



Machine Learning Approach to Detect & Annotate Eye Diseases using Retinal Images

TMP-23-162

Team Members

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Key Content

Introduction

Research Problem

Research Objectives

System Diagram

Individual Components

01. Introduction

- Development of an mobile application for the identification of eye diseases like diabetic retinopathy and age-related macular degeneration to aid eye specialists with reliable and accurate diagnoses.
- Detection of eye diseases using retinal images, grade their severity and classify according to their types.

02. Research Problem

- Diagnosis of eye diseases is time-consuming and requires expertise and training.
- Ability in improving accuracy of the outcomes
- Lack of resources results inability of early diagnosis

03. Research Objectives

- Improve accuracy and efficiency of the outcomes for better diagnosis
- Early diagnosis for patients
- Reduce workload for eye specialists in order to focus on critical situations
- Save time and resources of medical field

04. Sub Objectives

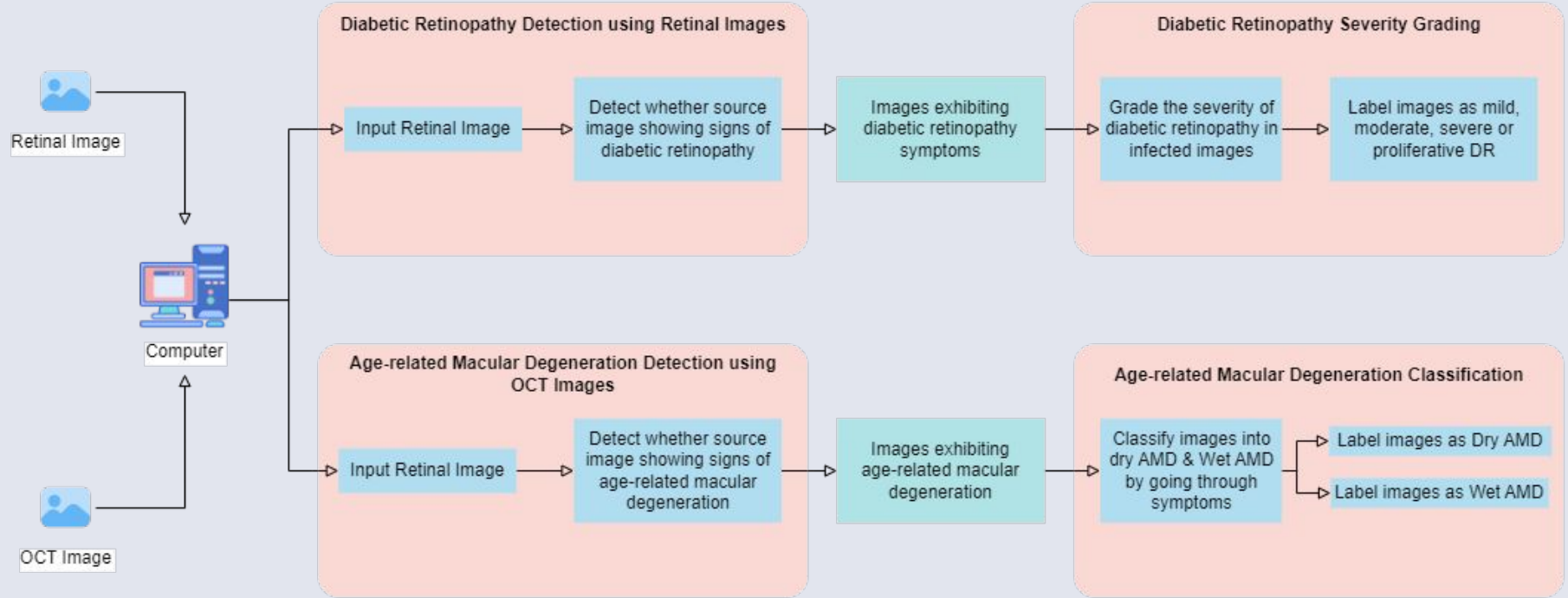
Detect Symptoms of Diabetic Retinopathy using Retinal Fundus Images

Grade Severity of Diabetic Retinopathy using Retinal Fundus Images

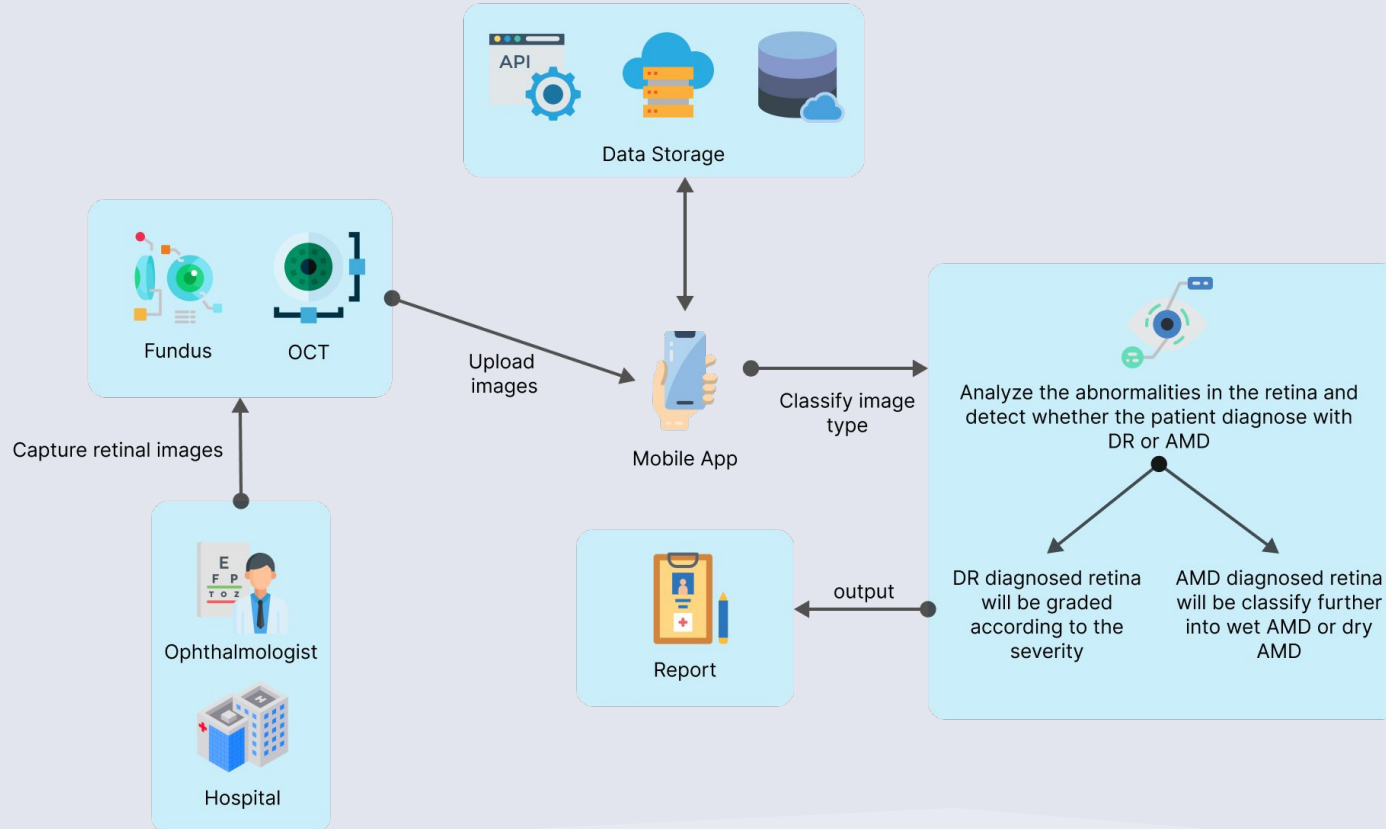
Detect Symptoms of Age-related Macular Degeneration using Retinal OCT Images

Classification of Age-related Macular Degeneration using Retinal OCT Images

05. Component Diagram



06. System Diagram



07. Links to Datasets

- <https://www.kaggle.com/datasets/obulisainaren/retinal-oct-c8>
- <https://www.kaggle.com/competitions/diabetic-retinopathy-detection/data>
- <https://www.kaggle.com/datasets/tanlikesmath/diabetic-retinopathy-resized>
- <https://www.kaggle.com/datasets/andrewmvd/ocular-disease-recognition-odir5k>



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Detect Symptoms of Diabetic Retinopathy using Retinal Fundus Images

Introduction

Background

Research Gap

Research Problem

Specific Objectives & Sub Objectives

01. Background

- Diabetic Retinopathy is a vicious complication of diabetes
- Diabetic retinopathy is the fourth leading cause of blindness and fifth common cause of visual impairment
- Early detection and continuous monitoring can reduce the impact of the patients

02. Research Gap

- Need of more accurate and reliable machine learning model (Sensitivity varying from 90% - 97%)
- Need of advance techniques to detect DR in early stages
- Need of integrating the tool for practical advantage in medical sector

02. Research Gap - Related Work

- A Novel Approach for the Early Recognition of Diabetic Retinopathy using Machine Learning (2021)
- Efficient Classification of Diabetic Retinopathy using Binary CNN (2021)
- Detection of Diabetic Retinopathy at Early Stage Using Retinal Fundus Images (2021)
- Classification of Diabetic Retinopathy based on Hybrid Neural Network (2020)

03. Research Problem

- Being able to optimize outcomes
- Continuous monitoring of DR requires lots of resources
- Ability to improve the accuracy and other parameters

04. Specific Objectives & Sub Objectives

- Preprocess retinal fundus image
 - Noise Removal
 - Standardization
- Feature Extraction
 - Color Analysis
 - Texture Analysis
 - Shape Analysis

04. Specific Objectives & Sub Objectives

- Development of a deep learning model
 - Prepare datasets of retinal fundus images
 - Select a model architecture (Ex: SVM, CNN)
 - Train the model
- Evaluation of the model
 - Evaluate the performance of the model
 - Analyse the metrics such as precision, accuracy, training time, resource allocation etc.

Methodology

System Diagram

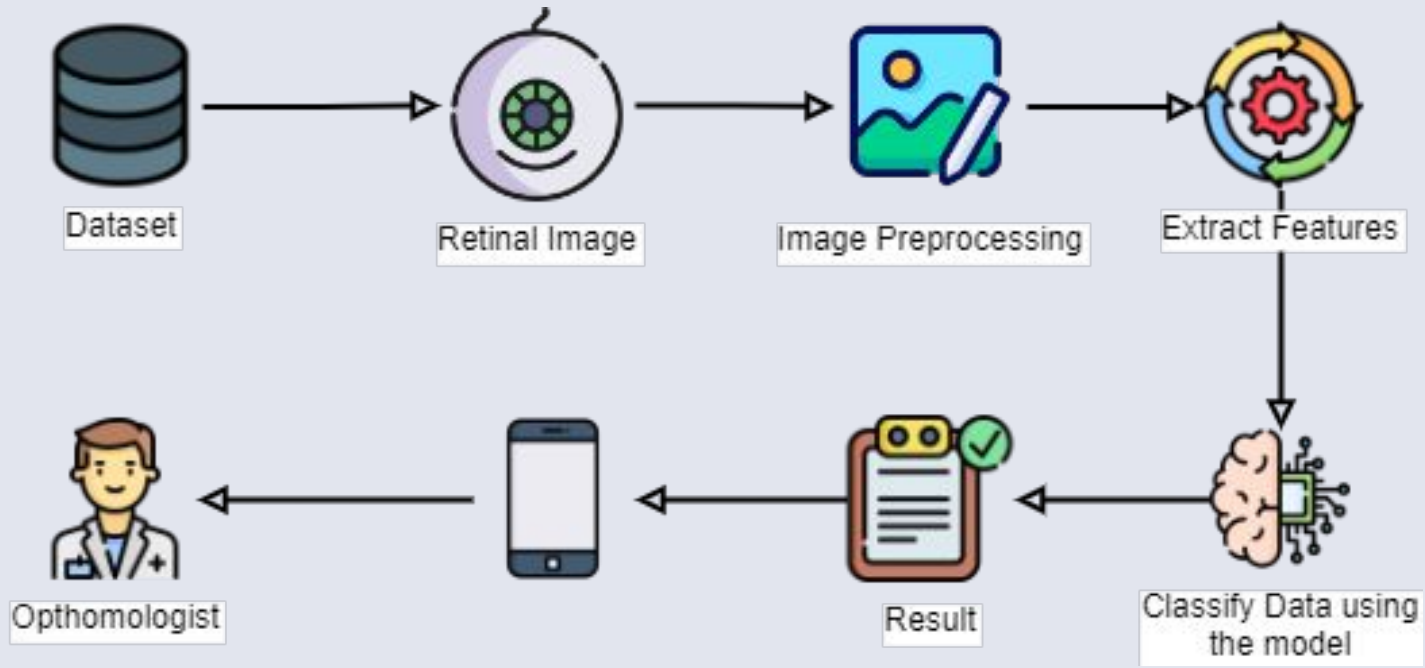
Technologies

Requirements

Gantt Chart

Breakdown Chart

01. System Diagram



02. Technologies

- Mobile Application - React Native
- Database - Firebase
- Python programming language
- Deep Learning Frameworks - TensorFlow, PyTorch, Keras
- Image Processing Libraries - OpenCV, Pillow
- Cloud Computing Platforms - AWS, GCP

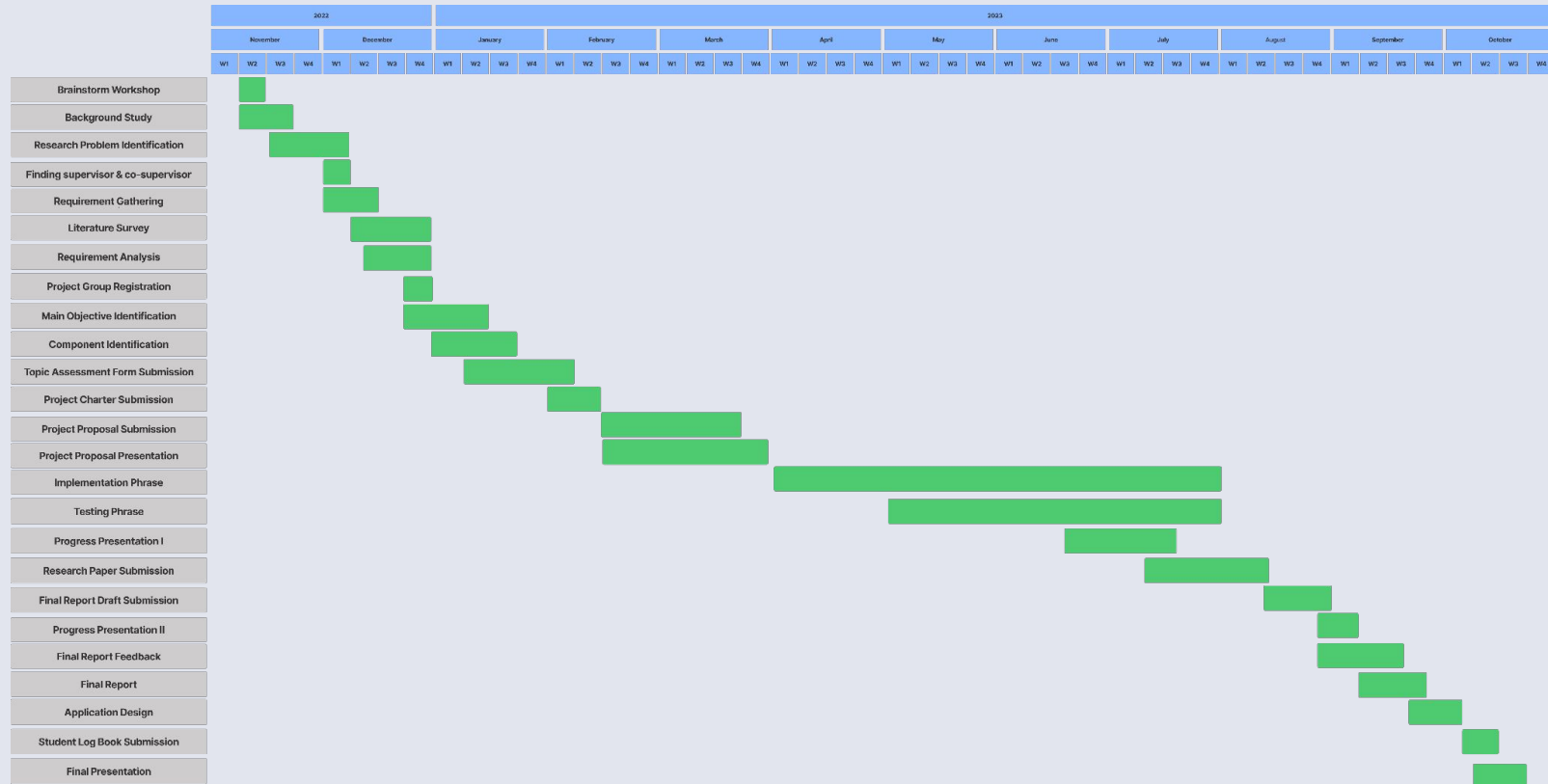
03. Functional Requirements

- Image Preprocessing
- Accurate classification of disease
- Feature extraction
- Low resource consumption

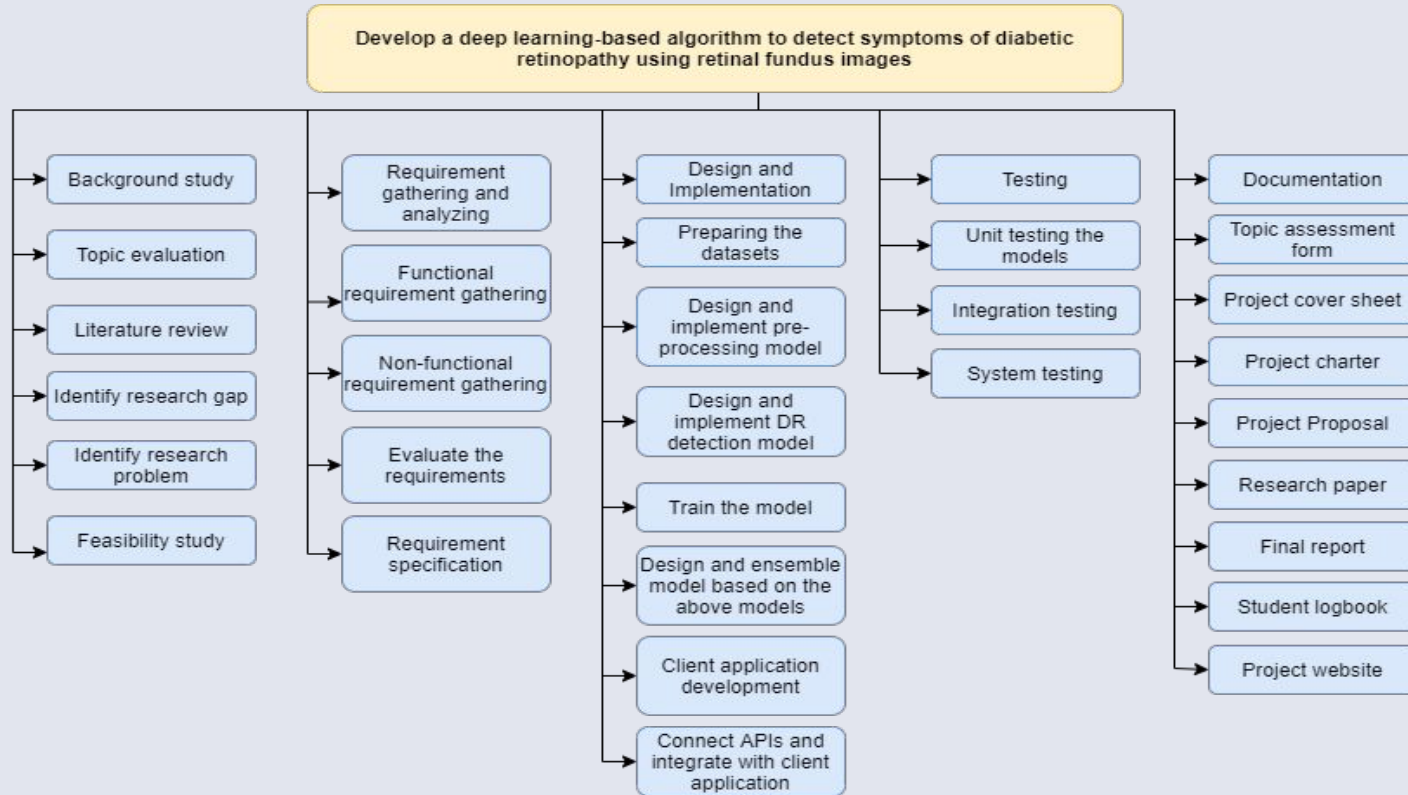
04. Non-Functional Requirements

- Accuracy
- Accessibility
- Usability
- Performance
- Data Security

05. Gantt Chart



06. Break Down Chart



Supportive Information

Commercialization

Budget

01. Commercialization

- The product can be marketed to eye specialists, ophthalmologists.
- The system can be developed into a product for private hospitals to purchase.

02. Budget

Task	Cost (Rs.)
Hosting	7000
Backups	5000
Testing	2000
Marketing	5000
Other	2000
Total Cost	21000



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Grade Severity of Diabetic Retinopathy using Retinal Fundus Images

Introduction

Background

Research Gap

Research Problem

Specific Objectives & Sub Objectives

01. Background

- 1/3 of Sri Lankan adults with self-reported diabetes have retinopathy
- 40 board-certified ophthalmologists and 6 vitreo-retinal surgeons in the region
- 77.5% (31 out of 40) specialists in Colombo district
- Highest DR infrastructure ratios in Colombo
- Medical officers' DR screening skills are low
- Western province lacks systematic DR screening program

01. Background (Cont.)

- Resources not aligned with population needs
- Urgent need for service expansion and mid-level HR training for DR screening and treatment in the region
- Skills for screening diabetic patients are lacking in Sri Lanka

02. Research Gap - Related Works

- Diabetic Retinopathy Grade Classification based on Fractal Analysis and Random Forest (2019)
- Diabetic Retinopathy Severity Classification with Transfer Learning (2020)
- Automatic detection and grading of diabetic maculopathy using fundus images (2020)
- Future Image Synthesis for Diabetic Retinopathy Based on the Lesion Occurrence Probability. Electronics (2021)

02. Research Gap - Why a novel approach?

- Typical accuracy ranges from 74% - 80%
- Challenge in distinguishing features
- Class overlapping
- Inadequate preprocessing
- Absence of DR Grading Mobile Apps

03. Specific & sub-objectives

- Acquire and preprocess the dataset of retinal images
 - Collect a large dataset of retinal images with varying DR severity levels
 - Label the images according to DR severity grades
 - Preprocess the images for efficient training of the deep learning model (e.g., resizing, normalization, augmentation)
- Develop the deep learning model
 - Select an appropriate deep learning architecture (e.g., CNN, ResNet, DenseNet)
 - Optimize hyperparameters for improved model performance.
 - Implement and train the model using the preprocessed dataset.

03. Specific & sub-objectives (Cont.)

- Evaluate and validate the model's performance
 - Measure the model's accuracy, sensitivity, specificity, and other relevant metrics
 - Compare the model's performance with existing DR grading systems and techniques
- Optimize the model for real-world deployment
 - Develop a user-friendly interface for healthcare professionals
 - Implement data security and privacy measures

Methodology

System Diagram

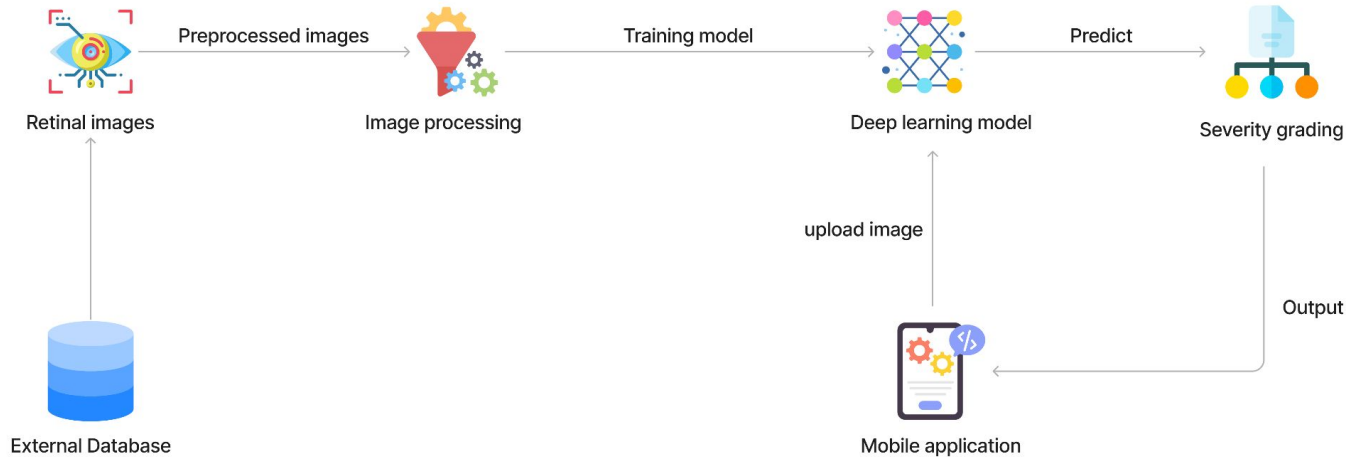
Technologies

Requirements

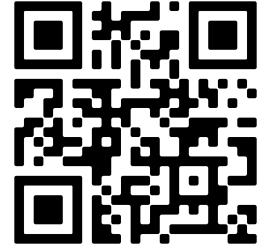
Breakdown Chart

Gantt Chart

01. System diagram



Visit for complete diagram



02. Technologies

- Mobile application - react native
- Database - firestore
- Programming language - Python
- Deep learning frameworks - Pytorch, Keras
- Image Processing Libraries - OpenCV, scikit-image
- Development Environment: Google Colab
- Dataset - Kaggle - [link](#)

Visit for dataset



03. Functional requirements

- Image Preprocessing: Enable consistent retinal image preprocessing (resizing, normalization, augmentation) for model training.
- Accurate Grading: Classify and grade diabetic retinopathy severity according to established grading systems.
- Robustness: Ensure performance on diverse retinal images for real-world clinical applicability.
- Efficient Processing: Achieve timely image processing for early detection and intervention.
- Model Interpretability: Provide interpretable outputs to help healthcare professionals understand grading decisions.

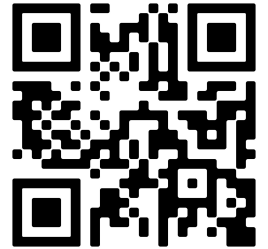
03. Non-functional requirements

- Scalability: Ensure performance with increasing image volumes for long-term clinical utility.
- Mobile Friendliness: Optimize for mobile device integration and accessibility.
- Security and Privacy: Adhere to data protection standards and healthcare regulations.
- Usability: Simplify integration into healthcare workflows and ease of use.
- Maintainability: Allow easy updates and improvements as research and technology advance.

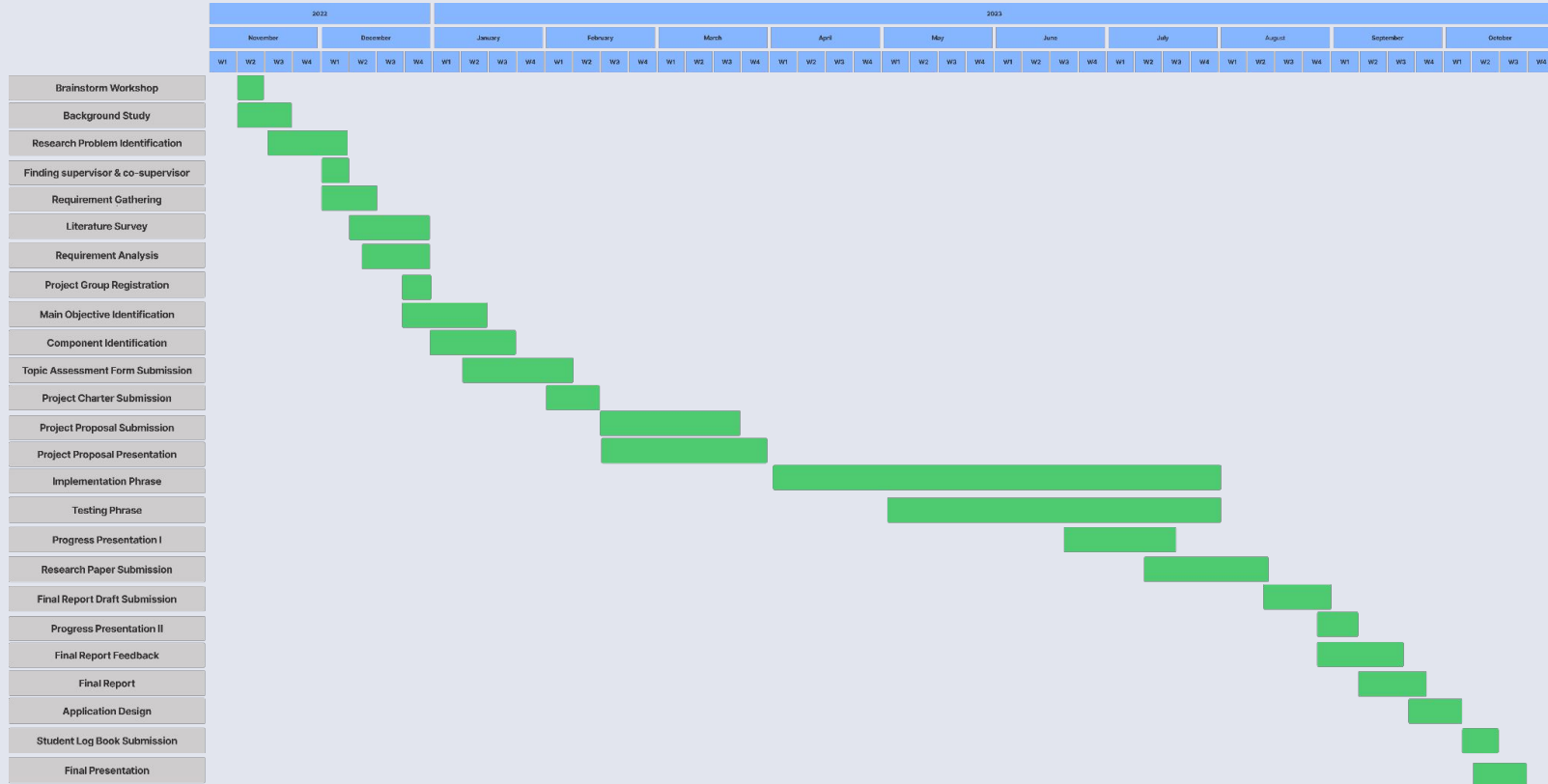
04. System diagram



Visit for complete diagram



05. Gantt Chart



Supportive Information

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02. References

- 1. M. M. P. N. Piyeana, G. V. S. Murthy, Availability of eye care infrastructure and human resources for managing diabetic retinopathy in the western province of Sri Lanka. Indian Journal of Ophthalmology. 68, 841–846 (2020).
- Katulanda, P., Ranasinghe, P. & Jayawardena, R. Prevalence of retinopathy among adults with self-reported diabetes mellitus: the Sri Lanka diabetes and Cardiovascular Study. BMC Ophthalmol 14, 100 (2014). <https://doi.org/10.1186/1471-2415-14-100>
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- Rajput, G.G.; Reshmi, B.; Rajesh, I. Automatic detection and grading of diabetic maculopathy using fundus images. Procedia Comput. Sci. 2020, 167, 57–66
- Ahn, S.; Pham, Q.T.; Shin, J.; Song, S.J. Future Image Synthesis for Diabetic Retinopathy Based on the Lesion Occurrence Probability. Electronics 2021, 10, 726.



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Detect Symptoms of Age-related Macular Degeneration using Retinal OCT Images

Introduction

Background

Research Gap

Research Problem

Specific Objectives & Sub Objectives

01. Background

- Age-Related Macular Degeneration (AMD) causes progressive vision loss and affects millions worldwide.
- Early detection of AMD is crucial for effective treatment and prevention of further vision loss.
- Optical Coherence Tomography (OCT) imaging is a valuable tool for detecting and monitoring AMD.

02. Research Gap

- Various research approaches have been attempted to build systems to detect and identify eye diseases using machine learning.
- Current machine learning models for AMD detection using OCT images are not optimized for fast and accurate detection, resulting in lower efficiency and scalability.
- I proposed a system that detects AMD detection using OCT images by combining two existing models and in this approach, a lightweight model is developed so that it will reduce computational requirements while maintaining high accuracy.

02. Research Problem

- The current manual process for AMD detection from OCT images is time-consuming and can be influenced by variations between different observers
- Misdiagnosis or delayed diagnosis of AMD can result in irreversible vision loss and decreased quality of life for patients.
- The lack of automated and accurate diagnostic tools for AMD detection from OCT images poses a significant challenge to early detection and treatment of AMD.

03. Specific Objectives & Sub Objectives

- Main objective
 - The main goal of this component is to develop a machine learning model for the detection of age-related macular degeneration (AMD) from optical coherence tomography (OCT) images.

03. Specific Objectives & Sub Objectives

- Sub objectives
 - To collect a dataset of OCT images for training the machine learning model.
 - Preprocess and clean OCT images to ensure high-quality input data.
 - Develop a machine learning model for accurate detection of AMD using deep learning.
 - Optimize the machine learning model for fast and accurate AMD detection with minimal computational resources

Methodology

System Diagram

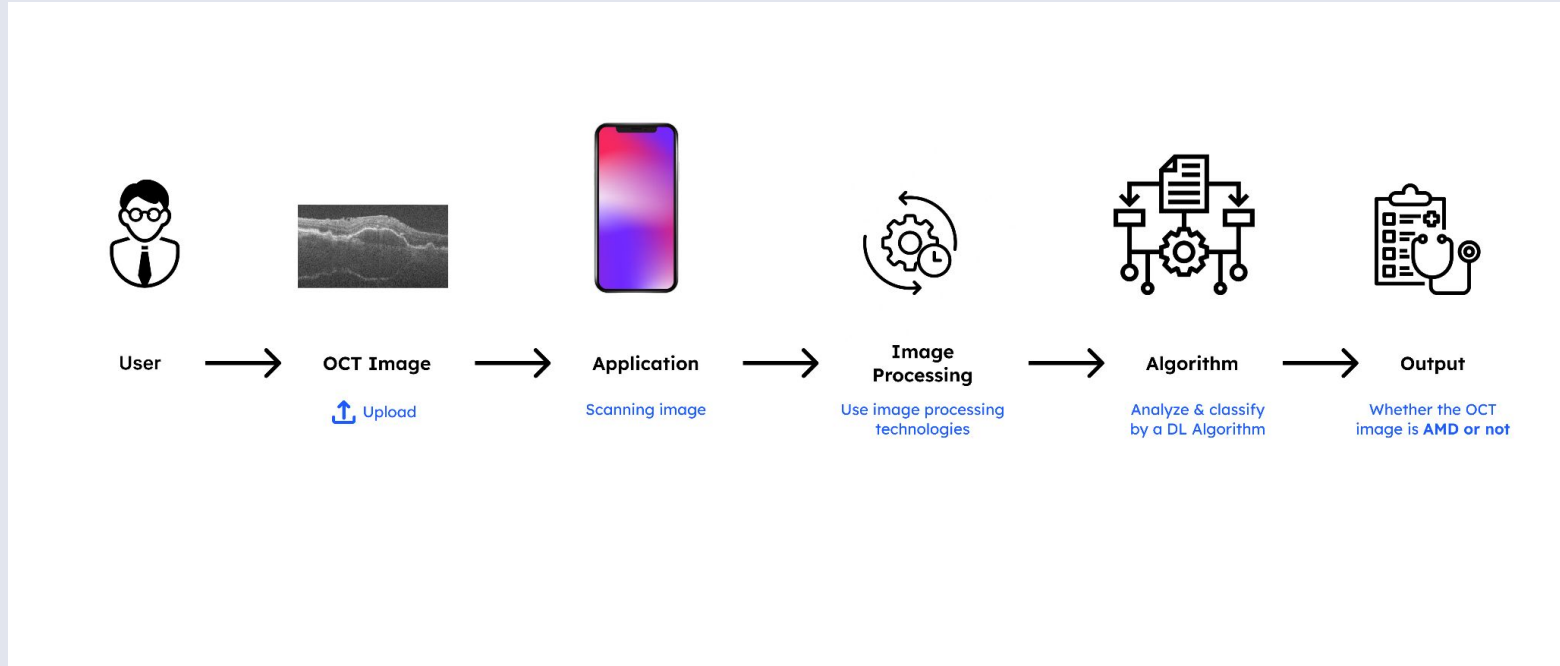
Technologies

Requirements

Gantt Chart

Breakdown Chart

01. System Diagram



02. Technologies

- Mobile Application - React Native
- Python programming language
- Database - Firebase
- Deep Learning Frameworks - TensorFlow, PyTorch, Keras
- Image Processing Libraries - OpenCV, Pillow
- Cloud Computing Platforms - AWS, GCP

03. User Requirements

- The application should have a user-friendly interface that is easy to operate.
- The application should process images quickly to minimize waiting times for patients.
- The application should ensure the privacy and security of patient data.

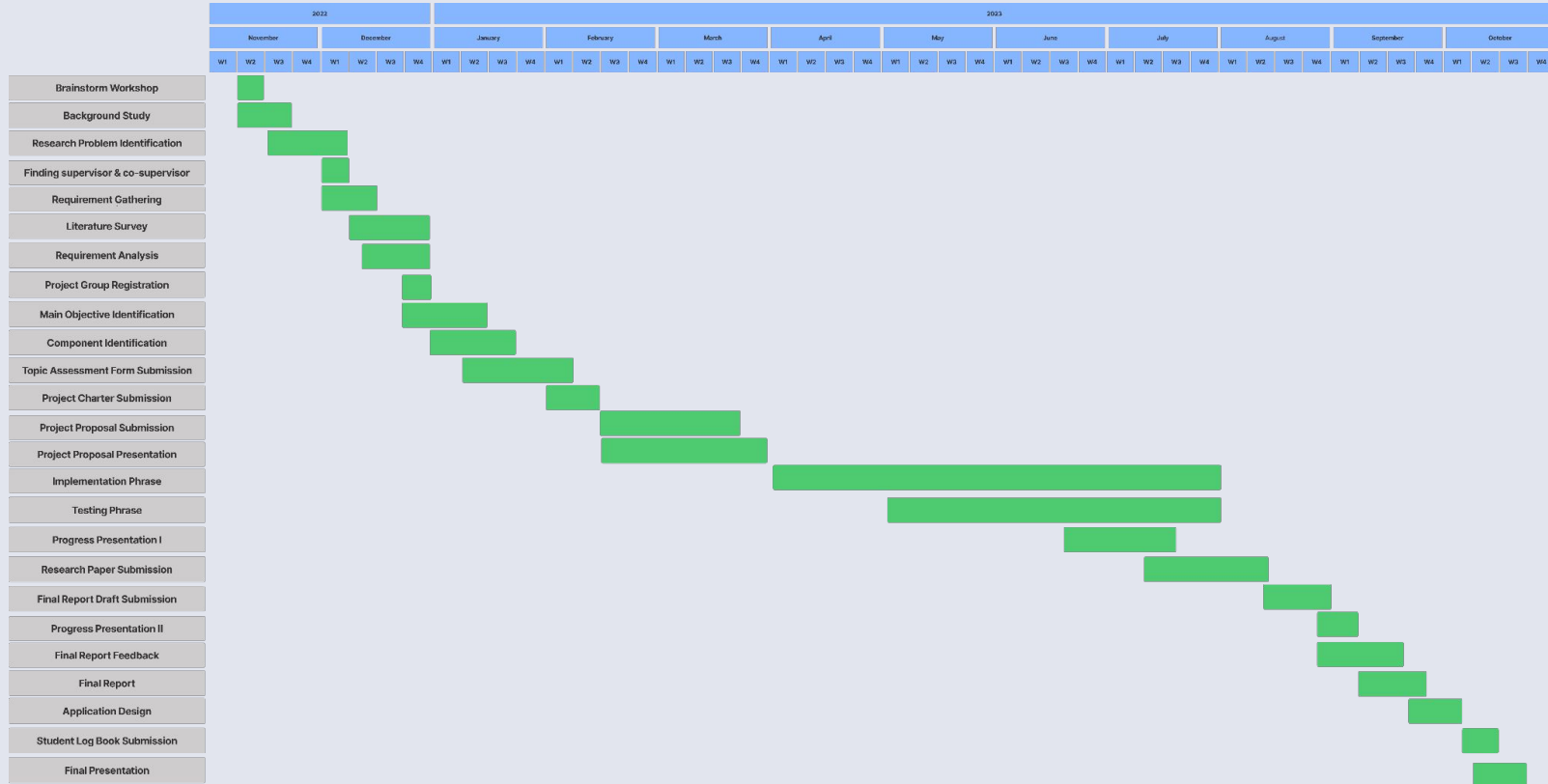
04. Functional Requirements

- The system should be able to import OCT images for analysis.
- The system should be able to identify AMD from OCT images.
- The system should provide a user interface for the input and output of OCT images.
- The system should be able to generate reports of AMD detection results.

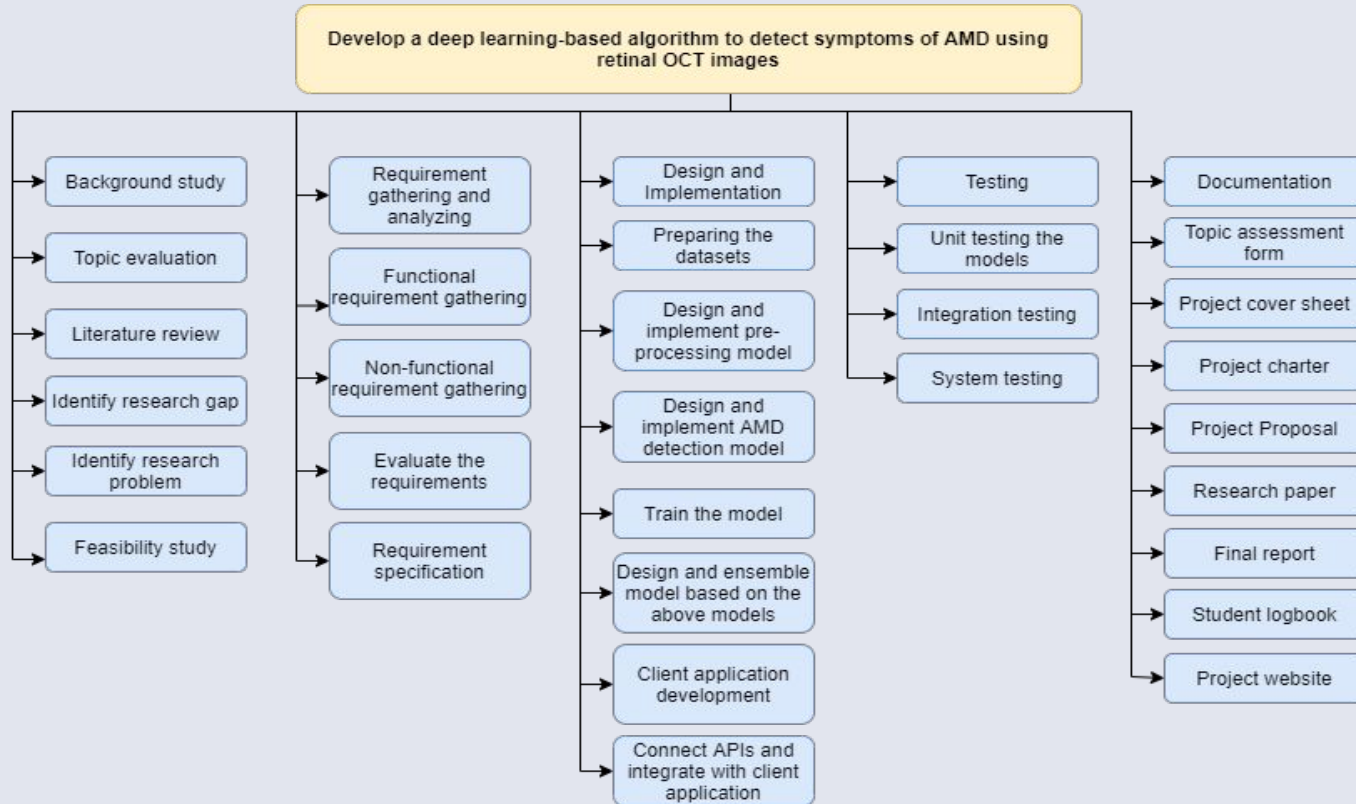
05. Non-Functional Requirements

- The system should have high accuracy in AMD detection from OCT images.
- The system should be able to process OCT images quickly and efficiently.
- The system should be user-friendly and easy to use for healthcare professionals

06. Gantt Chart



07. Break Down Chart



01. Commercialization

02. Budget

Task	Cost (Rs.)
• Hosting	7000
• Backups	5000
• Testing	2000
• Marketing	5000
• Other	2000
Total Cost	21000

07. References

- Lee, C. S., Baughman, D. M., & Lee, A. Y. (2017). Deep Learning Is Effective for Classifying Normal versus Age-Related Macular Degeneration OCT Images. *Ophthalmology Retina*, 1(4), 322–327. <https://doi.org/10.1016/j.oret.2016.12.009>
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- Srivastava, R., Ong, E. P., & Lee, B.-H. (2020). Role of the Choroid in Automated Age-related Macular Degeneration Detection from Optical Coherence Tomography Images; Role of the Choroid in Automated Age-related Macular Degeneration Detection from Optical Coherence Tomography Images. https://doi.org/10.0/Linux-x86_64
- A. Govindaiah, R. T. Smith and A. Bhuiyan, "A New and Improved Method for Automated Screening of Age-Related Macular Degeneration Using Ensemble Deep Neural Networks," 2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Honolulu, HI, USA, 2018, pp. 702-705, doi: 10.1109/EMBC.2018.8512379.
- <https://www.kaggle.com/datasets/obulisainaren/retinal-oct-c8>



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Classification of Age-related Macular Degeneration using Retinal OCT Images

Introduction

Background

Research Gap

Research Problem

Specific Objectives & Sub Objectives

01. Background

- Age-related macular degeneration(AMD) is a significant health burden that can lead to irreversible vision loss in the elderly.
- There are two types of AMD:
 - Dry AMD (Drusen)
 - Wet AMD (CNV)
- Current imaging procedures to diagnose AMD include:
 - OCT Imaging
 - Fundus Imaging

02. Research Gap

- Current AMD classification approaches rely on multiple OCT images [1]
- The current deep learning algorithm chooses the most dominant disease as the prediction label. [2]
- Most of the current approaches are developed for Web Applications [3]

03. Research Problem

- Time consuming, expensive, and require multiple visits to an ophthalmologist.
- Challenging to distinguish between dry and wet AMD in the same patient's eye.
- There is a need for a more efficient and accurate method for diagnosing and classifying AMD.

04. Specific Objectives & Sub Objectives

- Main Objective:
 - Develop a novel DL algorithm for identifying and classifying wet and dry AMD from a single OCT image and identify both diseases concurrently if they are present in the same eye

04. Specific Objectives & Sub Objectives

- Specific Objectives:
 - Collect a large dataset of OCT images for training and testing the proposed DL-based method
 - ❖ Drusen - 8600 OCT Images
 - ❖ CNV - 13000 OCT Images
 - ❖ Normal - 20000 OCT Images

(<https://www.kaggle.com/code/justforgags/retinal-oct-feature-map-and-filters-visualization/data>)

04. Specific Objectives & Sub Objectives

- Specific Objectives:
 - Investigate various pre-processing techniques for enhancing the quality of OCT images to improve the accuracy of the proposed DL-based method
 - Development of a deep learning model
 - ❖ Select an optimal model architecture (Ex: CNN,RNN)
 - Evaluate the performance of the proposed DL-based method on mobile devices

Methodology

System Diagram

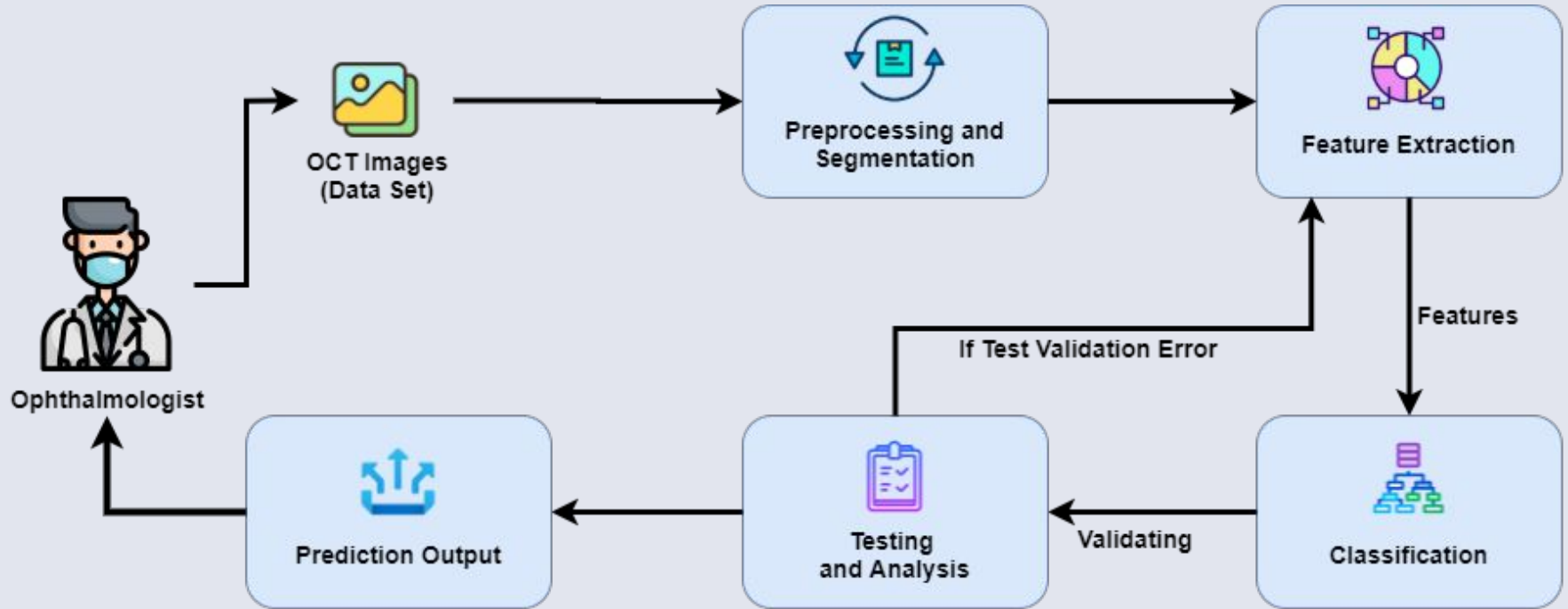
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03. User Requirements

- The system must be user-friendly.
- Users should be able to understand the behavior of the environment
- The user should be able to get the final result as the report in real-time.
- The system should work with various devices like tablets and mobile phones

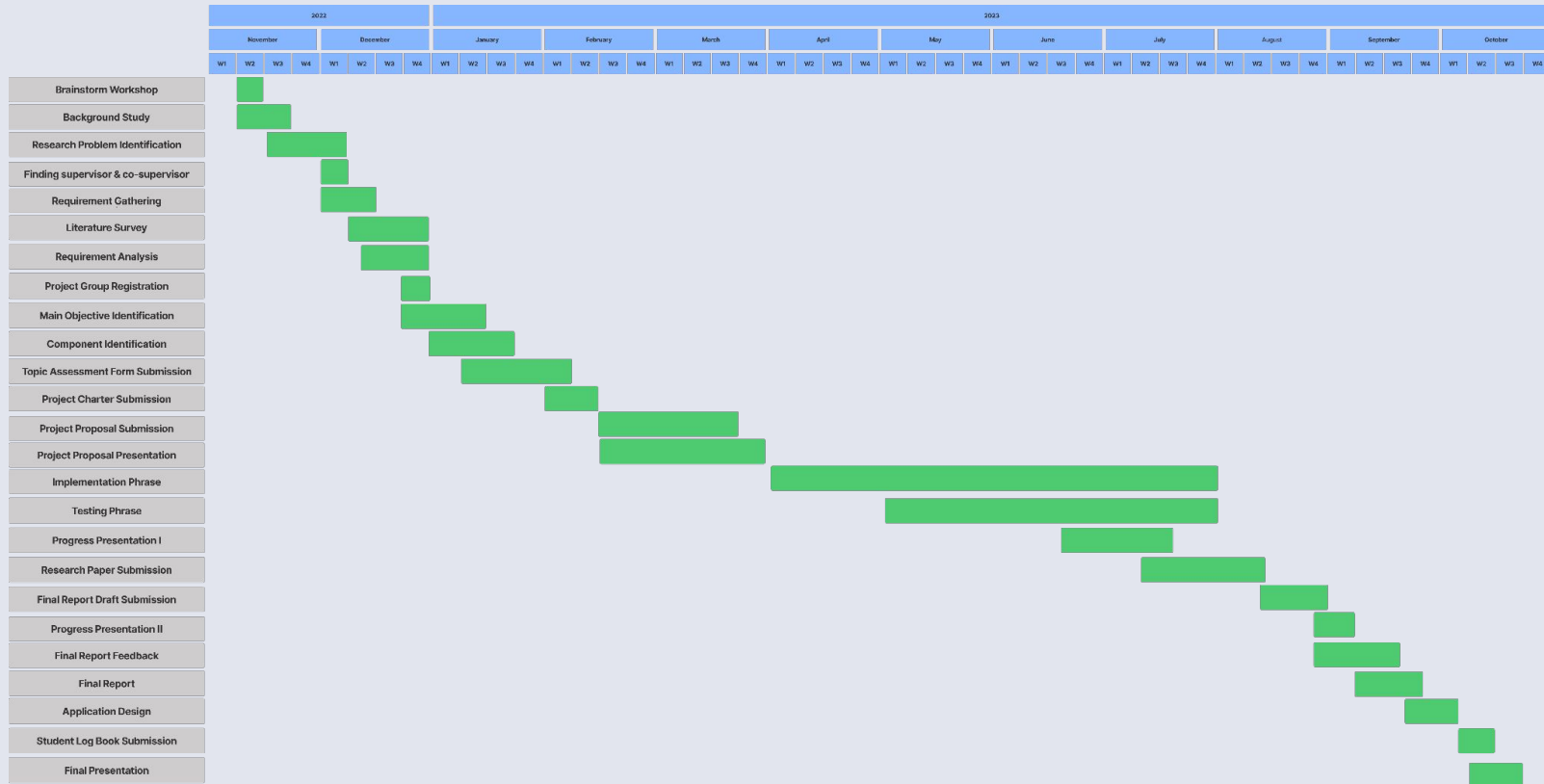
04. Functional Requirements

- The system must distinguish between wet and dry AMD from a single OCT image.
- The system must provide precise and trustworthy results once diagnosing AMD.
- The system must be capable of managing multiple user requests at once.
- The application's final output should be a detailed report.

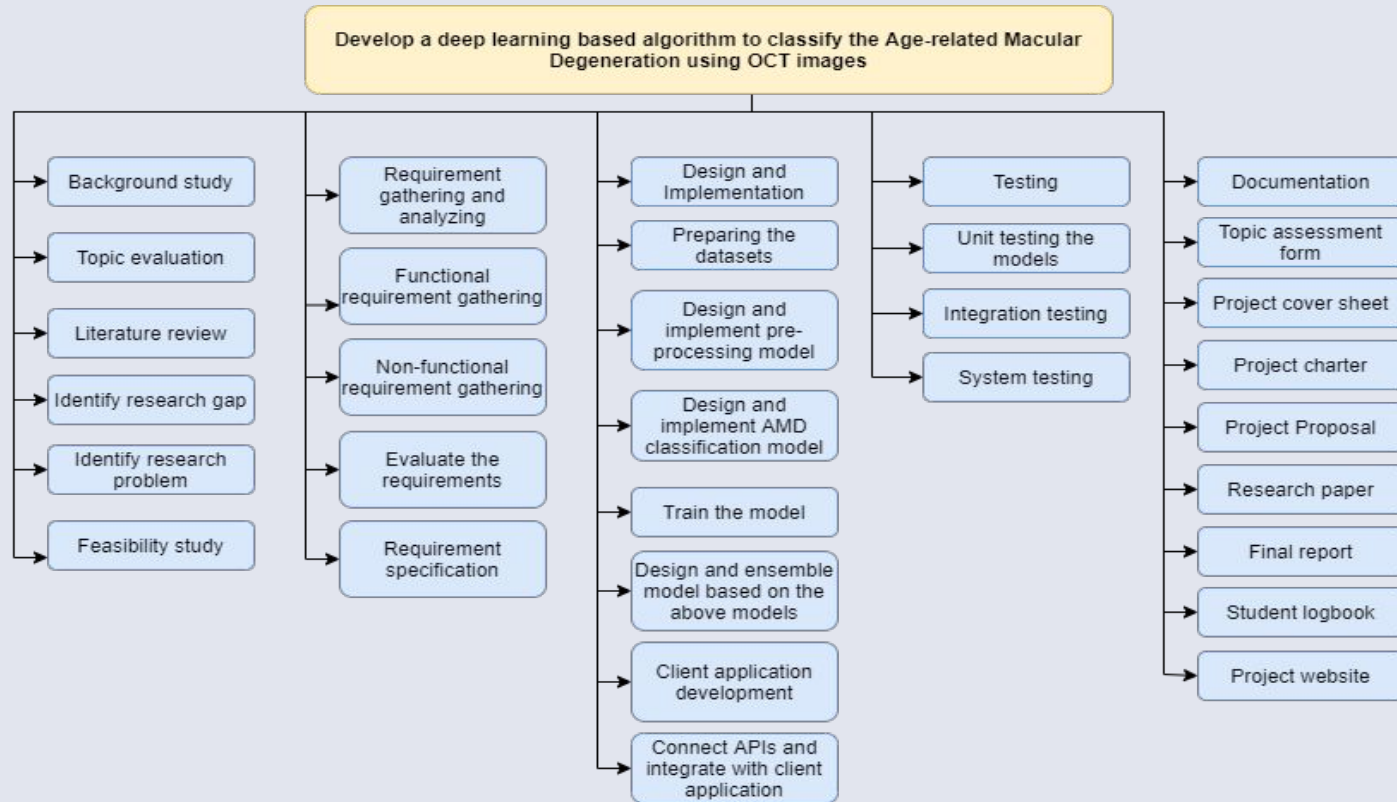
05. Non-Functional Requirements

- Data Security
- Accuracy
- Usability
- Performance
- Efficiency

06. Gantt Chart



07. Break Down Chart



Supportive Information

Commercialization

Budget

01. Commercialization

- This application will provide efficient and accurate way for ophthalmologists to classify the AMD
- This technology will help doctors to identify critical patients in early stages
- Provide cost-effective solution for rural areas.

02. Budget

Task	Cost (Rs.)
• Hosting	7000
• Backups	5000
• Testing	2000
• Marketing	5000
• Other	2000
Total Cost	21000

07. References

- [1] D. Gong, A. Kras, and J. B. Miller, “Application of Deep Learning for Diagnosing, Classifying, and Treating Age-Related Macular Degeneration,” *Seminars in Ophthalmology*, vol. 36, no. 4. Taylor and Francis Ltd., pp. 198–204, 2021. doi: 10.1080/08820538.2021.1889617.
- [2] Y. Wang, M. Lucas, J. Furst, A. A. Fawzi, and D. Raicu, “Explainable Deep Learning for Biomarker Classification of OCT Images,” in *Proceedings - IEEE 20th International Conference on Bioinformatics and Bioengineering, BIBE 2020*, Oct. 2020, pp. 204–210. doi: 10.1109/BIBE50027.2020.00041.
- [3] A. Abed, E. Fawzi, and S. S. A. Naser, “Retina Diseases Diagnosis Using Deep Learning,” 2022. [Online]. Available: www.ijeais.org/ijaer
- <https://www.kaggle.com/code/justforgags/retinal-oct-feature-map-and-filters-visualization/data>