of the values.

DAEs preserve the input information (input encode), second DAEs attempt to remove the noise.

Noisy Image

Autoencoder Output





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Timeline

Timeline	Week 1 & 2	Week 3 & 4	Week 5 & 6	Week 7 & 8	Week 9 & 10	Week 11 & 12	Week 13 & 14	Week 15 & 16	Week 17 & 18
Phase 1	Literature Review								
Phase 2			Denoising of OCT images						
Phase 3					Segmentation of retinal layers				
Phase 4								model Architection	

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Conclusion

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Questions are welcome

1

Our Motivation

OCT can provide means for early detection for various types of diseases

2

Work Done till now

Read and analysed papers related to OCT diseases and Denoising and Denoising.

3

Future Timeline

Gantt chart for effective project management and future roadmap.

Thankyou !

Future Works

- Retinal Layer segmentation
- Feature Extraction
- Deep learning methods

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References

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[6] Kermany, Daniel; Zhang, Kang; Goldbaum, Michael. “Labeled Optical Coherence Tomography (OCT) and Chest X-Ray Images for Classification”, Mendeley Data, V2, doi: 10.17632/rscbjbr9sj.2, (2018).