Software Design Specification

<Smart Mirror – AI-Based Eyewear Suitability System>

Project Code:
AUZ-272032

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Project Managers Signature

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Definition of Terms, Acronyms and Abbreviations

Term	Description
AI	Artificial Intelligence
CNN	Convolutional Neural Network
UI	User Interface
OpenCV	Open-Source Computer Vision Library
Raspberry Pi	Single-board computer used as processing unit Virtual Try-on

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1. Introduction

1.1 Purpose of Document

The purpose of this Software Design Specification (SDS) is to comprehensively describe the architectural design, system components, and logical data models for the **Smart Mirror - AI Based Eyewear Recommendation System**. This document translates the requirements defined inthe Software Requirements Specification (SRS) into a technical blueprint for implementation. It isintended for the project team, internal advisors, and software developers to ensure a unified understanding of the system's internal structure, interfaces, and data flows. The design methodology employed relies on Object-Oriented Design (OOD) principles and Component Based Architecture.

1.2 Project Overview

The "Smart Mirror" is an innovative retail solution designed for optical shops to alleviate the difficulty customers face when selecting eyeglass frames. Traditional frame selection often relies on subjective opinions or manual trial-and-error, leading to customer indecision.This system integrates a two-way mirror with a high-definition camera and a dedicated processing unit (Raspberry Pi). As a customer stands in front of the mirror, the system automatically capturestheir facial image. Utilizing advanced Computer Vision and Artificial Intelligence (specificallyConvolutional Neural Networks), the system analyzes facial landmarks and face shape. Based onthis analysis, the system computes a "Suitability Score" and retrieves the best-matching frames from a local database, displaying the recommendations directly on the mirror's reflective surface.

1.3 Scope

The scope of the project is strictly defined to the development of a functional prototype for **in store usage**.

- **In-Scope Functions:** Real-time facial image capture, face detection, landmark extraction, AI-based shape classification, suitability scoring (0-100%), and local database management for frame inventory .
- **Out-of-Scope Functions:** The system will **not** include online purchasing capabilities, cloud-based storage, or Augmented Reality (AR) virtual try-on features in this release.
- **Constraint:** All data processing occurs locally to ensure privacy and functionality without continuous internet access.

2. Design Considerations

2.1 Assumptions and Dependencies

The design of the Smart Mirror is predicated on several key assumptions established in the SRS:
• **Environmental Lighting:** It is assumed that the optical shop will provide consistent, adequate lighting to ensure the camera can capture clear images for the AI analysis.
• **Single User Interaction:** The system is designed to process one user at a time standing directly in front of the mirror.
• **Data Availability:** A labeled dataset of (Face Image, Worn Frame, Suitability Score) is assumed to be available for training the CNN model.
• **Hardware Stability:** It is assumed that the Raspberry Pi and camera module will operate within standard temperature and voltage ranges, supported by a reliable power supply.

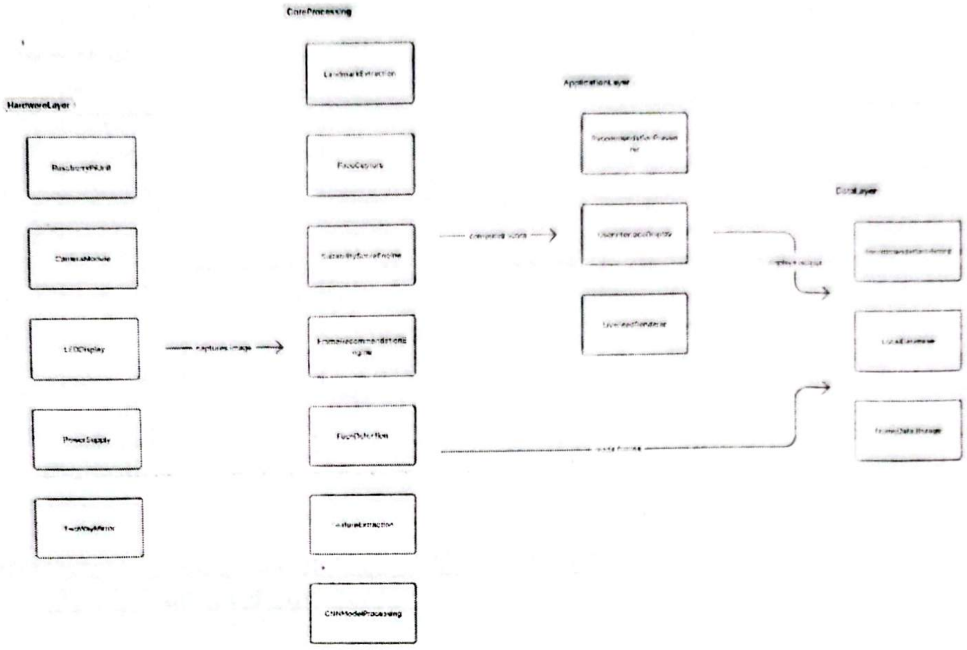
2.2 Risks and Volatile Areas

Several areas of the design present risks that require mitigation strategies:
• **Processing Latency:** The Raspberry Pi has limited computational power compared to desktop GPUs. There is a risk that complex CNN models may exceed the 8-second response time requirement. *Mitigation:* The design incorporates TensorFlow Lite for model optimization.
• **Lighting Sensitivity:** Computer vision algorithms are sensitive to backlighting or low light. *Mitigation:* The system uses image preprocessing and normalization components.
• **Data Privacy:** Storing images raises privacy concerns. *Mitigation:* The system is designed to process data in volatile memory and only store metadata (scores/history) in the local SQLite database, deleting images after the session.

3. System Architecture

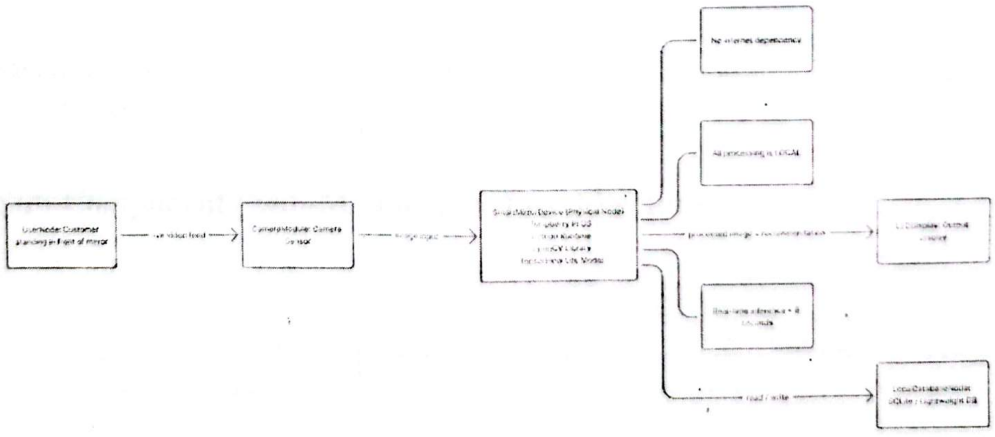
3.1System Level Architecture

Package diagram:



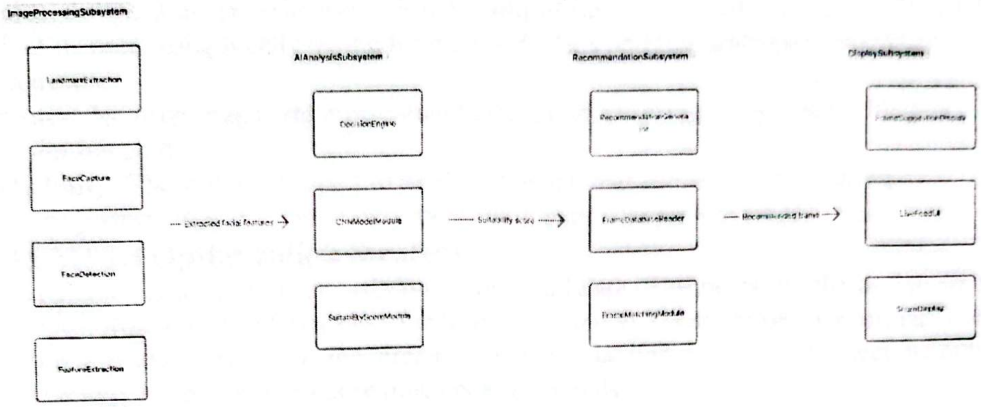
Source: https://www.figma.com/file/vHmOQC1rYRXjeBZDTBEXRr/Smart-Mirror-%E2%80%93-Package-Architecture

Deployment diagram:



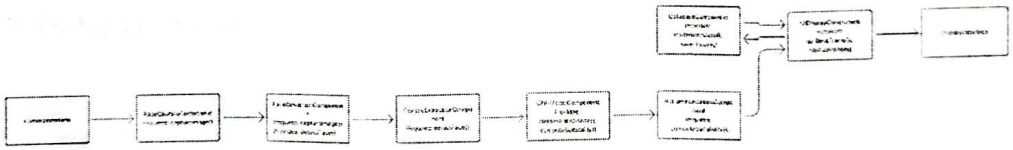
Source:https://www.figma.com/file/7WkXQ3qjS893sMuJXMr1nS/Smart-Mirror-%E2%80%93-Deployment-Architecture

3.2 Component Diagram:



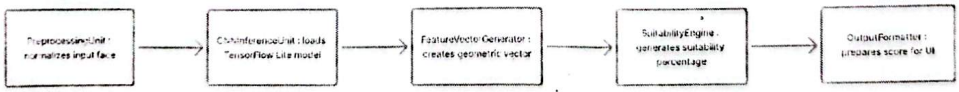
Source:https://www.figma.com/file/JYGGfmMEBcrndUsKL6WnXm/Smart-Mirror-%E2%80%93-Component-Architecture

Sub System / Module Level Architecture:



Source:https://www.figma.com/file/XlzKXIwu0jE3dm1vgrNQoz/Smart-Mirror-%E2%80%93-Subsystem-View

3.3 Sub-Component / Sub-Module Level Architecture



Source: https://www.figma.com/file/SEih49izU0qdd3SIqgKree/AI-Analysis-Submodule

4.Design Strategies

4.1 Edge Computing Strategy (Privacy & Reliability)

A critical design strategy is the use of **Edge Computing**. The system is architected to perform 100% of its processing locally on the Raspberry Pi. This decision addresses two major requirements:

1. **Privacy:** No user images are transmitted to the cloud, ensuring compliance with data protection standards.
2. **Reliability:** The system removes dependency on internet connectivity, ensuring consistent performance in retail environments with poor network coverage.

4.2 AI Model Optimization Strategy

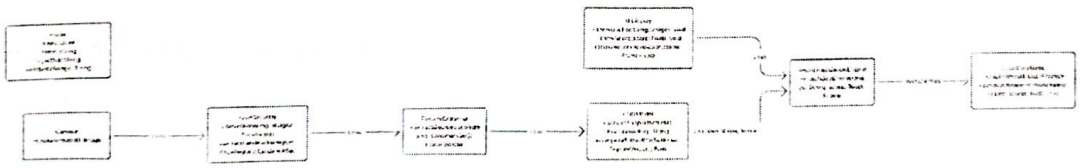
To run complex computer vision tasks on limited hardware (Raspberry Pi), the design employs **Model Quantization**. The CNN model will be converted to **TensorFlow Lite** format. This strategy reduces the model size and inference latency, enabling the system to meet the non functional requirement of a response time under 8 seconds.

4.3 "Magic Mirror" User Interface Strategy

The user interface design follows the "Magic Mirror" paradigm. The UI is rendered on a black background, which becomes transparent when displayed behind a two-way mirror. This creates an augmented reality effect where digital information (scores, frames) appears to float over the user's reflection. The strategy prioritizes minimalism—showing only the live feed and the recommendation—to avoid overwhelming the user.

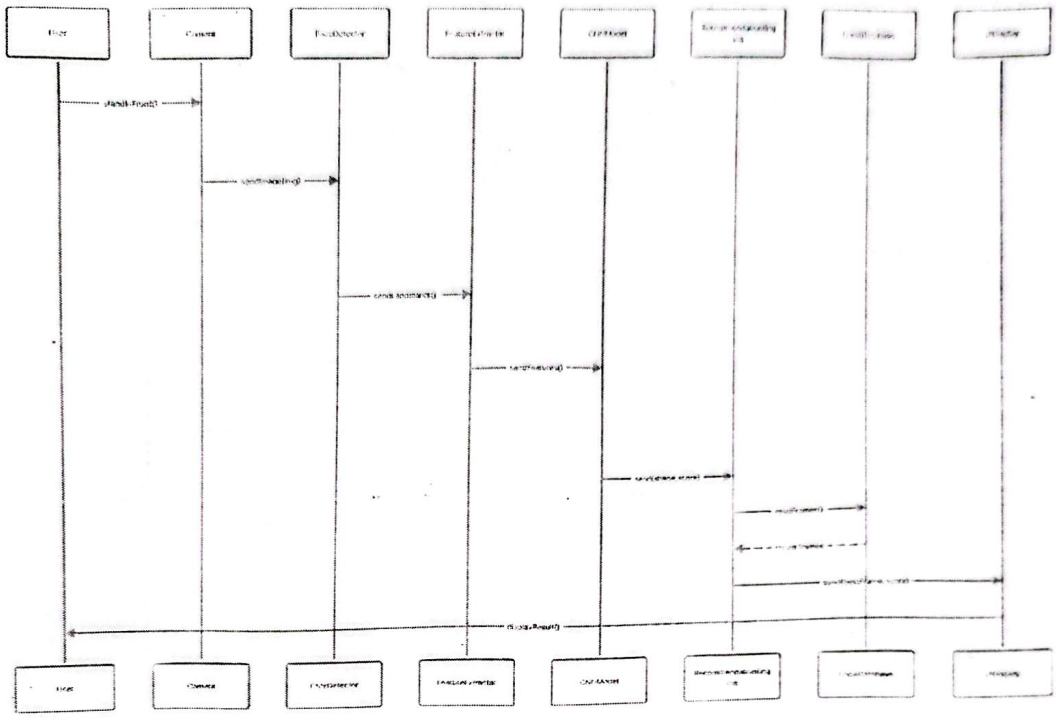
4. Detailed System Design

CLASS DIAGRAM



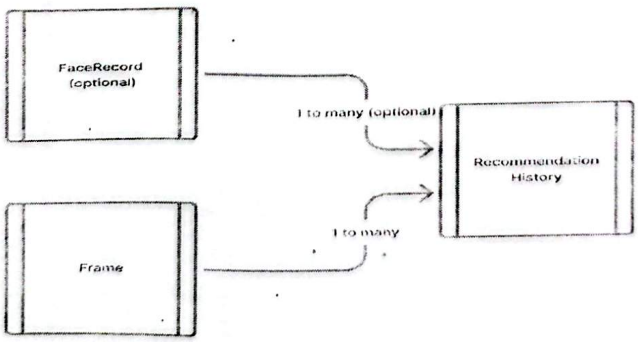
Source:https://www.figma.com/file/r0SBWjONcxPazJfdookWeU/Smart-Mirror-%E2%80%93-Class-Diagram

SEQUENCE DIAGRAM



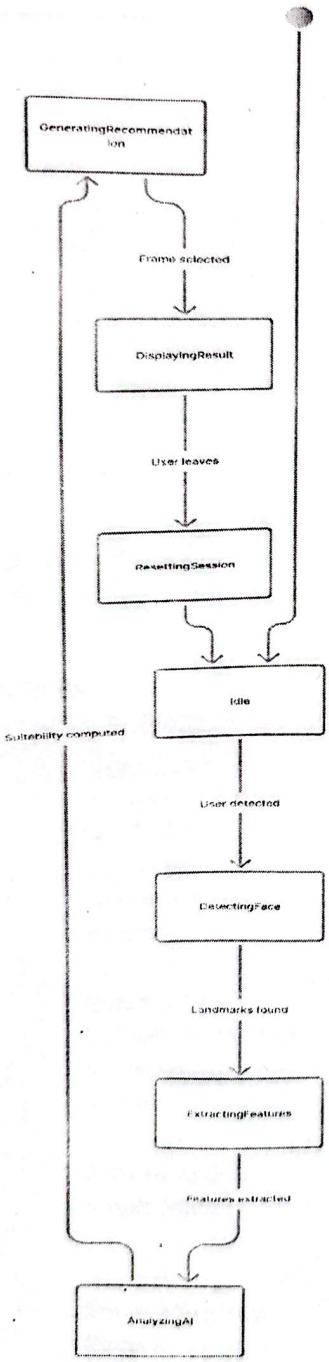
Source:https://www.figma.com/file/7dG3nI22KAspMgQhetV9Dt/Real-Time-Recommendation-Flow

LOGICAL DATA MODEL



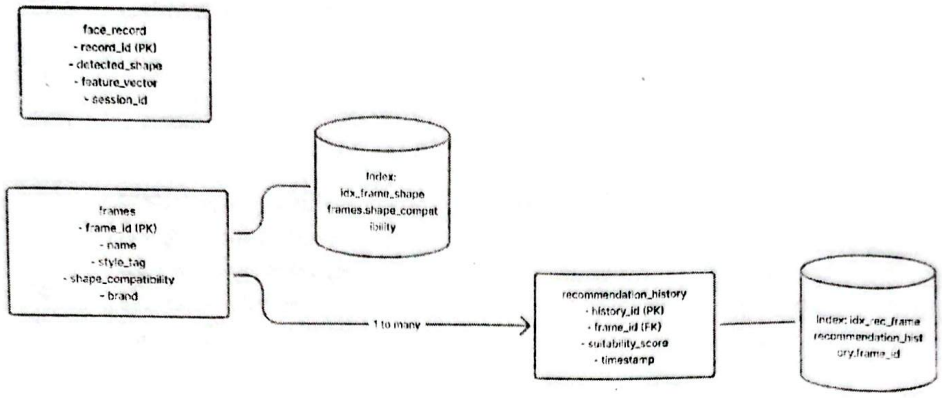
Source: https://www.figma.com/file/mmrYreYnBsltYOP1ISehBP/Smart-Mirror-%E2%80%93-Logical-Data-Model

TRANSTION STATE DIAGRAM



Source: https://www.figma.com/file/GdO0H4tqHvTdFoR8PVhlRf/Smart-Mirror-%E2%80%93-User-Interaction-States

Physical data models



Source:https://www.figma.com/file/mInvI1IsK4wAyFaSSrdBHB/Smart-Mirror-%E2%80%93-DB-Schema

6. References

Ref. No.	Document Title	Date of Release/ Publication	Document Source
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2	Smart mirror fashion technology for better customer brand experience	2025	https://www.tandfonline.com/doi/full/10.1080/17543266.2023.2243485
3	How to build a Smart Mirror	2024	https://www.youtube.com/watch?v=J2S75AhPqnM
4	Smart Mirror on Beauty	2024	https://lutpub.lut.fi/bitstream/10024/170036/1/mastersthesis_Islam_Adhity%20Rizwana.pdf

Ref. No.	Document Title	Date of Release/ Publication	Document Source
5	Magic Mirror Using Raspberry Pi	2022	https://www.journal-dogorangsang.in/no_1_Online_22/89.pdf?utm_source=chatgpt.com
6	Determining Face Shape with Python and Recommending Glasses Frames Accordingly	2025	https://www.journal-dogorangsang.in/no_1_Online_22/89.pdf?utm_source=chatgpt.com