Funds Eye

AI-Powered Diabetic Retinopathy Screening & Patient Management System

Project Overview

Fundus Eye is a cross-platform mobile healthcare application developed using **Flutter**, designed to assist in the early screening of **Diabetic Retinopathy (DR)** through AI-based analysis of retinal fundus images. The system integrates **on-device machine learning (TensorFlow Lite)** with a **secure cloud backend (Firebase)** to provide a complete solution for patient data management, image acquisition, automated diagnosis, and report generation.

The application is optimized for use in clinics, hospitals, and remote healthcare environments where quick, reliable preliminary screening is required.

Problem Statement

Diabetic Retinopathy is a leading cause of preventable blindness worldwide. Early detection is critical, yet many regions lack access to specialized ophthalmologists and diagnostic equipment. Manual screening is time-consuming, costly, and dependent on expert availability.

There is a strong need for a **portable, cost-effective, and intelligent screening tool** that can assist healthcare professionals in identifying DR at an early stage.

Technical Stack

Frontend & Mobile Framework
- **Flutter (Dart):** Utilized for its **Single Codebase** efficiency, ensuring a pixel-perfect UI and consistent performance across both Android and iOS devices.
- **Provider (State Management):** To maintain a clean separation between the UI and business logic, ensuring the app remains scalable and easy to test.

On-Device Artificial Intelligence
- **TensorFlow Lite (TFLite):** Implemented a **Quantized CNN Model** for edge inference. This allows the app to perform medical screening in under 2 seconds without requiring an active internet connection, protecting patient data by keeping it on the device.
- **Bilinear Image Pre-processing:** Custom Dart logic to resize and normalize raw camera frames to 224\224 pixels, optimizing them for model accuracy.

Cloud Infrastructure & Security
- **Firebase Authentication:** Provides secure, industry-standard OAuth 2.0 and multi-factor authentication for healthcare professionals.
- **Cloud Firestore:** A NoSQL document database used for real-time synchronization of patient metadata and diagnostic history.
- **Firebase Storage:** Secure, scalable bucket storage for high-resolution fundus images, mapped via unique UUIDs to maintain data integrity.

Hardware & System Integration
- **Camera API (Flashlight Override):** Low-level hardware integration to programmatically control the LED flash, ensuring high-fidelity retinal illumination during capture.
- **PDF Template Engine:** A custom reporting module that injects patient data and AI results into a professional medical template.
- **Platform-Specific Intents:** Integration with **Android/iOS Share Sheets** to enable direct "One-Click" distribution to WhatsApp, Email, or Wi-Fi-enabled printers.

<u>Core Features</u>

1. **Automated Retinal Diagnostic Analysis**
   - **Multi-Stage Classification:** Employs a deep learning model to instantly categorize fundus images into five clinically recognized stages: No DR, Mild, Moderate, Severe, and Proliferative DR.
   - **Instant Qualitative Output:** Provides real-time feedback to the clinician, reducing the diagnostic window from days to seconds.
2. **Advanced Hardware Integration**
   - **Programmatic Flashlight Control:** Deep integration with the Mobile Camera API to force an "Always-On" LED flash state, ensuring the retina is perfectly illuminated for high-fidelity imaging.
   - **Intelligent Capture Interface:** Custom camera overlay designed specifically for ophthalmic use, helping the user align the lens for optimal retinal centering.
3. **"Edge-First" AI Architecture**
   - **Offline Inference Engine:** All AI analysis is performed locally on the handset using the TensorFlow Lite interpreter, allowing for life-saving screenings in remote areas without internet access.
   - **Low-Latency Processing:** Optimized model execution ensures that the classification and confidence scores are generated without taxing the device's thermal or battery performance.
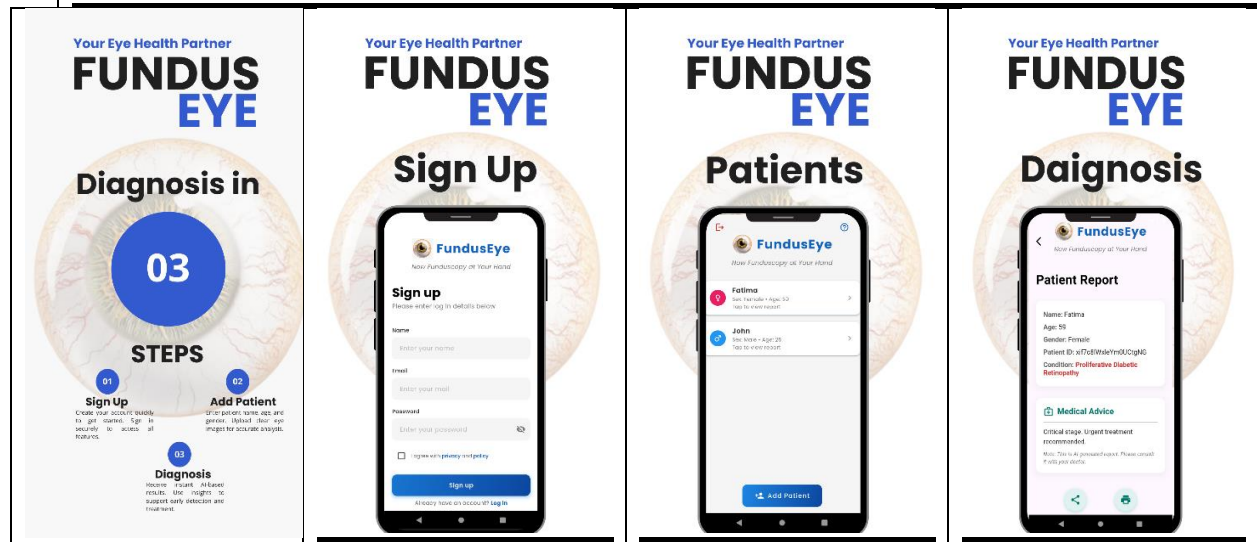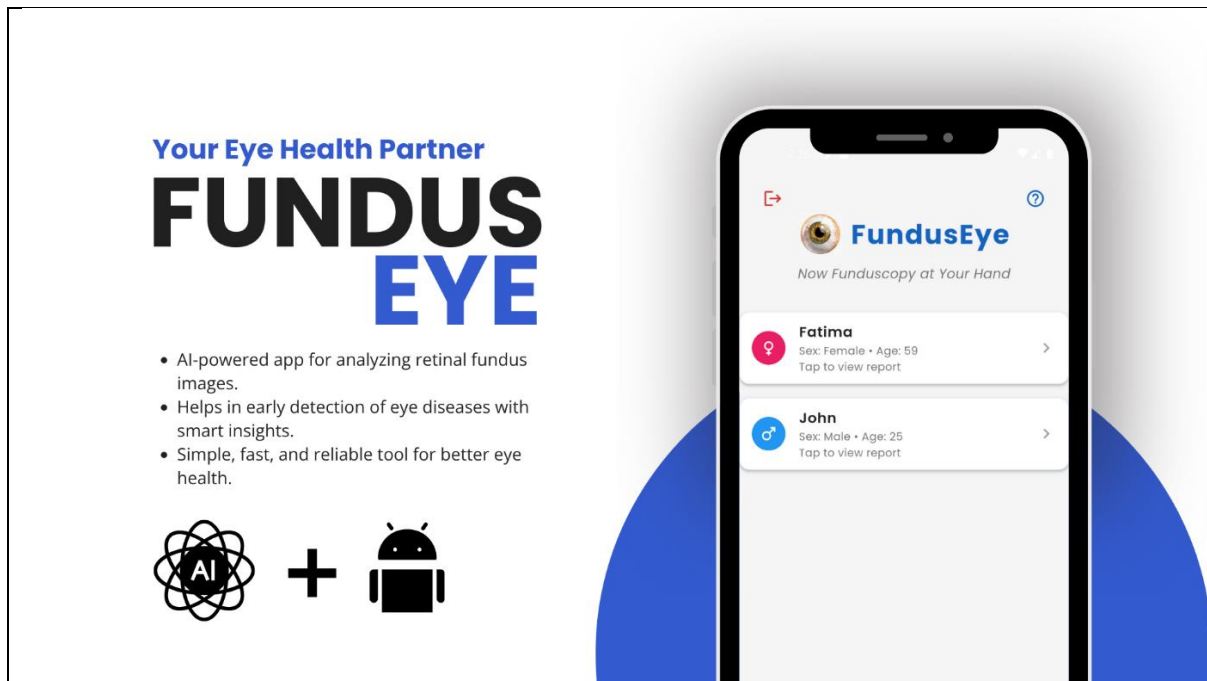4. **Secure Data Persistence & Compliance**
   - **HIPAA-Compliant Sync:** Utilizes industry-standard encryption for data at rest and in transit, ensuring all patient records meet global healthcare privacy standards.
   - **Cloud Archival:** Automated synchronization with Firebase Cloud Firestore ensures that patient history and diagnostic images are backed up and accessible across authorized devices.
5. **Professional Medical Reporting**
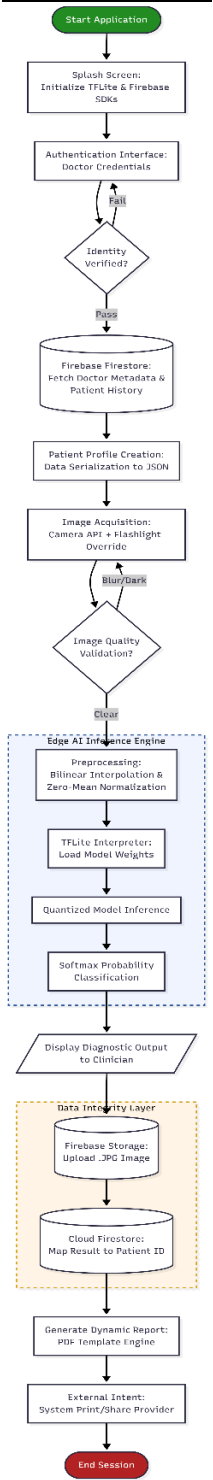   - **Dynamic PDF Generation:** Automatically compiles patient demographics, captured retinal images, and AI grading into a professional, ready-to-print medical document.
   - **Multi-Channel Distribution:** Integrated sharing module that utilizes system intents to allow instant report transmission via WhatsApp, Email, or WiFi-enabled printers.

Graphical UI

System Architecture Flowchart

Flow Chart

Application Flow

🚀 **APP CLICK**

Splash Screen
(Logo & Permissions)

Session Found?

No

Onboarding
(App Tutorials)

Account?

Sign Up → **Sign Up Screen** (Create Profile)

Sign In → **Sign In Screen** (Enter Credentials)

Verification Screen
(OTP/Email)

Syncing Data
(Firebase Auth)

Main Home Screen
(Dashboard)

[+] Add Patient

⚙ **Settings**

Patient Form

Edit Profile

Help & Support

About FundsEye

LOGOUT

Input Details

Name	Age	Sex

Camera Interface

Flashlight: ON

Capture Image

Processing...
(AI Analysis Engine)

Result Display
(DR Grade & Score)

Cloud Upload

📊 **History List**

Select Patient

Medical Report

Export

WhatsApp	Print PDF	Email