Project Design Phase
Solution Architecture

Date	08/02/2026
Team ID	LTVIP2026TMIDS83275
Project Name	Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy
Maximum Marks	4 Marks

Solution Architecture:

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1. Architecture Overview

The proposed system follows a Three-Tier Client–Server Architecture consisting of:

1. Presentation Layer (User Interface)
2. Application Layer (Backend Processing)
3. Model Layer (Deep Learning Inference Engine)

The system is designed to automate diabetic retinopathy detection using a trained Convolutional Neural Network (CNN) model integrated with a web-based application.

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2. High-Level Architecture Flow

User
↓
Web Interface (HTML/CSS)
↓
Flask Backend Server
↓
Image Preprocessing Module
↓
Deep Learning CNN Model
↓
Prediction Output
↓
Result Display on UI

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3. Layer-wise Architecture Description

◈ 3.1 Presentation Layer (Front-End)

Purpose:
Handles user interaction.

Components:

- Web interface for image upload
- Result display section
- Severity classification output

Technologies Used:

- HTML
- CSS
- JavaScript (optional)
- Bootstrap (optional)

Function:

- Accept retinal fundus image (.jpg/.png)
- Send image to backend for processing
- Display prediction result

🔷 3.2 Application Layer (Backend Logic)

Purpose:
Controls business logic and communication between UI and model.

Components:

- Flask Server
- Image Validation
- Image Preprocessing Module
- Model Loader

Technologies Used:

- Python
- Flask
- NumPy
- OpenCV / PIL

Functions:

- Receives uploaded image
- Resizes image (e.g., 224x224)
- Normalizes pixel values
- Converts image to tensor format

- Sends processed image to CNN model
- Receives prediction
- Returns result to UI

◈ 3.3 Model Layer (Deep Learning Engine)

Purpose:
Performs classification of diabetic retinopathy severity.

Model Type:

- Convolutional Neural Network (CNN)

Technologies Used:

- TensorFlow
- Keras

Model Operations:

- Feature extraction via convolution layers
- Pooling layers for dimensionality reduction
- Fully connected layers
- Softmax output layer for classification

Output Classes Example:

- No DR
- Mild
- Moderate
- Severe
- Proliferative DR

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4. Data Flow Description

1. User uploads fundus image.
2. Image stored temporarily on server.
3. Image preprocessing applied.
4. Processed image fed to trained CNN model.
5. Model predicts severity class.
6. Result displayed to user.

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5. Deployment Architecture

◈ Local Deployment

- Python Virtual Environment
- Flask Development Server
- Local CPU execution

◈ Cloud Deployment (Optional)

- Cloud Platform (Railway / AWS / Azure)
- Gunicorn WSGI Server
- Containerized Deployment (Docker – optional)

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6. Architecture Characteristics

- Modular design
- Model separated from UI
- Easy retraining capability
- Stateless inference
- Scalable cloud-compatible structure

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7. Security Considerations

- Secure file upload validation
- Limited file type acceptance
- No permanent storage of patient images
- HTTPS-based deployment (for cloud)

Solution Architecture Diagram

Figure 1: Architecture and Data Flow Diagram

User

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Web Interface (Upload Image)

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Flask Backend

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Image Preprocessing

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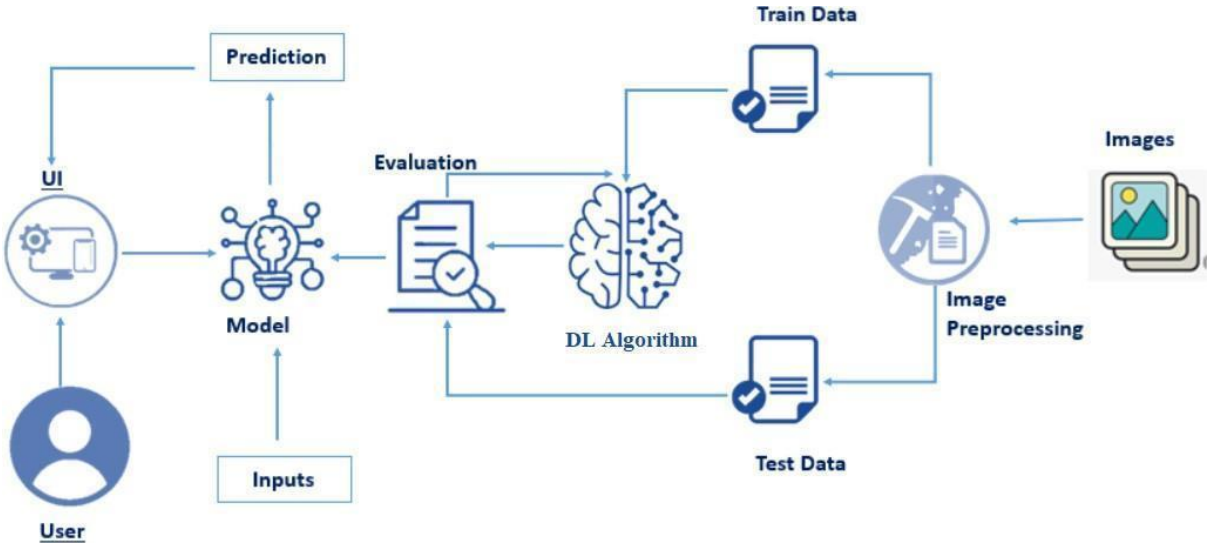
CNN Model (.h5)

↓

Prediction Output

↓

Result Display on UI



Flow:

Fundus Image Dataset → Preprocessing → Train/Test Split → CNN Model Training → Evaluation → Model Saving (.h5) → Web Integration → Prediction → User

Training Phase Flow:

Dataset → Preprocessing → Train/Test Split → CNN Training → Evaluation → Save Model