Smart Internz

Project Report of

VISION-AI

AI Powered Medical Image Analysis for Disease Diagnosis

February 01, 2025 *to* March 14, 2025

Smart **Interz** - EPBL

SUBMITTED BY

Team Vision-AI

Vision-AI EPBL REPORT

Team Name: *Vision AI*

Team ID : PNT2025TMID04206

Project Type : Eye Disease Detection using DeepLearning

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1.Introduction

1.1 Overview:

1. **Project Name:** ***Vision AI***, AI-Powered Eye Disease Detection System

2. **Project Objective:** The Eye Disease Detection System is an AI-powered diagnostic tool designed to analyze retinal images and detect eye diseases such as diabetic retinopathy, glaucoma, cataracts, and macular degeneration. The system aims to provide fast, accurate, and accessible diagnostics to help patients, doctors, and healthcare providers in early disease detection and management.

1.2 PURPOSE:

1.2.1 Project Scope:

- For Patients: Enables users to upload retinal images and receive an AI-generated diagnosis along with a detailed medical report.
- For Healthcare Providers: Assists ophthalmologists and clinics by automating the analysis of retinal scans, reducing manual workload and improving diagnostic accuracy.
- For Administrators: Allows system admins to manage user accounts, security settings, AI model updates, and system logs.

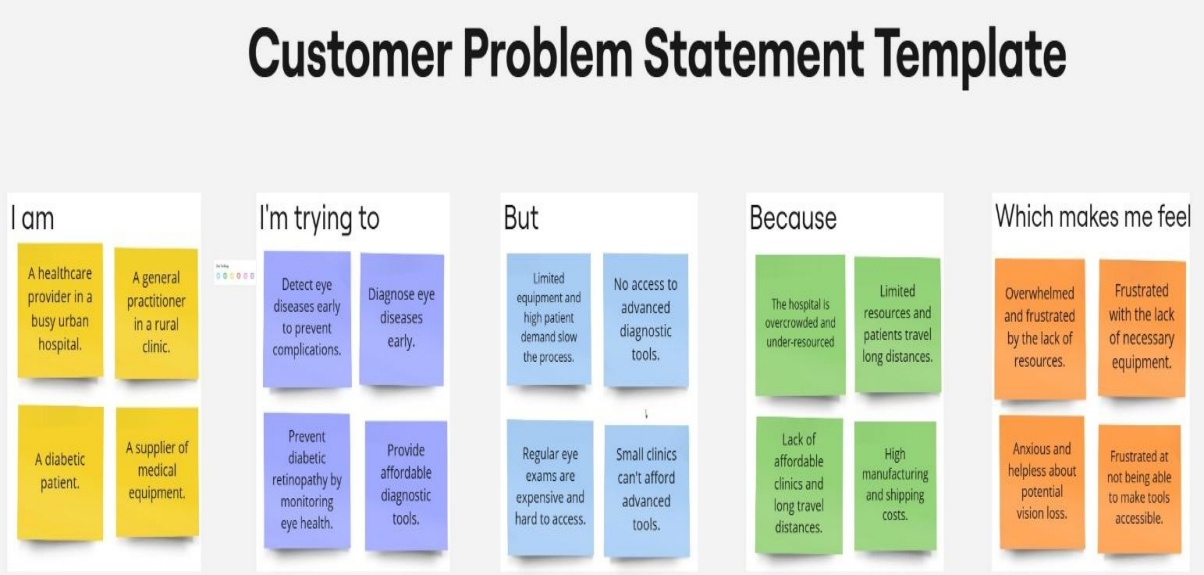
1.2.2 Expected Outcomes:

- Faster Diagnosis: Reduces the time required for analysis from hours to minutes.
- Increased Accuracy: AI-powered models ensure precise detection of eye diseases.
- Improved Accessibility: Allows remote patients and clinics in underserved areas to access affordable diagnostics.
- Scalability: Cloud-based infrastructure enables expansion to hospitals and clinics globally.

2.Ideation Phase

2.1 Problem Statement:

Healthcare providers, include in busy urban hospitals, rural clinic practitioners, and medical equipment suppliers, face significant challenges in detecting and diagnosing eye diseases early. Patients, especially those with diabetes and at high risk of vision loss, struggle to access affordable and timely diagnostic tools. The main objective is to detect eye diseases early, prevent complications, and provide accessible, cost-effective diagnostic solutions. However, the process is hindered by limited equipment, high patient demand, expensive eye exams, and the lack of access to advanced diagnostic tools, especially in small clinics. This issue arises because hospitals and clinics are often overcrowded and under-resourced, forcing patients to travel long distances for eye checkups. Additionally, small clinics cannot afford advanced diagnostic tools, and high manufacturing costs further restrict accessibility. As a result, healthcare professionals feel overwhelmed and frustrated due to a lack of resources, while patients experience anxiety and helplessness about potential vision loss. A cost-effective, AI-powered eye disease detection system is needed to automate screening, improve diagnostic accuracy, and ensure accessibility, especially for underserved regions.

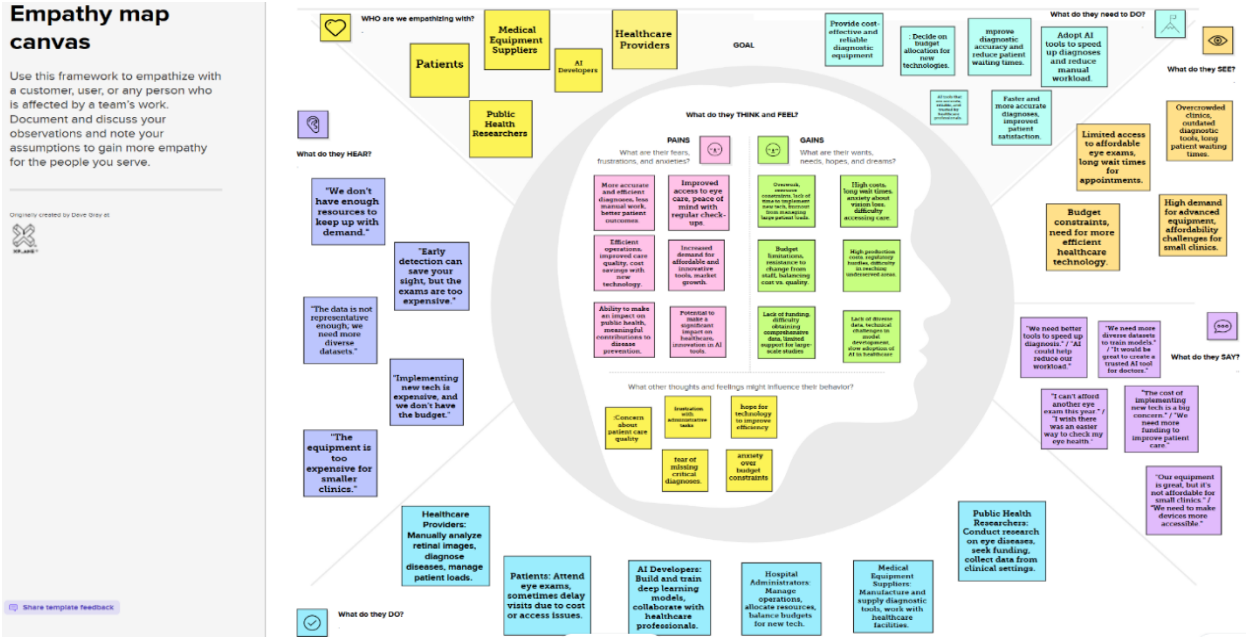


2.2 Empathy Map Canvas:

Patients, healthcare providers, AI developers, medical equipment suppliers, and public health researchers all face significant challenges in diagnosing and managing eye diseases effectively. Patients struggle with long wait times, high costs, and limited access to affordable eye exams, leading to delayed diagnoses and increased risk of vision loss. Healthcare providers are overwhelmed with high patient demand, inefficient manual diagnostic processes, and a lack of advanced tools to speed up screenings. Many clinics, especially in underserved areas, cannot afford expensive diagnostic equipment, making early detection difficult.

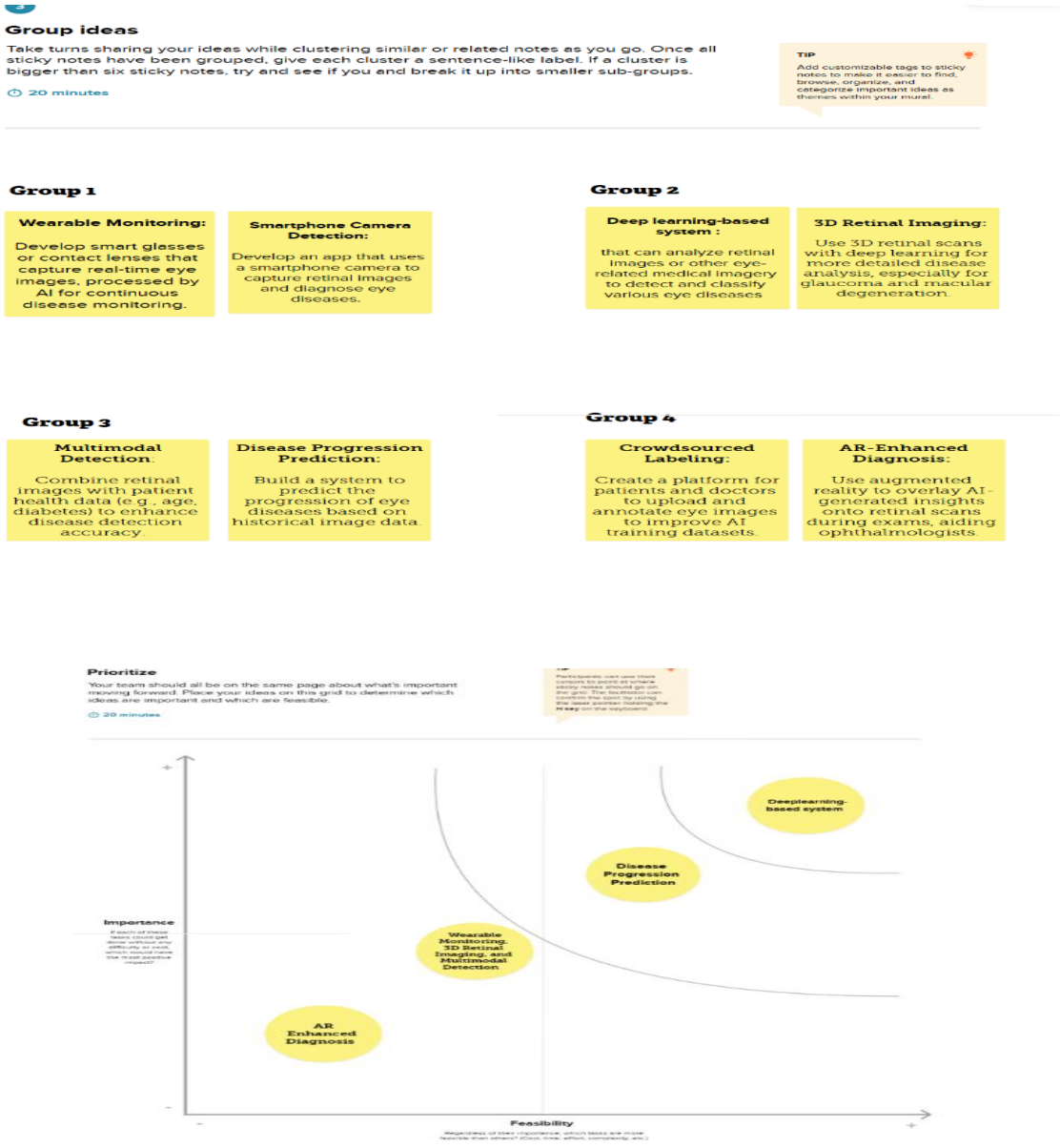
AI developers and medical equipment manufacturers see the potential of new technology to improve efficiency and accuracy, but budget constraints, lack of diverse datasets, and skepticism about AI's reliability slow down adoption. Public health researchers stress the importance of better funding, real-world clinical data, and scalable innovations to make eye care more accessible and affordable.

With growing demand for faster and more accurate diagnoses, there is a clear need for AI-powered tools that can reduce the manual workload of doctors, enhance patient care, and provide cost-effective solutions for clinics of all sizes. However, successful implementation will require affordable technology, strategic budget allocation, and trust-building among healthcare professionals to integrate AI into routine eye screenings effectively.



2.3 Brainstorming and Ideas:

The AI-Powered Eye Disease Detection System will utilize deep learning, multimodal analysis, and real-time AI enhancements to improve early detection, diagnosis, and disease monitoring. The most feasible solutions focus on automated AI analysis, smartphone-based screening, and predictive disease modeling. Long-term innovations such as wearable AI devices and AR-enhanced diagnostics have the potential to revolutionize eye healthcare but require further research and technological advancements. The next steps involve prototyping the AI model, testing different imaging techniques, and integrating the system into healthcare workflows. This will ensure scalability, accuracy, and accessibility, ultimately reducing preventable blindness worldwide.



3.REQUIREMENT ANALYSIS

3.1 Customer Journey Diagram:

The AI-Powered Eye Disease Detection System enhances the patient journey from awareness to follow-up care, ensuring early detection and diagnosis of eye diseases while reducing the manual workload of healthcare providers.

1. *Entice (Awareness & Interest)*
    - Patients learn about AI-based eye screening through hospitals, social media, and referrals.
    - Doctors and healthcare organizations promote early detection benefits.
2. *Enter (Getting Started)*
    - Users register on a mobile/web platform and upload retinal scans for analysis.
    - AI explains how the diagnosis works and guides users through the process.
3. *Engage (Diagnosis & Analysis)*
    - AI analyzes retinal images using deep learning, detects abnormalities, and classifies risk levels.
    - Users receive instant AI-generated reports, with doctor consultation options if needed.
4. *Exit (Results & Recommendations)*
    - Patients receive comprehensive reports and recommendations for follow-up actions.
    - If a high-risk condition is detected, the system schedules an appointment with a specialist.
5. *Extend (Follow-up & Monitoring)*
    - Users get reminders for follow-up screenings and eye health monitoring.
    - The system provides personalized health tips and long-term tracking dashboards.

3.1.1 Customer Journey MAP Image:

3.2 Solution Requirements:

The AI-Powered Eye Disease Detection System, also known as Vision AI, is designed to provide fast, accurate, and accessible diagnosis of eye diseases such as diabetic retinopathy, glaucoma, and macular degeneration through AI-based retinal image analysis. The system includes functional features like user registration, profile management, and secure login via email, Gmail, or LinkedIn, ensuring a seamless user experience. It also integrates email and OTP-based confirmations, password reset options, and AI-powered diagnostic tools to improve early disease detection and healthcare accessibility. Non-functional requirements ensure the system is user-friendly, secure, reliable, high-

performing, available, and scalable, making it suitable for hospitals, clinics, and remote healthcare applications. By leveraging deep learning models and cloud-based diagnostics, Vision AI aims to reduce manual workload, enhance diagnostic accuracy, and ensure early intervention to prevent vision loss globally.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Profile Management	Edit Profile Information Upload Profile Picture Change Password
FR-4	User Login	Login through Email/Password Login through Gmail Login through LinkedIn
	Forgot Password	Password Reset via Email Password Reset via OTP

Non-functional Requirements:

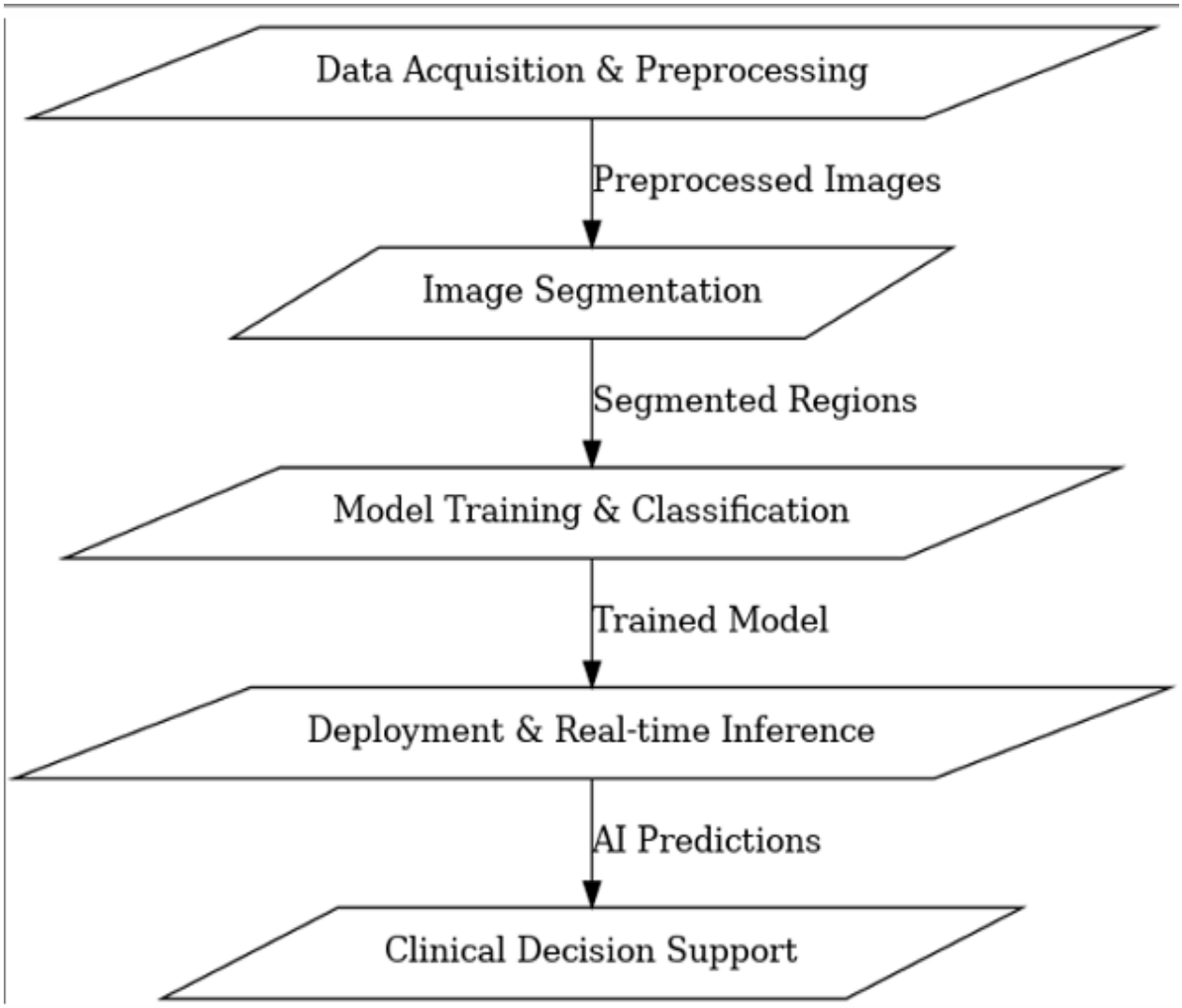
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The system should be easy to use, with a user-friendly interface that requires minimal training for end users.
NFR-2	**Security**	The system must ensure the protection of sensitive data and be resistant to unauthorized access or attacks.
NFR-3	**Reliability**	The system should function consistently under expected conditions, with minimal downtime or failures.
NFR-4	**Performance**	The system must meet defined speed and response time requirements, ensuring it operates efficiently even under load.
NFR-5	**Availability**	The system should be operational and accessible as needed, with minimal interruptions or downtime.
NFR-6	**Scalability**	The system must be able to handle increasing workloads or users without compromising performance or reliability

3.3 Dataflow Diagram:

The AI-Powered Eye Disease Detection System (Vision AI) is an advanced deep learning-based solution designed to detect and classify eye diseases such as diabetic retinopathy, glaucoma, and macular degeneration using retinal image analysis. The system offers seamless user registration, secure authentication, AI-driven diagnosis, and automated report generation, ensuring fast, reliable, and accessible healthcare solutions for patients, doctors, and healthcare providers.

Key functionalities include image upload, AI-powered detection, risk assessment, and cloud-based data storage, with a focus on scalability, security, and user experience. By integrating telemedicine, AI, and cloud computing, Vision AI aims to enhance diagnostic accuracy, reduce manual workload, and improve accessibility to early disease detection, ultimately helping prevent vision loss on a global scale.



3.4 Technology Stack:

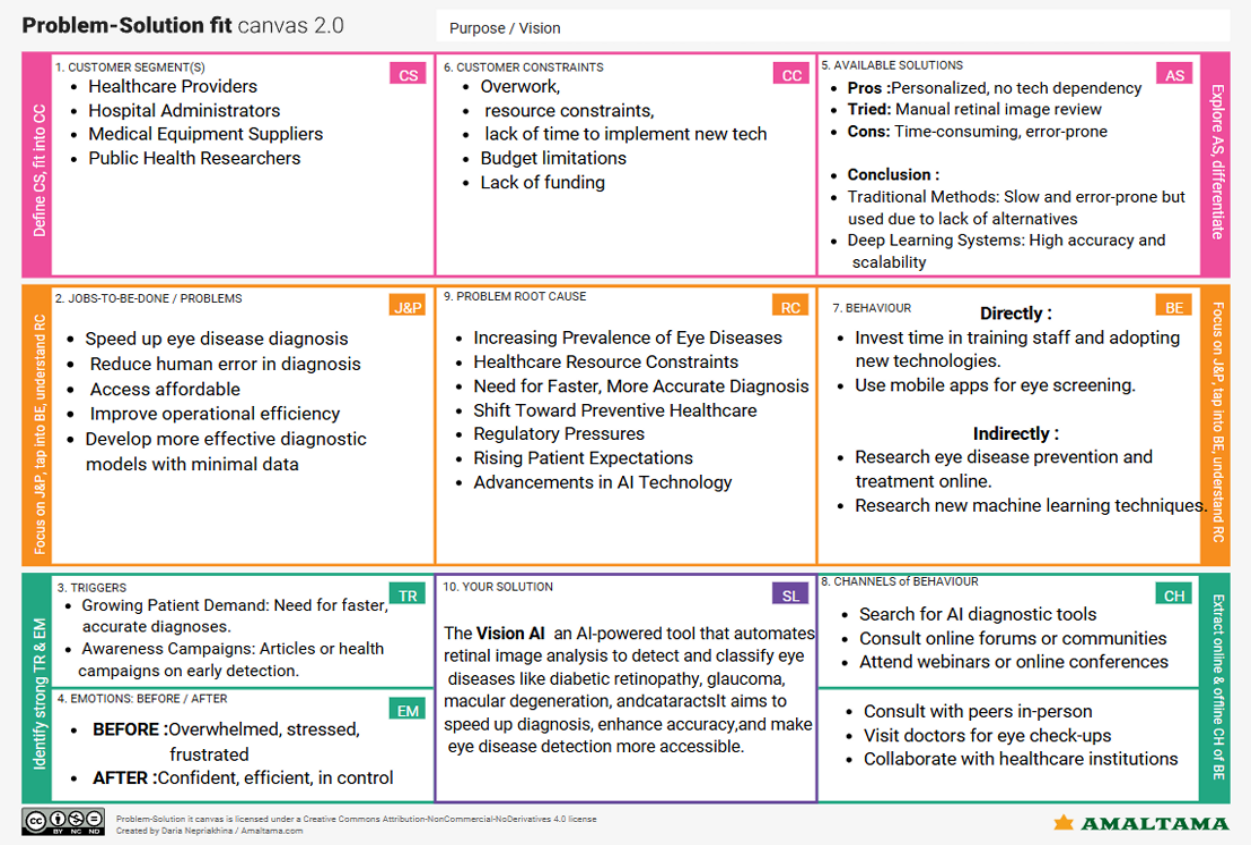
The Vision AI project is an AI-powered eye disease detection system that utilizes deep learning models, cloud computing, and scalable infrastructure to diagnose eye diseases such as diabetic retinopathy, glaucoma, and macular degeneration through automated retinal image analysis. The system features a React.js-based web interface for doctors and patients, Flask-based backend processing, and TensorFlow/Keras-powered machine learning models for image preprocessing, segmentation, and disease classification. It incorporates cloud-based storage (AWS, Firebase, MongoDB) for scalability, Docker/Kubernetes for microservices deployment, and security implementations such as AES-256 encryption and JWT authentication to ensure data privacy. Additionally, the platform leverages external APIs for image enhancement and authentication, making it a highly efficient, secure, and scalable diagnostic solution aimed at reducing vision loss through early disease detection.

S.No	Component	Description	Technology
1.	User Interface	Web UI for doctors and patients	React.js, HTML, CSS
2.	Application Logic-1	Image preprocessing & segmentation	Python, OpenCV, NumPy
3.	Application Logic-2	Model inference for disease detection	TensorFlow, Keras
4.	Application Logic-3	Patient report generation & insights	Flask, ReportLab, Matplotlib
5.	Database	Stores patient records and images	PostgreSQL, MongoDB
6.	Cloud Database	Cloud-based storage for scalability	Firebase, AWS RDS
7.	File Storage	Stores uploaded medical images	AWS S3, Google Drive API
8.	External API-1	Medical image enhancement	OpenAI DALL-E API
9.	External API-2	Authentication (e.g., Aadhaar API)	AWS Cognito, Aadhaar API
10.	Machine Learning Model	Eye disease classification using CNN	EfficientNetB3, VGG-16
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System and on Cloud	AWS EC2, Docker

4.Project Design

4.1 Problem Solution Fit:

The Vision AI project is a cutting-edge AI-powered system designed to automate the detection of eye diseases such as diabetic retinopathy, glaucoma, and macular degeneration using advanced deep learning models and cloud computing. The system addresses the challenges of slow, expensive, and inaccessible manual diagnosis methods by providing fast, accurate, and scalable AI-driven retinal image analysis. With a user-friendly web and mobile interface, cloud-based storage, and seamless integration with telemedicine platforms, Vision AI ensures early detection, reduces the workload of ophthalmologists, and enhances accessibility for patients in underserved areas. By leveraging secure authentication, encrypted data storage, and scalable deployment models, the system offers a cost-effective, high-performance solution to prevent vision loss globally.



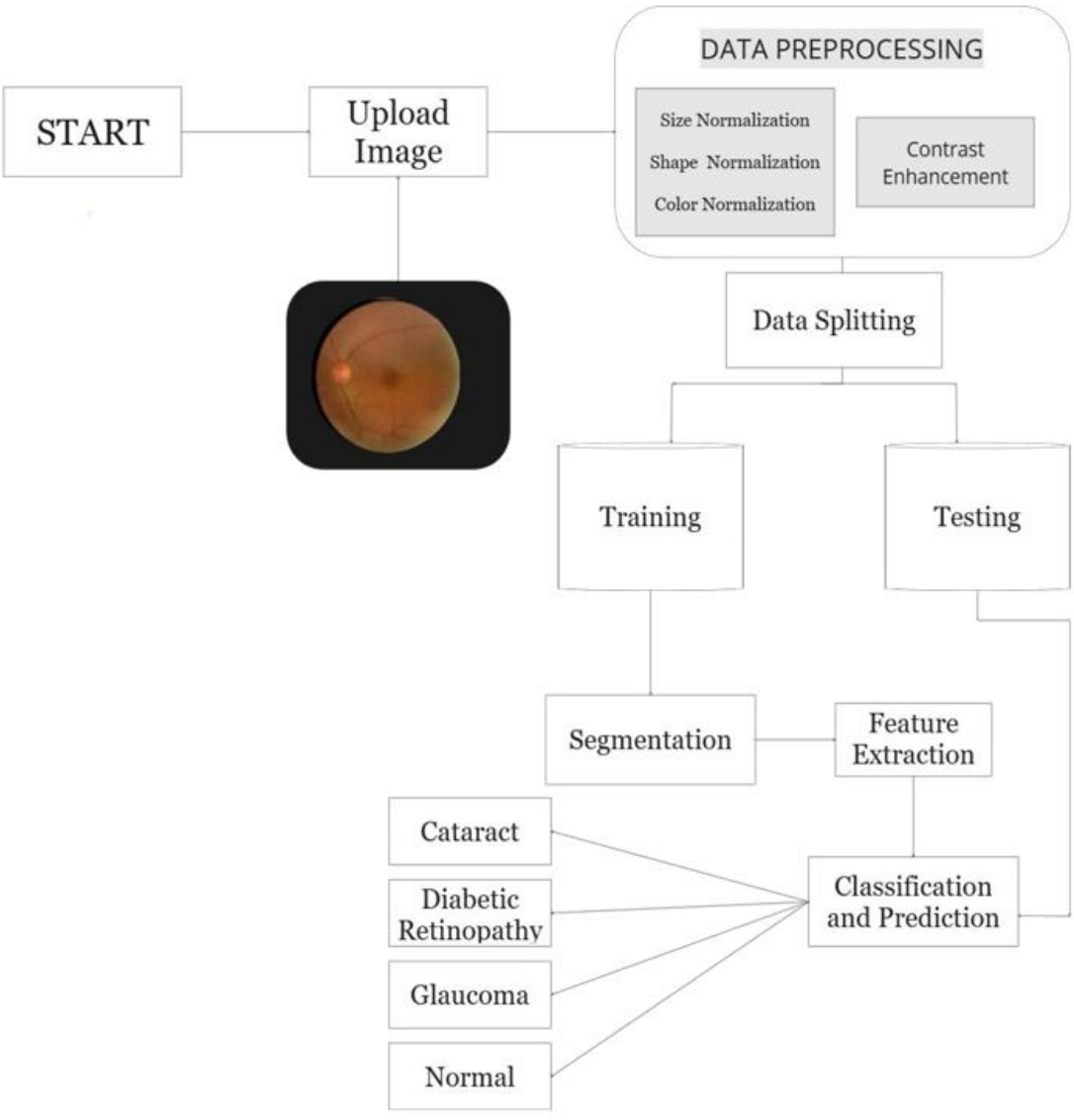
4.2 Proposed Solution:

The Vision AI project is an AI-powered eye disease detection system designed to automate the analysis of retinal images for early detection of diabetic retinopathy, glaucoma, and cataracts. Traditional diagnostic methods are slow, error-prone, and inaccessible due to the shortage of specialists and resources, making early intervention difficult. Vision AI leverages advanced deep learning models like EfficientNetB3 and U-Net to provide high-precision diagnosis, integrating with cloud-based platforms for scalability and accessibility. The system aims to reduce preventable vision loss, improve healthcare accessibility, and empower both patients and medical professionals with faster and more accurate diagnoses. The business model includes subscription plans for healthcare providers, licensing fees for large-scale systems, and a freemium model for patients, ensuring affordability and wide adoption. With scalable cloud integration, Vision AI is built to expand across hospitals, clinics, and telemedicine services, making AI-driven eye disease detection accessible worldwide.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Early detection of eye diseases like diabetic retinopathy, glaucoma, and cataracts is critical, but traditional diagnostic methods are slow, prone to human error, and inaccessible to many people due to a lack of specialists and resources.
2.	Idea / Solution description	The Eye Disease Detection System is an AI-powered tool that automates the analysis of retinal images to quickly and accurately detect and classify eye diseases, improving diagnosis speed and accessibility for healthcare providers and patients.
3.	Novelty / Uniqueness	The system combines advanced deep learning models, such as EfficientNetB3 and U-Net, to detect early-stage eye diseases with high precision. It leverages cloud-based integration for easy access and scalability, making it a unique, scalable solution for global healthcare needs.
4.	Social Impact / Customer Satisfaction	The system improves access to timely diagnosis, particularly in underserved areas, reduces preventable vision loss, and provides patients with quicker, more accurate diagnoses. It empowers both healthcare professionals and patients with actionable insights for better health outcomes.
5.	Business Model (Revenue Model)	The revenue model includes **subscription fees** for healthcare providers accessing the diagnostic tool, **one-time licensing fees** for large-scale systems, and a **freemium model** for patients to access basic diagnostic results, with premium features offered for detailed reports.
6.	Scalability of the Solution	The cloud-based platform can scale to accommodate increasing volumes of diagnostic images and users. Its flexible integration with existing healthcare systems, coupled with low-cost AI models, enables it to expand across hospitals, clinics, and telemedicine services globally.

4.3 Solution Architecture:

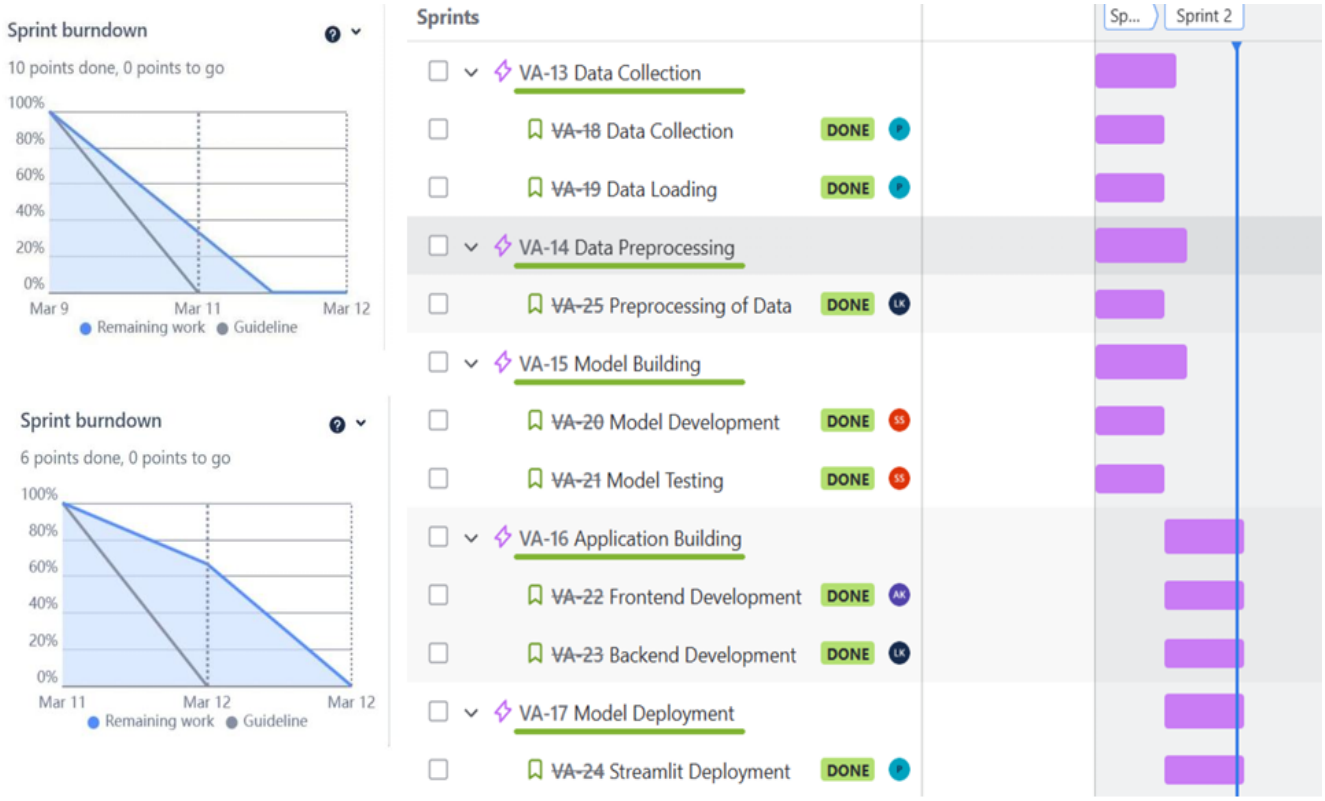
The Vision AI project is an AI-powered eye disease detection system that leverages deep learning models and cloud-based architecture to provide fast, accurate, and accessible retinal disease diagnosis. By automating the detection of diabetic retinopathy, glaucoma, and macular degeneration, Vision AI addresses the challenges of slow manual diagnosis, limited specialist availability, and high healthcare costs. The system integrates AI-based image analysis, cloud storage, secure authentication, and telemedicine capabilities to ensure scalability, efficiency, and real-time accessibility. Designed for hospitals, clinics, and remote healthcare providers, Vision AI enhances early detection, reduces preventable blindness, and streamlines ophthalmic diagnostics using a secure, high-performance, and cost-effective solution.



5.Project Planning & Scheduling

5.1 Project Planning:

The Vision AI project is an AI-driven eye disease detection system designed to automate the analysis of retinal images for early detection of conditions like diabetic retinopathy, glaucoma, and macular degeneration. The project follows an agile development approach, with planned sprints covering data collection, preprocessing, model development, frontend/backend development, and AI deployment. Using deep learning models and cloud-based infrastructure, Vision AI provides fast, accurate, and scalable solutions for healthcare providers and patients, reducing diagnostic delays and enhancing accessibility to eye care. With a structured product backlog, sprint planning, velocity tracking, and burndown charts, the project ensures efficient execution and continuous improvements, ultimately aiming to prevent vision loss and revolutionize AI-assisted ophthalmic diagnostics.



6.Functional and Performance Testing

6.1 Performance Testing:

VisionAI is an AI-powered eye disease detection system that leverages deep learning models for automated analysis of retinal images, enabling early detection of diseases such as diabetic retinopathy, glaucoma, and macular degeneration. The system incorporates image preprocessing, segmentation, and feature extraction to enhance diagnostic accuracy. The AI model undergoes rigorous training, validation, and testing, ensuring high precision in disease prediction. VisionAI features a user-friendly dashboard, developed with Streamlit, HTML, CSS, and Java, allowing seamless interaction for patients and healthcare professionals. The system provides real-time predictions, diagnostic reports, and a scalable, cloud-based architecture, making AI-assisted ophthalmic diagnostics more accessible and efficient for hospitals, clinics, and telemedicine services.

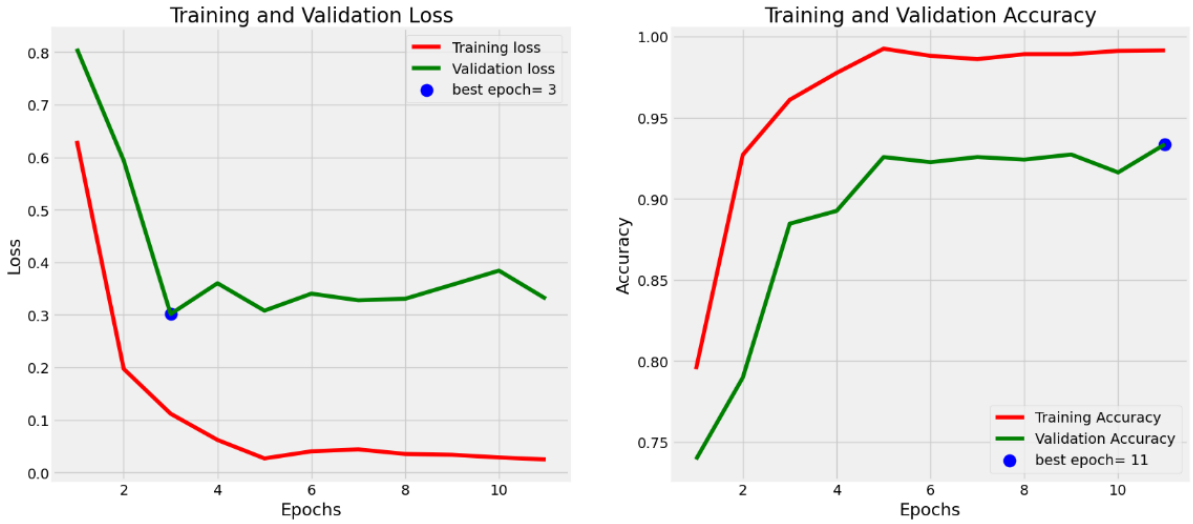


Fig 6.1: Model Training & Validation Accuracy

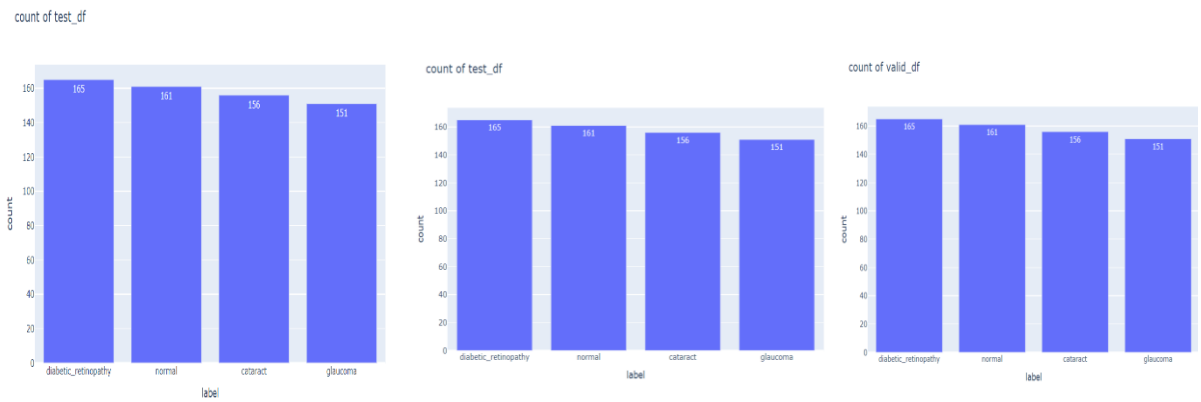


Fig 6.2: Count of Train, Test & Validation of Data

7.RESULTS

7.1 Output Screenshots:

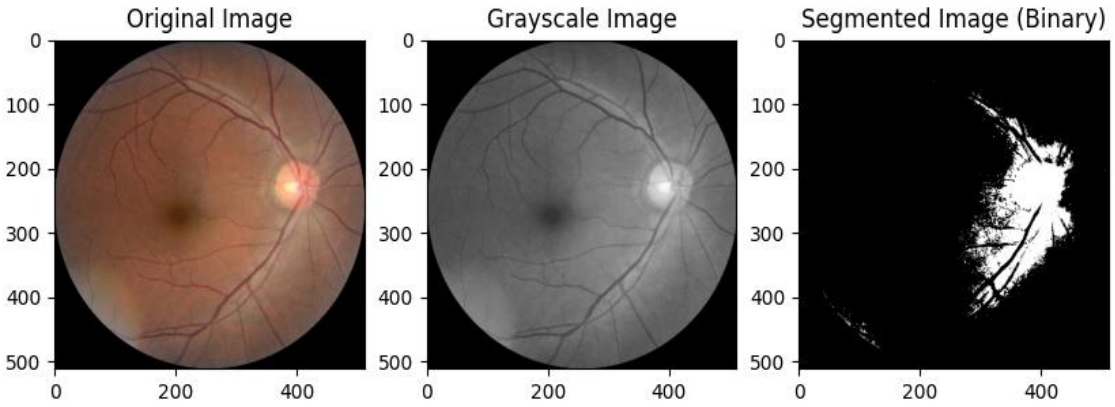


Fig 7.1: Image preprocessing, Segmentation & Feature Extraction of an Eye Image

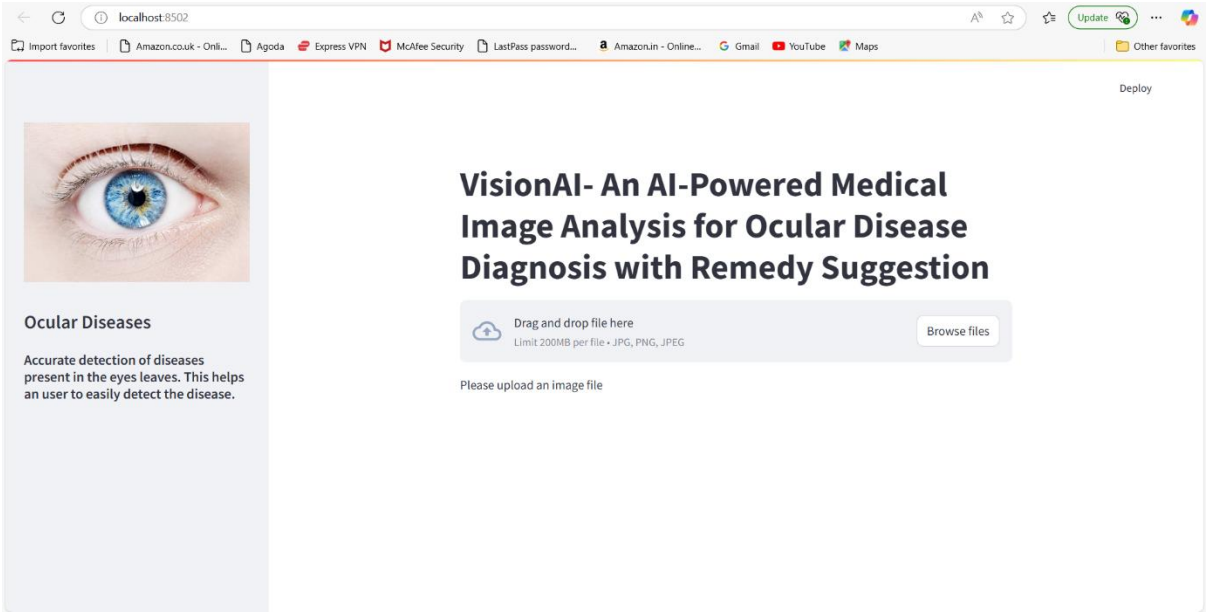


Fig 7.2: UI or Dashboard by Streamlit of VisionAI

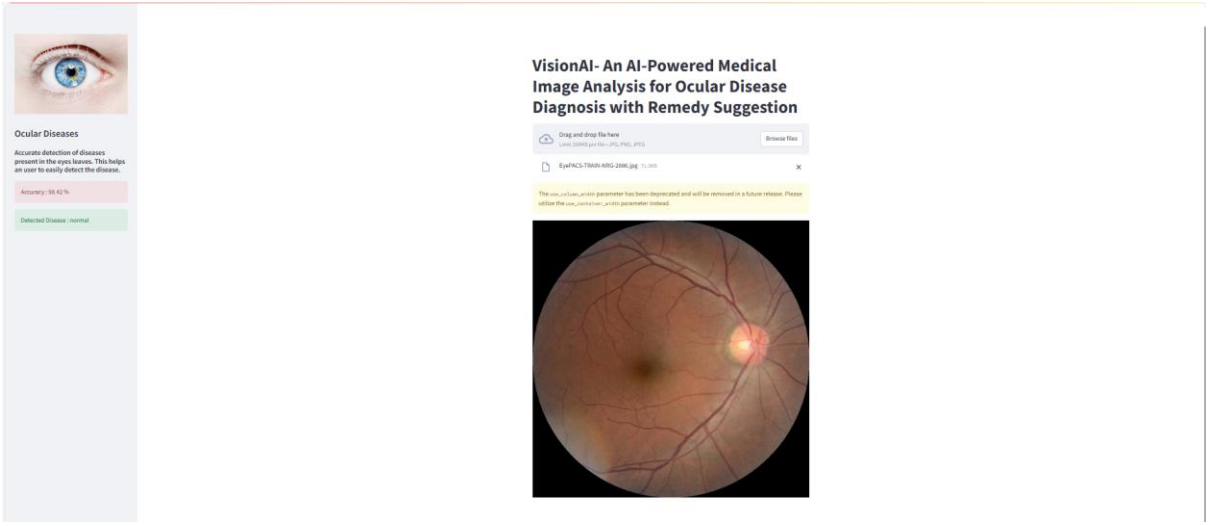


Fig 7.3: Predicated eye disease by using of VisionAI in Streamlit

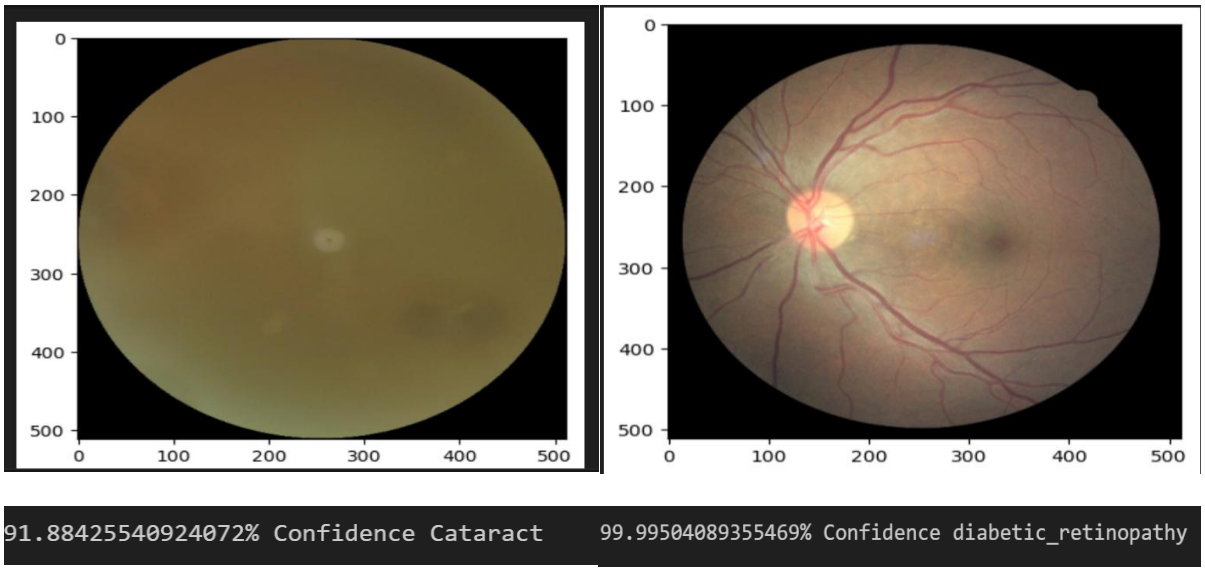


Fig7.4: Final Predication of Eye Disease

	precision	recall	f1-score	support
cataract	0.88	0.95	0.91	156
diabetic_retinopathy	1.00	0.99	0.99	165
glaucoma	0.85	0.81	0.83	151
normal	0.89	0.86	0.87	161
accuracy			0.91	633
macro avg	0.90	0.90	0.90	633
weighted avg	0.91	0.91	0.90	633

Fig7.5: Final Predication of Given Data

8.Advantages & Disadvantages

8.1 Advantages

- Early Disease Detection – AI-powered retinal analysis enables early diagnosis of diabetic retinopathy, glaucoma, and cataracts, reducing the risk of vision loss.
- Faster and Automated Diagnosis – Reduces manual screening time from hours to minutes, allowing instant AI-based results.
- Improved Accuracy – Uses deep learning models (EfficientNetB3, U-Net) to provide high-precision disease classification, minimizing human error.
- Accessibility and Scalability – The system is cloud-based, making it accessible in remote areas and easily scalable for hospitals and clinics.
- Cost-Effective Solution – AI-driven diagnostics reduce the need for expensive medical equipment and manual expert screening costs.
- User-Friendly Interface – The system is designed with a simple dashboard (Streamlit, HTML, CSS, Java) for easy interaction by doctors and patients.
- Real-Time Results and Reporting – Generates instant diagnostic reports, allowing patients to seek timely medical intervention.
- Integration with Healthcare Systems – Can be linked with telemedicine platforms for seamless patient management and doctor consultations.
- Automated Follow-Up and Monitoring – The system provides automated health tracking and follow-up reminders, ensuring continuous patient care.

8.2 Disadvantages

- Dependence on High-Quality Retinal Images – The accuracy of AI predictions depends on clear, high-resolution images, which may not always be available.
- Limited Trust in AI Diagnoses – Some patients and doctors may hesitate to rely entirely on AI for medical decisions, requiring human validation.
- Potential False Positives/Negatives – AI models can sometimes misclassify diseases, leading to unnecessary anxiety or missed diagnoses.
- Data Privacy Concerns – Handling sensitive medical images and patient data requires strong encryption and compliance with healthcare regulations.
- Technical Barriers in Adoption – Some clinics may lack the infrastructure to implement AI-based diagnostic systems, limiting accessibility.
- High Initial Training and Setup Costs – While cost-effective in the long run, developing, training, and deploying AI models requires significant initial investment.
- AI Model Requires Continuous Training – The model must be regularly updated with new medical datasets to improve accuracy and adapt to new diseases.
- Challenges in Real-World Integration – Integrating AI seamlessly into existing hospital workflows and medical imaging systems may be complex.
- Regulatory and Compliance Issues – The system must meet healthcare standards and legal compliance (e.g., HIPAA, GDPR) before full deployment.

9.Conclusion

- The ***VisionAI*** project is a groundbreaking AI-powered eye disease detection system designed to revolutionize ophthalmic diagnostics by leveraging deep learning and cloud-based technologies. By automating retinal image analysis, VisionAI provides faster, more accurate, and accessible diagnoses for diabetic retinopathy, glaucoma, cataracts, and other eye diseases, addressing the limitations of traditional manual screening methods.

- The key advantages of VisionAI include early disease detection, real-time diagnosis, enhanced accuracy, reduced workload for healthcare professionals, and greater accessibility to eye care, especially in underserved areas. Its scalable cloud-based infrastructure, integration with telemedicine, and AI-driven automation make it a cost-effective and high-impact solution for hospitals, clinics, and mobile health services.

- However, challenges such as data privacy concerns, the need for high-quality retinal images, regulatory compliance, and potential trust issues with AI-based diagnostics must be addressed to ensure widespread adoption and long-term sustainability. Continuous AI model training, seamless integration with existing healthcare systems, and patient awareness initiatives will be crucial for the system’s success.

- In conclusion, VisionAI has the potential to transform global eye care, reducing preventable blindness and improving healthcare accessibility through innovative AI-driven technology. With ongoing improvements, strategic implementation, and regulatory compliance, VisionAI can become a pioneering force in AI-assisted medical diagnostics, making vision-saving healthcare solutions more efficient, reliable, and accessible worldwide.

10.Future Scope

- Multi-Disease Detection – Expand AI to detect AMD, retinal detachment, hypertensive retinopathy, and ocular melanoma.

- Smartphone & Wearable Integration – Develop mobile-based AI screening and integrate with smart glasses or AI-powered contact lenses for real-time eye monitoring.

- AI-Driven Disease Tracking – Enable predictive analytics to track disease progression and personalize treatment recommendations.

- Enhanced AI Models – Use federated learning for privacy-focused AI training, improving accuracy and self-learning capabilities.

- Global Accessibility – Deploy low-cost AI screening kits for rural and underprivileged regions, supported by governments and NGOs.

- Cross-Medical AI Expansion – Extend AI to detect systemic diseases (diabetes, hypertension) from retinal scans and integrate with Electronic Health Records (EHRs).

- Regulatory Compliance & Ethical AI – Achieve FDA, CE, HIPAA approvals for global adoption, ensuring trust, transparency, and medical standardization.

11.Appendix

- SOURCE CODE Link:

  https://github.com/Prashantpacific53/VisionAI--An_AI_Eye_Disease_Detection_Using_Deep_Learning_-Smartinternz-.git

- Dataset Link:

  https://www.kaggle.com/datasets/gunavenkatdoddi/eye-diseases-classification

- Github & Project Demo Link:

  Github Link

  https://github.com/Prashantpacific53/VisionAI--An_AI_Eye_Disease_Detection_Using_Deep_Learning_-Smartinternz-.git

  Demo Video Link

  https://drive.google.com/file/d/13mplqYdRQcd-jrvLT_jR_oncVlZYDUSf/view?usp=drivesdk

Thank You Note,

"Thank you for taking the time to explore our project, ***VisionAI:*** *AI-Powered Medical Image Analysis for Disease Diagnosis. We hope our work contributes meaningfully to advancements in the field of medical technology. Your feedback is highly valued and appreciated."*

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