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Smart AI Suite

Bachelor of Science in Information Technology

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CERTIFICATE

This is to certify that the project report titled **Smart AI Suite**, submitted by **Mr. Mustafa Masood Sherwani** and **Mr. Shawaiz Kashif**, has been examined and is found to be in accordance with the required standards for the partial fulfillment of the degree of **Bachelor of Science in Information Technology**.

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Abstract

The Smart AI Suite is a unified, web-based artificial intelligence platform that consolidates multiple AI capabilities into a single application. The system integrates a conversational assistant (supporting Google Gemini and OpenAI GPT models), client-side image processing (conversion, background removal, enhancement), Optical Character Recognition (OCR) with multilingual support, speech-to-text, a text humanizer backed by a FastAPI microservice running a T5 model, and productivity tools including a CV maker, GPA calculator, PDF merger, and a todo manager. The platform is built with Next.js 15 and React 18 on the frontend, with Supabase providing authentication, PostgreSQL storage, and row-level security (RLS). Client-side libraries such as Tesseract.js, @imgly/background-removal, and pdf-lib enable privacy-preserving processing for images and documents. Empirical tests show conversational latency typically below two seconds, image processing completing within five to ten seconds on mid-tier hardware, and reliable concurrency for typical classroom or small team usage. This document presents the complete lifecycle, including literature review, requirements, architecture and design (with UML), implementation, testing and evaluation, and future work.

Acknowledgments

In the name of Allah, the Most Gracious and the Most Merciful. All praises are for Allah Almighty who gave us the knowledge, ability, strength, and determination to successfully complete this Final Year Project, despite the numerous challenges faced during the development process. Without His blessings, it would not have been possible to come this far. We would like to express our sincere gratitude to our project supervisor, Maam Mona Leeza, for the consistent guidance, encouragement, technical support, and critical insights provided throughout the project. Their invaluable suggestions, timely feedback, and motivation have greatly contributed to the completion of this work. We are also deeply thankful to all the faculty members and management of the Department of Information Technology, Bahria University, Islamabad Campus, for creating a learning environment that constantly pushed us to explore new technologies and practical problem-solving.

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List of Abbreviations

Abbreviation	Full Form
AI	Artificial Intelligence
API	Application Programming Interface
CSR	Client-Side Rendering
CRUD	Create, Read, Update, Delete
CV	Curriculum Vitae
DB	Database
DOM	Document Object Model
ERD	Entity Relationship Diagram
FR	Functional Requirement
GPA	Grade Point Average
CGPA	Cumulative Grade Point Average
SGPA	Semester Grade Point Average
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
JWT	JSON Web Token
LLM	Large Language Model
NFR	Non-Functional Requirement
OCR	Optical Character Recognition
OEM	OCR Engine Mode
PSM	Page Segmentation Mode
PWA	Progressive Web Application
RBAC	Role-Based Access Control
RLS	Row Level Security
REST	Representational State Transfer
SSR	Server-Side Rendering
STT	Speech-to-Text
TLS	Transport Layer Security
UI	User Interface
UML	Unified Modeling Language
UX	User Experience
WCAG	Web Content Accessibility Guidelines
XSS	Cross-Site Scripting
CSRF	Cross-Site Request Forgery

Chapter 1

Introduction

1.1 Project Overview

Smart AI Suite is created to minimize the workflow fragmentation by providing multiple complementary AI functions in a coherent interface [1], [2]. The system opens up a talking assistant with provider choice (Gemini or OpenAI) [3], picture maker and image handling applications which run locally in the internet for protection [4], customize OCR to extract text in various languages [5], voice-to-text by utilizing internet paths [6] as well as a humanizer that edits AI-created prose [7]. In the space around these AI components, there are useful applications such as CV maker, GPA calculator, PDF merger, and a todo manager ensuring that users will do end-to-end jobs without having to alternate between platforms [8]. The platform is aimed at learners, educators, professional individuals, and small groups of professionals which need affordable, secure, and accessible AI functionality with low operation overhead [9]. Cognitive load can be greatly lowered by distributing the various functions of AI to one platform, thereby simplifying work processes [10].

1.2 Problem Statement

New AI devices are efficient yet have been segmented into different apps and vendors [11], [12]. The typical workflow, which includes chatting with an AI, creating or editing pictures, reading text in pictures, enhancing the style of text, turning speech into text, and combining documents, involves several interfaces, logins, and payments [13], [14]. This fragmentation consumes time, makes the learning process more difficult, multiplies the expenses, and exposure to privacy as sensitive information is published in numerous services [15]. There is also no central administration of organizations that control access and keep track of usage [16]. Such a platform can be built around a single, unified platform with high security controls, privacy-conserving client-side processing and single-access points, which can significantly enhance this situation [17], [18].

1.3 Objectives

The project aims to: Adopt a single, production-ready web platform, which combines conversational AI, image generation and processing, OCR, speech-to-text, a humanizer service, and productivity utilities [19]. Offer multi provider LLM with a standardized

interface [20]. Use client-side processing when processing privacy-sensitive tasks is necessary [21]. Implement a strong authentication and authorization that can be audited [22]. Realize responsiveness, scalability [23]. Has a modular codebase, is documented and testable and can be extended in future with minimal friction [24].

1.4 Scope

It is within the scope of a browser-based application written in Next.js 15 and TypeScript, a Supabase authentication and database backend, a paraphrasing/humanization microservice using FastAPI, as well as integrations with Gemini and OpenAI [1], [3], [25]. In scope are: Multi-provider AI Chatbot. Image generator, image conversion/background removal/enhancement [4], [26]. Multiple language text extraction and OCR [5]. Speech-to-text [6] Text humanization [7] CV generator, GPA calculator, PDFs merger, and to-do list [8], [27]. Native mobile applications, subscription/payment solutions, co-editing real-time multi-user, and deep analytics other than dashboards, and complete offline AI are out of scope [28].

1.5 Methodology

Iterative, incremental development was employed [29]. User interviews and existing platform analysis were used to collect the requirements [30]. Prior to the feature implementation, architecture and UML models were developed [2]. The development was done in the form of modules and tested constantly. Early considerations were made on security, performance and usability. Installed environment-driven configuration of the application was used and a comprehensive documentation was provided [1].

Chapter 2

Literature Review

2.1 Introduction

The rapid advancement of artificial intelligence has resulted in a wide range of publicly available AI applications such as ChatGPT, Google Gemini, Adobe Photoshop, and Canva. These systems are developed to solve specific problems including conversational interaction, image processing, document handling, and content creation.Although these applications are very individual in their performance, usually they are isolated. systems, which are making users work with many tools in order to do various tasks [1][2]. This fragmentation prompts the necessity of a unified platform that includes several AI features within a single environment.

2.2 Conversational AI Applications

ChatGPT is an application built on the GPT models of OpenAI and is one of the most popular conversational applications.AI systems and provides text generation, question answering and code assistance in the form of a cloud-based interface [1]. Equally, Google Gemini offers a multimodal conversational application that can process both text and images, and is mainly accessed via web platforms or APIs [2]. Although they may be deemed to be strong, these systems are entirely comitted to conversational tasks. They have no native support of auxiliary AI features like OCR or image editing.In the same workflow, it is necessary to have the users switch between various applications [1], [2].Moreover, end-users are not usually free to choose between providers as AI is normally locked into one single provider.

2.3 Image Processing and Creative AI Applications

A professional-level image processing tool with the functionality of Firefly AI called Adobe Photoshop can be used in removing the background, filling the images with new ones, and editing them to create new ones in a content-aware way [3]. Another trendy design tool online is Canva that offers an AI-assisted design and image generation with document handling capabilities aimed at non-technical users [4]. Both tools, however, offer high-ranking image centric functionality; however, they represent specialized applications. Little to no integration with conversational AI or OCR systems and processing is mainly

done on servers that are run by vendors, and which have privacy implications on sensitive information [3], [4]. Additionally, these tools do not allow developer-level control over AI workflows or model selection.

2.4 Optical Character Recognition Systems

Textual data is extracted using OCR systems in order to read text in images and scanned documents. Conventional OCR solutions are usually made in the form of cloud APIs where documents are uploaded on remote servers to be processed [5]. OCR client side libraries have come up to address the privacy and latency problems by allowing text to be recognized locally or inside the browser of the user [5]. Nevertheless, OCR systems are typically used as standalone applications and are not typically linked to conversational AI or document-processing pipelines. This weakness diminishes their performance in end-to end intelligent document processes.

2.5 Existing Integrated AI Platforms

There are some contemporary platforms that seek to integrate AIs in parts. Office suites have productivity assistants that combine limited conversational functionality with document-based tools [6]. Nevertheless, such platforms are closely integrated with certain vendors, offer very little control over processing layers and are not modularly extensible to integrate third-party or open-source AI services [6].

Table 2.1: Technical and Architectural Comparison

Feature	**Existing Applications**	**Smart AI Suite**
Multiple AI tools in one system	No	Yes
Multi-provider conversational AI	No	Yes
Client-side AI execution	Limited	Yes
Vendor lock-in	High	Low
Admin & governance control	Limited	Yes
Modular system expansion	Restricted	Supported

2.6 Utility-Based Productivity Applications

Besides the conversational and media-processing AI applications, there is an impressive assortment of utility-based web applications to assist with daily productivity. They are online resume and CV makers, college GPA calculators, document converters, grammar and paraphrasing programs and simple data transformation programs [6], [15]. The available utility tools are usually designed to apply to particular domain of problems as single purpose applications. Incidentally, CV builders specialize in the formatting of documents. and templates, whereas GPA calculators are a ready numerical computation according to a predefined grading scheme. Grammar and text tools are typically distributed across

a variety of platforms and require users to alternate between applications in order to perform distinct tasks [6].

Tough, these tools increase user effeciency but they are distributed across multiple platforms and the user needs to switch among differnet applications for different tasks.Moreover, the privacy and control issues arise due to the fact that user information typed in these utilities is usually processed on the server of a third-party.Integration with conversational AI or document understanding systems is generally limited or absent [15].

Recent integrated platforms attempt to embed selected utilities within broader systems; however, these utilities are often restricted in customization and are not designed to operate as modular components within an extensible architecture. As a result, users still lack access to a unified environment where multiple utility-based functions can be combined with advanced AI services in a seamless workflow.

2.7 Comparison Of Technologies Used in Smart Ai suite

React with Next.js offers component reusability and hybrid rendering [9][10]. TypeScript is type safe and maintainable [11]. Supabase provides PostgreSQL, authentication, and role-level security (RLS), with power and approachability [12]. The environment-configured routing between Gemini and OpenAI is built-in to the platform [1], [2]. Tesseract.js, background-removal (libraries of @imgly), and pdf-lib are client-side libraries with minimal data transfer and cheap operation [5], [13] and [14] respectively. The image generator tool can also be used to generate or modify images in-browser, maintain privacy, and minimize the use of various external applications [15]. Controllable humanization that is based on T5 family at CPU-friendly scales is enabled by a Python FastAPI microservice [16].

2.8 Similarities and Differences

Similarities:

- Smart AI Suite and existing applications utilize pretrained AI models rather than custom model training[1] [3].
- All systems aim to improve productivity through automation and AI-assisted features [2], [4].

Differences:

- ChatGPT and Gemini provide only conversational functionality, whereas Smart AI Suite integrates chat, OCR, and image processing in one platform.
- Adobe Photoshop and Canva focus on image-related tasks and lack conversational intelligence or document-aware automation.
- Smart AI Suite supports client-side processing for privacy-sensitive tasks, unlike most commercial tools that rely entirely on server-side computation.

- The system introduces a unified authentication and governance mechanism across all AI services.

2.9 Research Gap and Motivation

The reviewed literature and applications show that current AI tools excel in isolated domains but fail to provide a unified solution combining conversational AI, image processing, and document understanding [1]–[6]. The existing applications do not have privacy-conscious client-side processing, support multiple providers, or governance on a per-system basis. Smart AI Suite is capable of filling these gaps through providing an integrated, modular AI platform with increased flexibility and control.

2.10 Summary

This chapter, explored real-life uses of AI such as ChatGPT, Google Gemini, Adobe Photoshop, Canva and OCR systems. In the comparative analysis, it was noted that, despite the effectiveness of each of them when used separately, these tools are not well integrated. and architectural plasticity. The following limitations warrant the creation of Smart AI Suite that will bring together various AI services in one, extensible platform.

Chapter 3

Requirement Specifications

3.1 Existing System

The earlier processes involved the use of different platforms to chat with AI, edit images, OCR, paraphrasing, speech recognition, and document editing [1][2][3]. All the tools required their own accounts, pricing models, various interfaces, and exposed the user to. privacy risks [4][5]. It had no centralized control or administrative visibility [6].

3.2 Gap Identification

The key identified gaps are:

- Lack of integration across tools (not unified)[7].
- Usability inconsistency- too complex or simplistic [8].
- Increased financial load because of numerous subscriptions [9].
- Privacy issues based on server-based processing [10].
- Weak institutionalization and administration [11].
- Locked-in vendor and lack provider independence [12].

It is on these gaps that system requirements and architecture are defined [13].

3.3 Proposed System

In this section, the proposed system of Smart AI Suite is presented. The aim of the proposed system will eliminate the drawbacks that were found in current AI applications by offering a one centralized platfrom that integrates the conversational AI, image processing, OCR, and utility tools. The system proposed is centered on usability, privacy, flexibility and centralized management using pretrained AI models and the current web technologies [1], [2].

3.3.1 Overview of the Proposed System

The suggested system is a web-based single AI platform that is aimed at integrating several services based on AI in one application. In contrast to the current systems, which offer limited functionality like chat only, image only or utility only systems, Smart AI Suite combines all these features into a logical workflow [1], [6].

The system gives users opportunity to chat with conversational AI, handle images, retrieve text in documents and productivity utilities without having to switch applications. Tasks involving privacy as OCR and simple image processing are computed on the client side, whereas tasks with greater computing needs are computed on the more powerful server utilizing dedicated services [5], [16]. The use of a centralized authentication and access control system ensures the safe usage as well as administrative control [12].

3.3.2 Proposed Unified AI System Framework

The Smart AI Suite is built on the unified framework that oraganizes various AI services in clear layers. The architecture divides the interaction of users, AI processing and security issues to enhance the maintainability and scalability of the system [9]. [10].

The framework enables routing between two or more conversational AI providers including OpenAI and Google Gemini and does not rely on any single vendor and allows configuration flexibility [1], [2]. Wherever possible, client-side AI execution is utilized to minimize the data transfer and maximize user privacy, where server-side microservices are utilized to execute the tasks that require consistent and reusable model execution [5][16].

This unified framework makes sure that all AI tools will run on the same platform with shared authentication, similar user experience, and controlled governance.

3.3.3 Description of Framework Components

The proposed framework consists of the following key elements:

- **User Interface Layer:**This layer gives the graphical interface through which users engage with the platfrom. It manages user input including text prompts, image,Utility data, uploads, document selection, and utility data entry. The interface is designed to provide the same and smooth experience in all the tools [9][10].

- **Input Processing and Validation Component:** This is done prior to any processing of AI taking place.The user inputs are checked and formatted. This makes sure that information that is conveyed to AI services is secure and satisfies constraints that are required and enhance system reliability [11].

- **AI Provider Routing Component:**This is a component that controls the conversational AI and sends them on request or routes them dynamically to the chosen provider, like OpenAI or Google Gemini according to system configuration. This allows multi-provider assistance and minimizes vendor lock-in [1], [2].

- **Client-side AI Processing Component:** Some of the operations such as OCR,image background elimination, and document processing, are directly done in the user's browser using client-side libraries. This strategy reduces transmission of data,lowers the load on the server, and increases privacy [5], [13], [14].

- **Server-side AI Microservices Component:** Activities or tasks that require control ,continuous and consistent processing like text humanization are handeled by server-side microservices.These services are implemenated using Python enabling effective CPU-level inference with pretrained T5 models [16].
- **Security and Access Control Component:** The authentication and authorization of users is handled by a centralized backend system. Role-based access control enforces the ability of users to only view authorized features and data, whereas administrative users can monitor usage in the systems [12].
- **Output Formatting and Response Component:** The final results or the ouputs that is generated by AI services are formatted and dispalyed in a consistent manner.This includes chat responses, text extraction, processed images and utility outputs, making them usable across all system modules [6]

Key Features

- Multi-provider chatbot (Gemini + OpenAI) with streaming, file-sensitive prompts, history and provider switching[1][2].
- Client-side image tools: format conversion, background removal, enhancement, and AI image generation [4][16].
- OCR in 20 languages, and customizable PSM, OEM and confidence.
- Speech-to-text supporting both browser capture and server-side transcription [6].
- A text humanizer powered by a FastAPI + T5 microservice [16].
- Utility tools: CV Maker, GPA Calculator, PDF Merger, To-Do Manager [7][17].

Benefits

The system offers reduced cognitive load, consolidated costs, improved privacy through local processing, institutional oversight, and increased resilience through multi-provider support [18].

3.4 User Requirements

Table 3.1 lists the core user requirements including unified access, ease of use, privacy options, responsiveness, and administrative control [19].

Table 3.1: User Requirements

ID	Requirement	Description
UR1	Unified AI Suite	Single platform for chat, image tools/image generator, OCR, STT, humanizer, and productivity utilities.
UR2	Ease of Use	Intuitive, consistent UI for technical and non-technical users.
UR3	Privacy Options	Client-side processing for images/OCR when possible.
UR4	Mobile Responsiveness	Functional on desktop, tablet, and mobile browsers.
UR5	Administrative Oversight	Admin dashboards for user and message management.

3.5 Functional and Non-Functional Requirements

Functional requirements describe expected module behaviors (Table3.2). Non-functional requirements describe performance, security, scalability, usability, reliability, and maintainability aspects (Table3.3) [21].

Table 3.2: Functional Requirements

ID	Requirement	Description
FR1	Authentication	Email/password, OAuth (Google, GitHub, Microsoft), email verification, password reset.
FR2	RBAC	Roles for user, moderator, admin; route guards and database RLS.
FR3	Chatbot	Multi-provider (Gemini/OpenAI), streaming responses, sessions, file context.
FR4	Image Generator	Generates images based on client prompts.
FR5	Image Tools	Conversion, background removal, enhancement, client-side operations.
FR6	OCR	Tesseract.js with multilingual support and advanced parameters.
FR7	Speech-to-Text	Browser Web Speech and server transcription; exportable text.
FR8	Humanizer	FastAPI + T5 variants with adjustable creativity and length.
FR9	CV Maker	Templates, live preview, validation, and PDF export.
FR10	GPA Calculator	CGPA/SGPA with multiple grading policies.
FR11	PDF Merger	Client-side merge with preview and reordering.
FR12	Admin Panel	User management, messages, SMTP responses, and activity logs.

Table 3.3: Non-Functional Requirements

ID	Category	Requirement
NFR1	Performance	Chat < 2 s; image tasks < 10 s for 5 MB.
NFR2	Security	HTTPS/TLS, JWT, bcrypt, XSS/CSRF protection, least privilege, RLS.
NFR3	Scalability	Horizontal scaling, caching, and API rate limiting.
NFR4	Usability	WCAG AA standards, consistent patterns, meaningful validation.
NFR5	Reliability	99% uptime, graceful failure, backups.
NFR6	Maintainability	TypeScript contracts; modular design; documentation and tests.

3.6 Limitations of the Project

The system depends on third-party AI providers, which may impose pricing or rate-limits [22]. Client-side performance varies based on user device capabilities [16]. Tesseract.js provides slower results than commercial OCR engines on complex layouts [5]. Offline features are limited to non-AI utilities. Analytics are basic and no native mobile applications are provided in the current version [23].

3.7 Use Cases and Use Case Diagram

Primary actors include:

- Guest Users.
- Registered Users.
- Admin Users.

Typical flows involve registration/login, AI chat with provider selection, image generation, background removal, multilingual OCR, and admin message management [16][25].

Guest User Use Case Diagram:

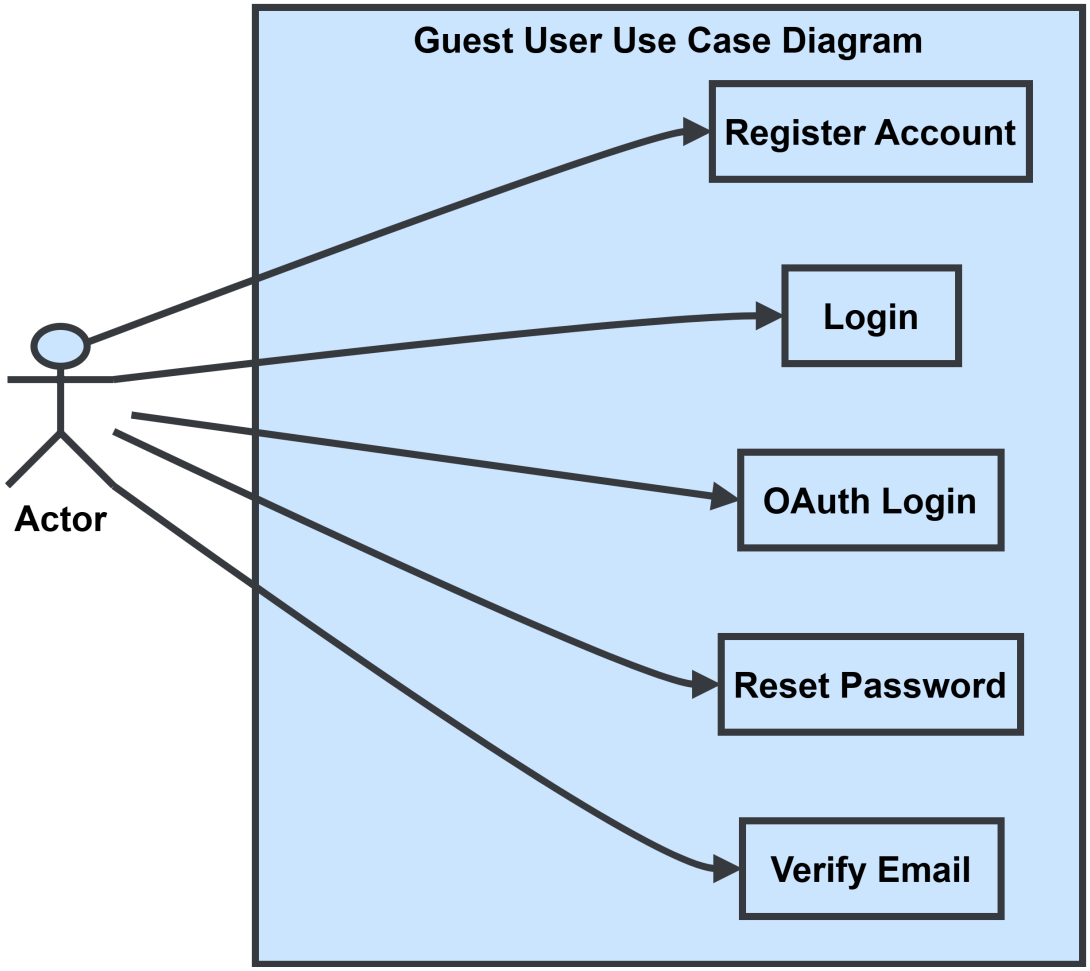

Figure 3.1: Guest User Use case diagram

Table 3.4: Use Case UC-1: Signup / Login

Field	Description
Use Case ID	UC-1
Title	Signup / Login
Actor	Guest User
Description	Guest registers, verifies email, and logs into the system.
Trigger	User taps/clicks the “Signup” or “Login” button.
Pre-conditions	User is on the website/app.
Assumptions	User has valid email and internet connectivity.
Special Requirements	Verification email must be valid.
Post-conditions	User becomes a registered and logged-in user.
Exceptions	Invalid email, server issues, no internet.
Issues	None

Registered User Use Case Diagram:

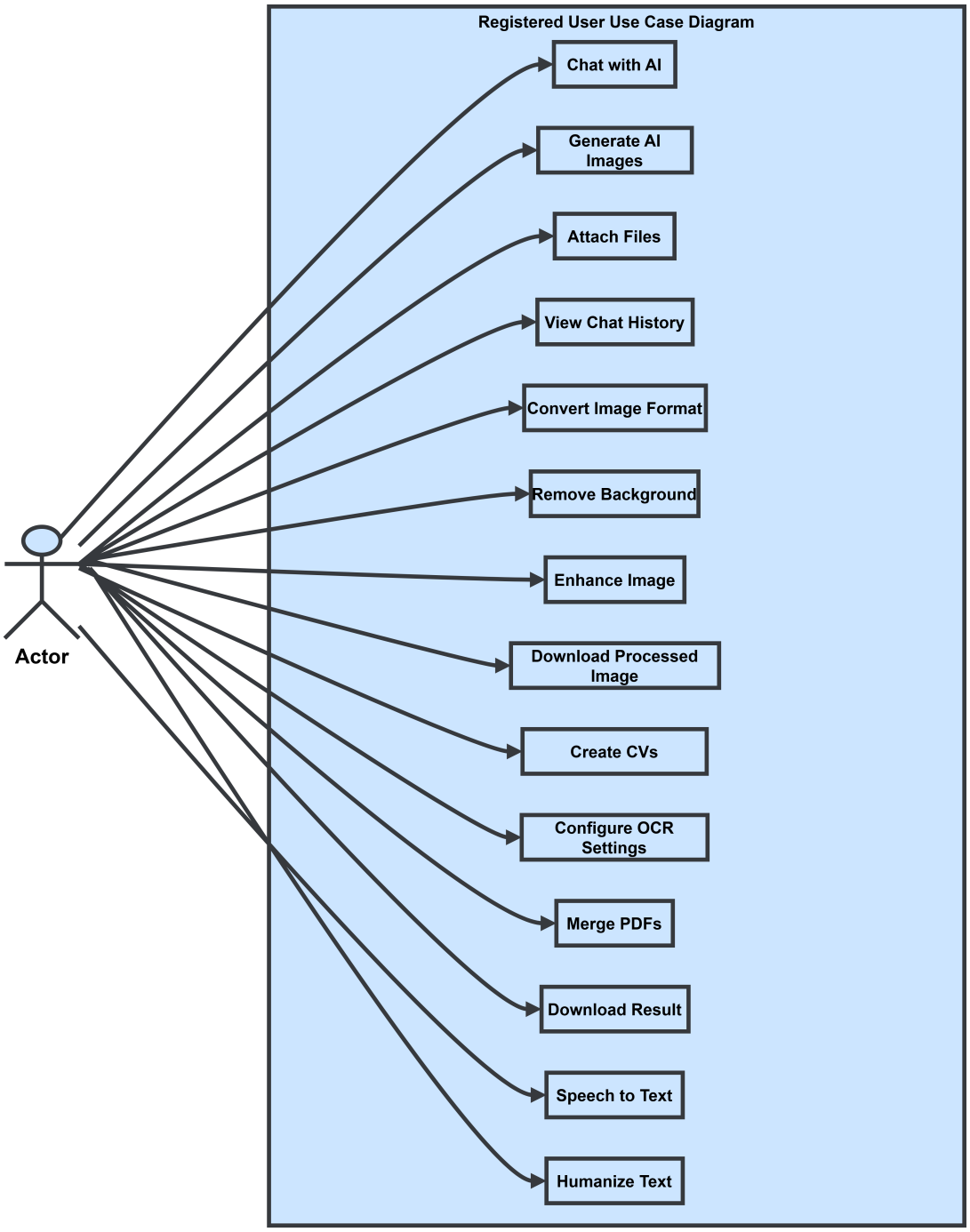

Figure 3.2: Registered User Use case diagram

Admin User Use Case Diagram:

Table 3.5: Use Case UC-2: Chat with AI

Field	Description
Use Case ID	UC-6
Title	Chat with AI
Actor	Registered User
Description	User interacts with AI, uploads files, and selects AI provider.
Trigger	User opens the chat window.
Pre-conditions	User must be logged in.
Assumptions	AI provider is available.
Special Requirements	Internet connectivity and valid API keys.
Post-conditions	Conversation saved to chat history.
Exceptions	AI API fails, file upload errors.
Issues	None

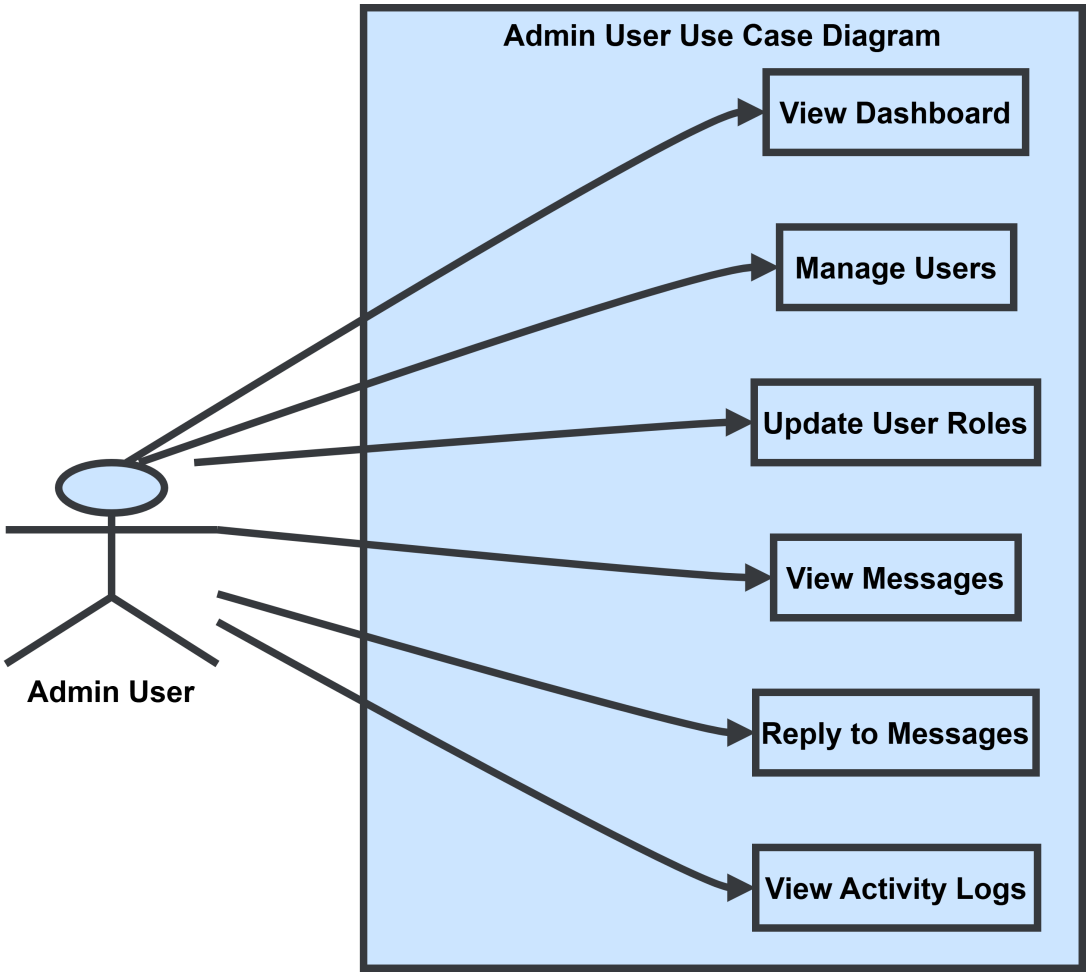

Figure 3.3: Admin User Use case diagram

Table 3.6: Use Case UC-2: Chat with AI

Field	Description
Use Case ID	UC-6
Title	Chat with AI
Actor	Registered User
Description	User interacts with AI, uploads files, and selects AI provider.
Trigger	User opens the chat window.
Pre-conditions	User must be logged in.
Assumptions	AI provider is available.
Special Requirements	Internet connectivity and valid API keys.
Post-conditions	Conversation saved to chat history.
Exceptions	AI API fails, file upload errors.
Issues	None

Chapter 4

System Design

4.1 System Overview and Architecture

The system follows a layered architecture model [1][2].The presentation layer comprises of a Next.js/React application that does the rendering of the UI and client-side processing [3].Serverless API routes in Next.js are located in the application layer, and they are used to perform authentication,business logic, and external AI service communication [4]. The data layer uses Supabase (PostgreSQL, Auth, RLS, Storage) [5]. The Humanizer operates as an independent FastAPI microservice written in Python [6]. Images, PDFs and image generation tasks is done on the client side to enhance privacy and minimize the round-trip delay [7][8].

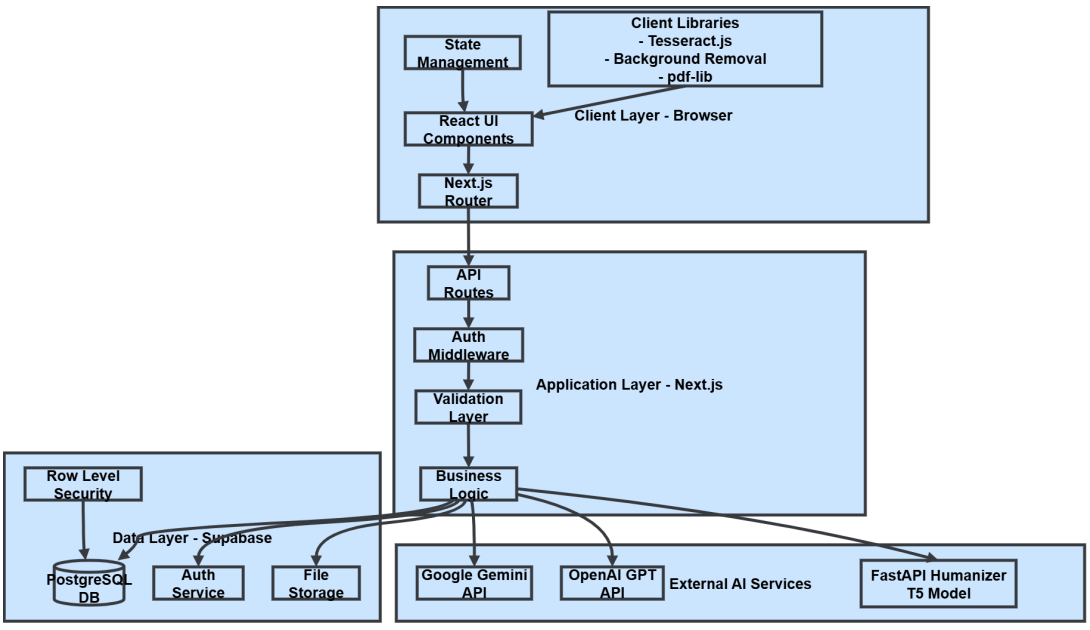

Figure 4.1: System Architecture Diagram

4.2 Design Constraints and Methodology

The constraints of this system are such as browser compatibility of Web Speech API, client CPU/memory limitations for OCR and image processing and external API.usage cost

limits [9][10].Cold-start delays can also be experienced by serverless functions. Security relies on TLS, protection of tokens, RLS, and measures suggested by OWASP [11]. The methodology involves Domain-Driven Design, component-based architecture, API-first TypeScript and performance optimizations like Lazy loading and indexed queries [12].

4.3 Workflows and UML

This is the section where workflows and sequence diagrams of the major components are introduced.

Chatbot Workflow

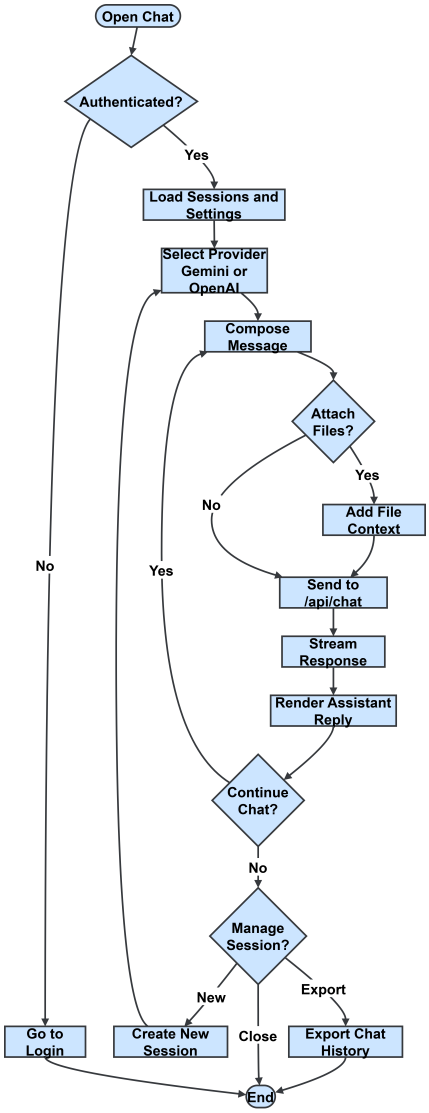

Figure 4.2: Chatbot Workflow Diagram

Image Tools Workflow

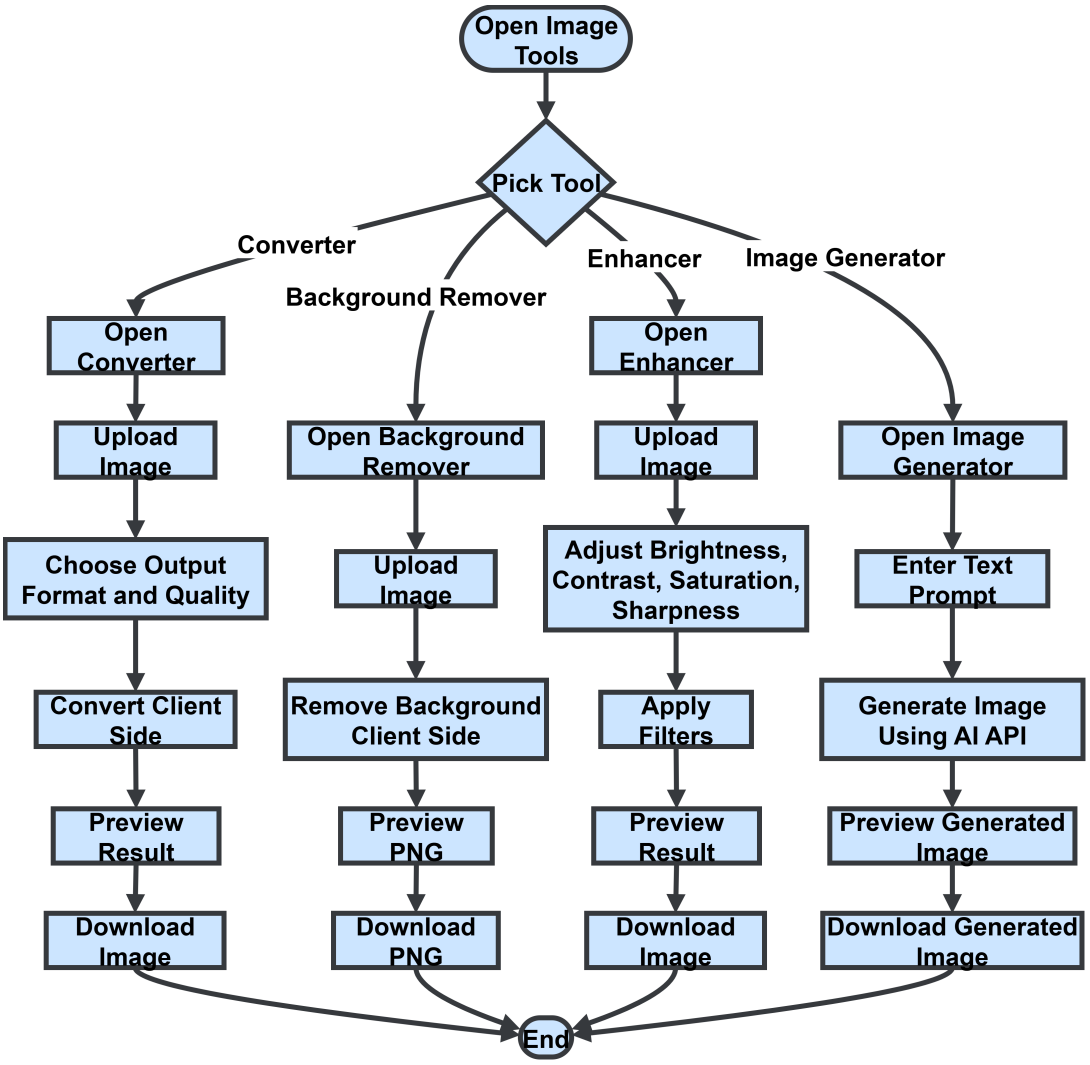

Figure 4.3: Image Tools Workflow Diagram

OCR Workflow

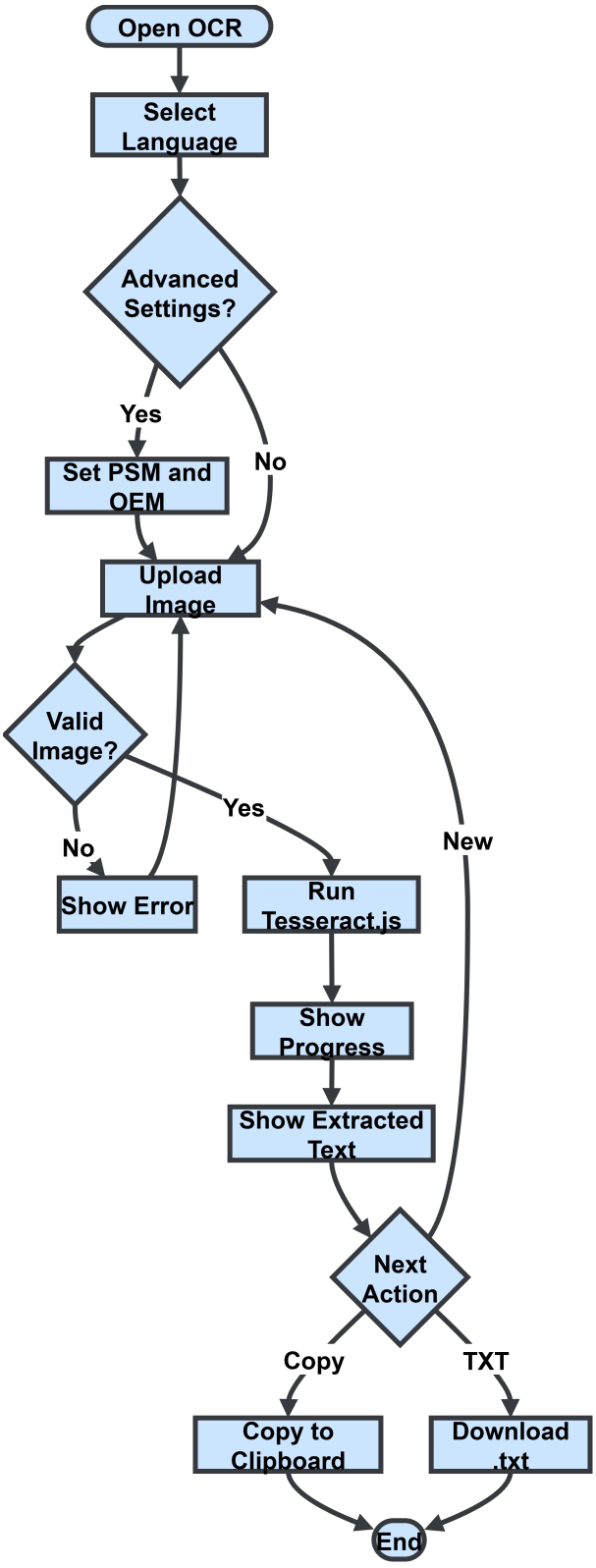

Figure 4.4: OCR Workflow Diagram

Speech-to-Text Workflow

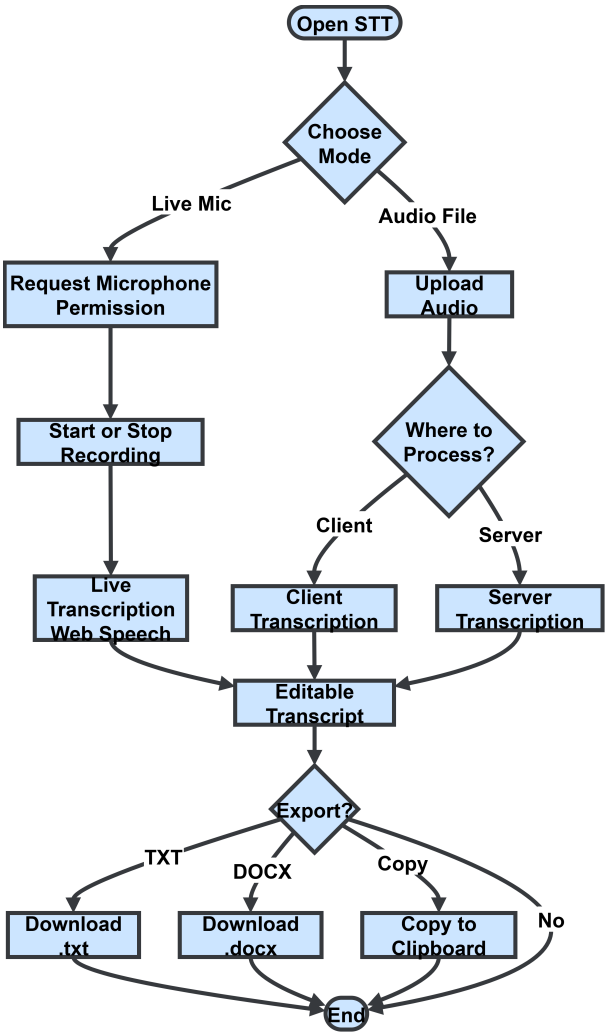

Figure 4.5: Speech-to-Text Workflow Diagram

Humanizer Workflow

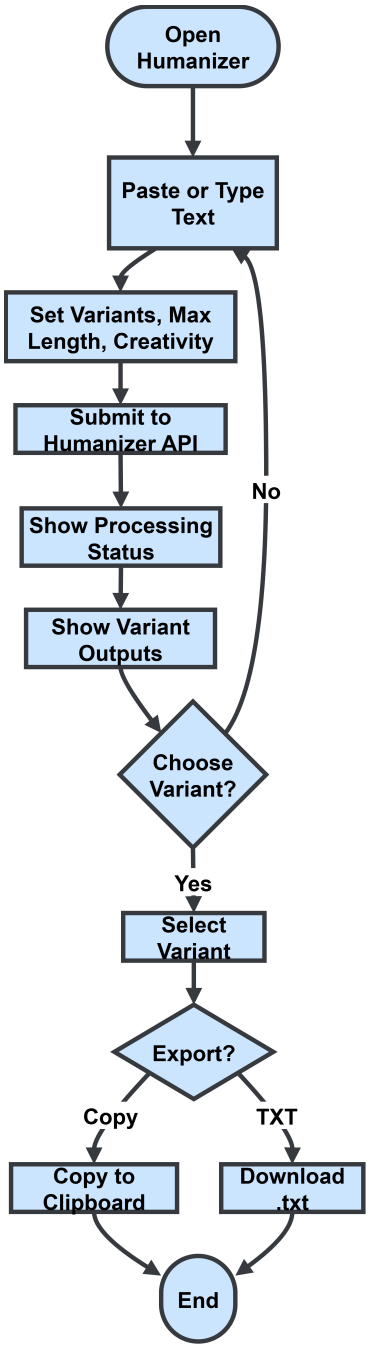

Figure 4.6: Humanizer Workflow Diagram

CV Maker Workflow

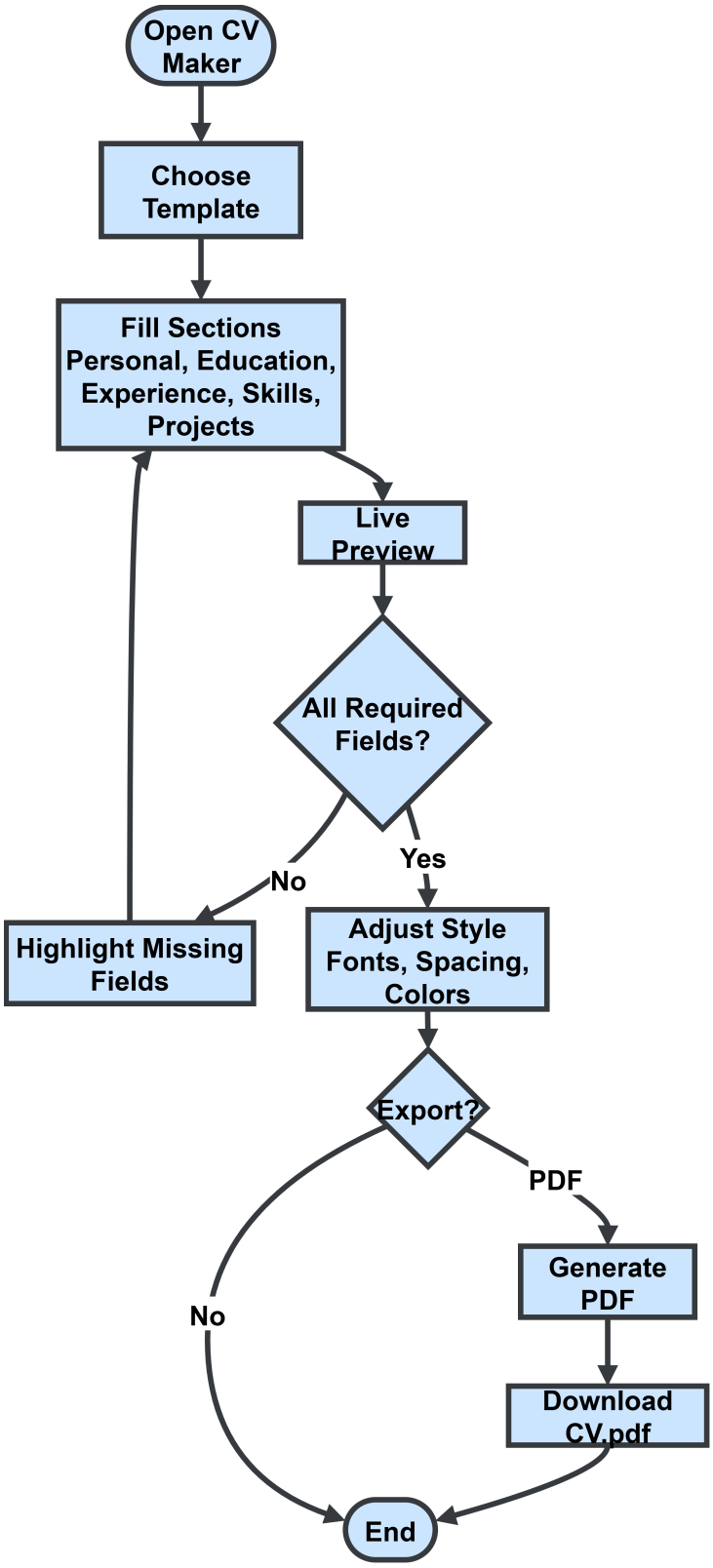

Figure 4.7: CV Maker Workflow Diagram

GPA Calculator Workflow

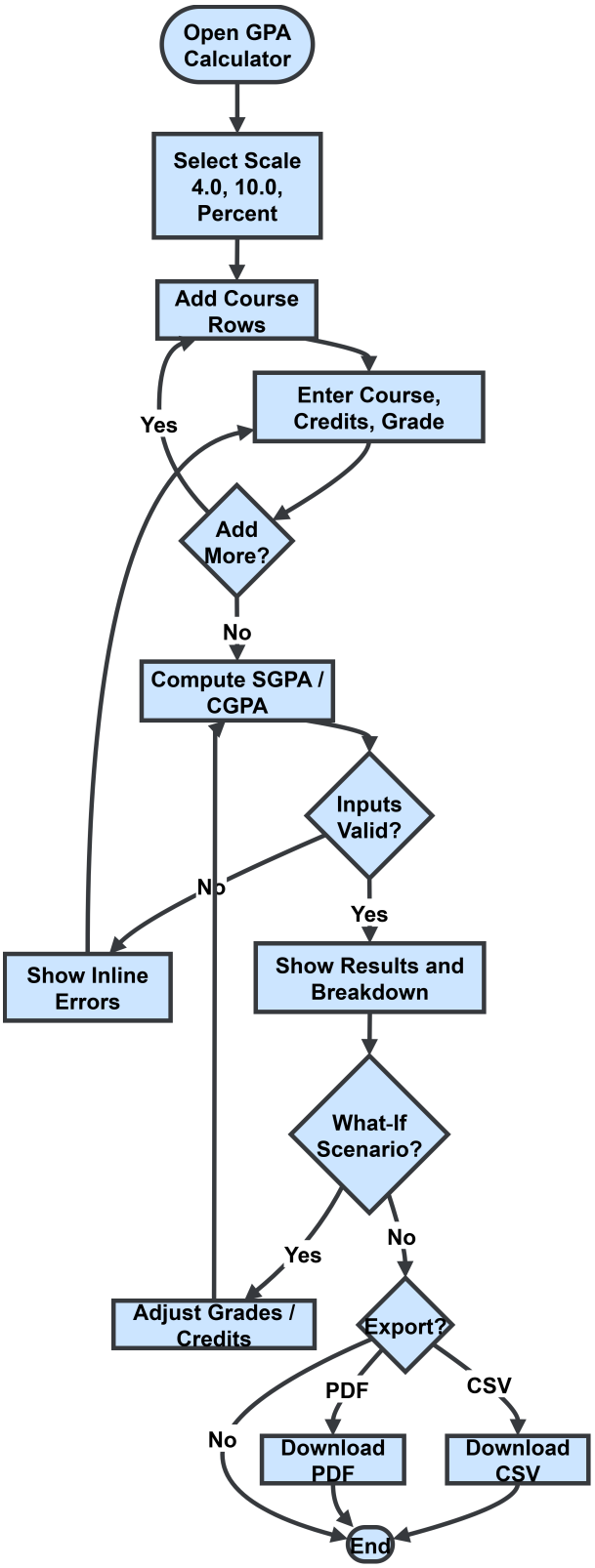

Figure 4.8: GPA Calculator Workflow Diagram

PDF Merger Workflow

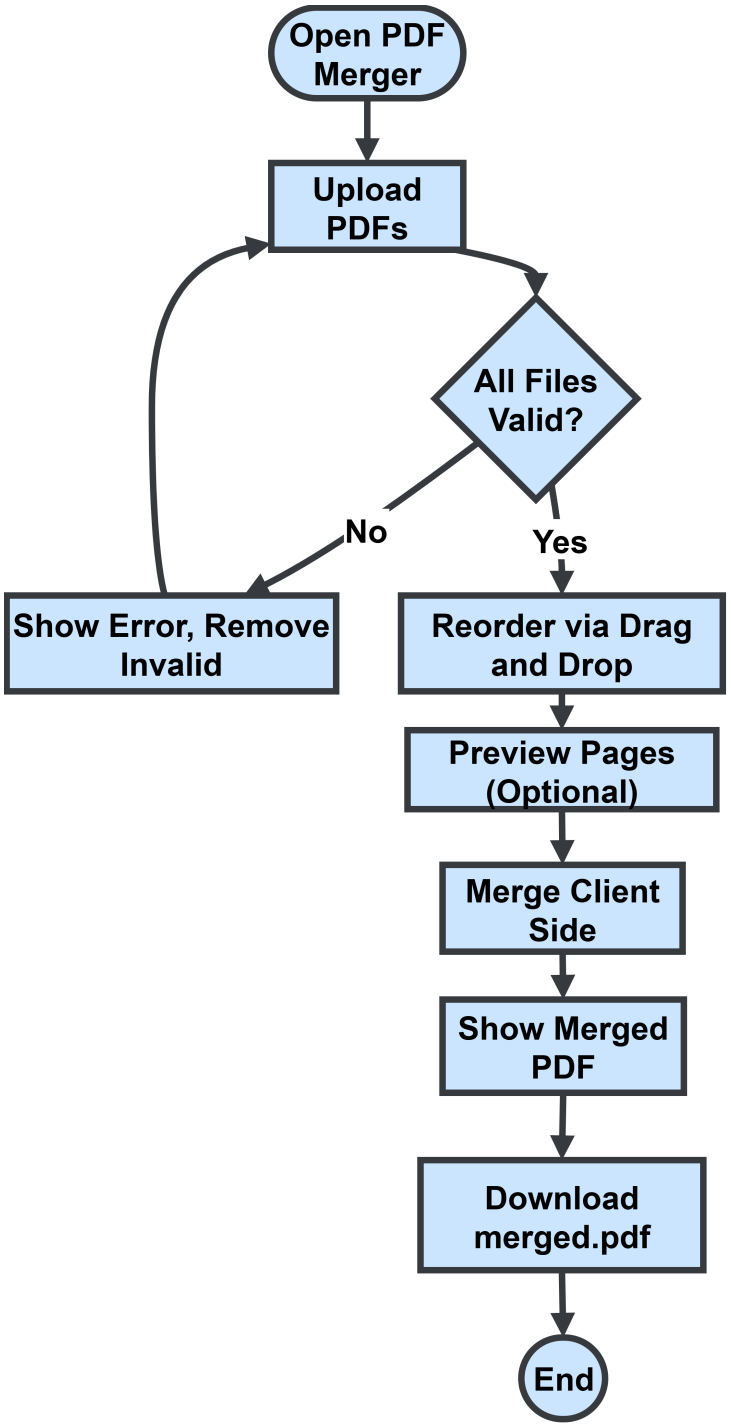

Figure 4.9: PDF Merger Workflow Diagram

TODO List Workflow

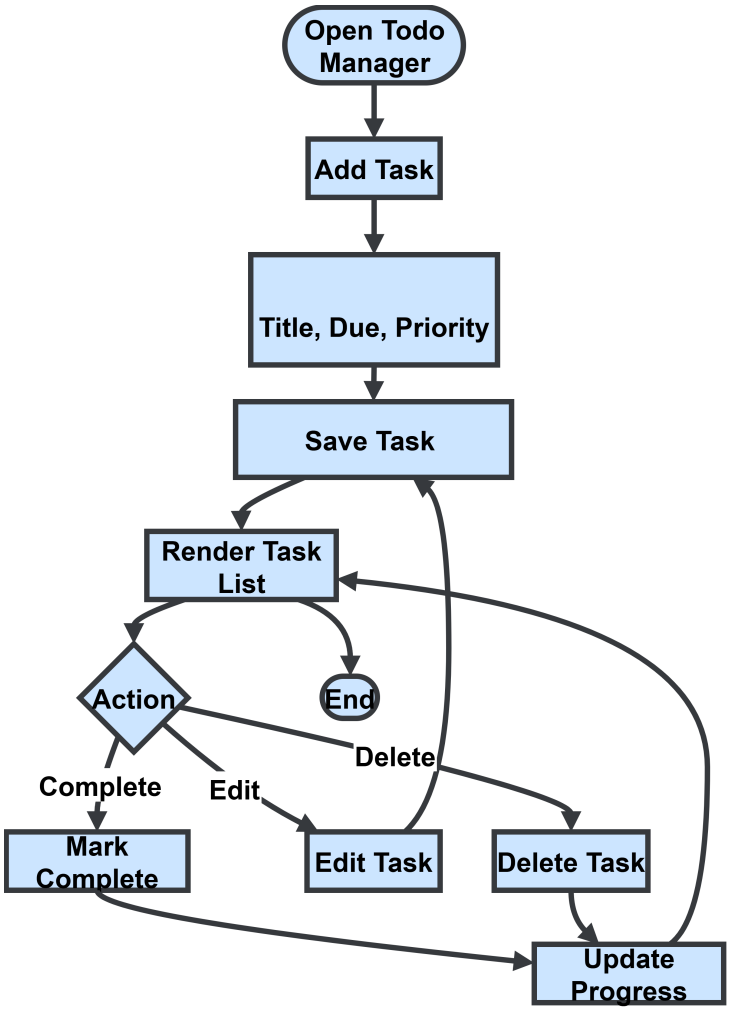

Figure 4.10: TODO List Workflow Diagram

Admin Panel Workflow

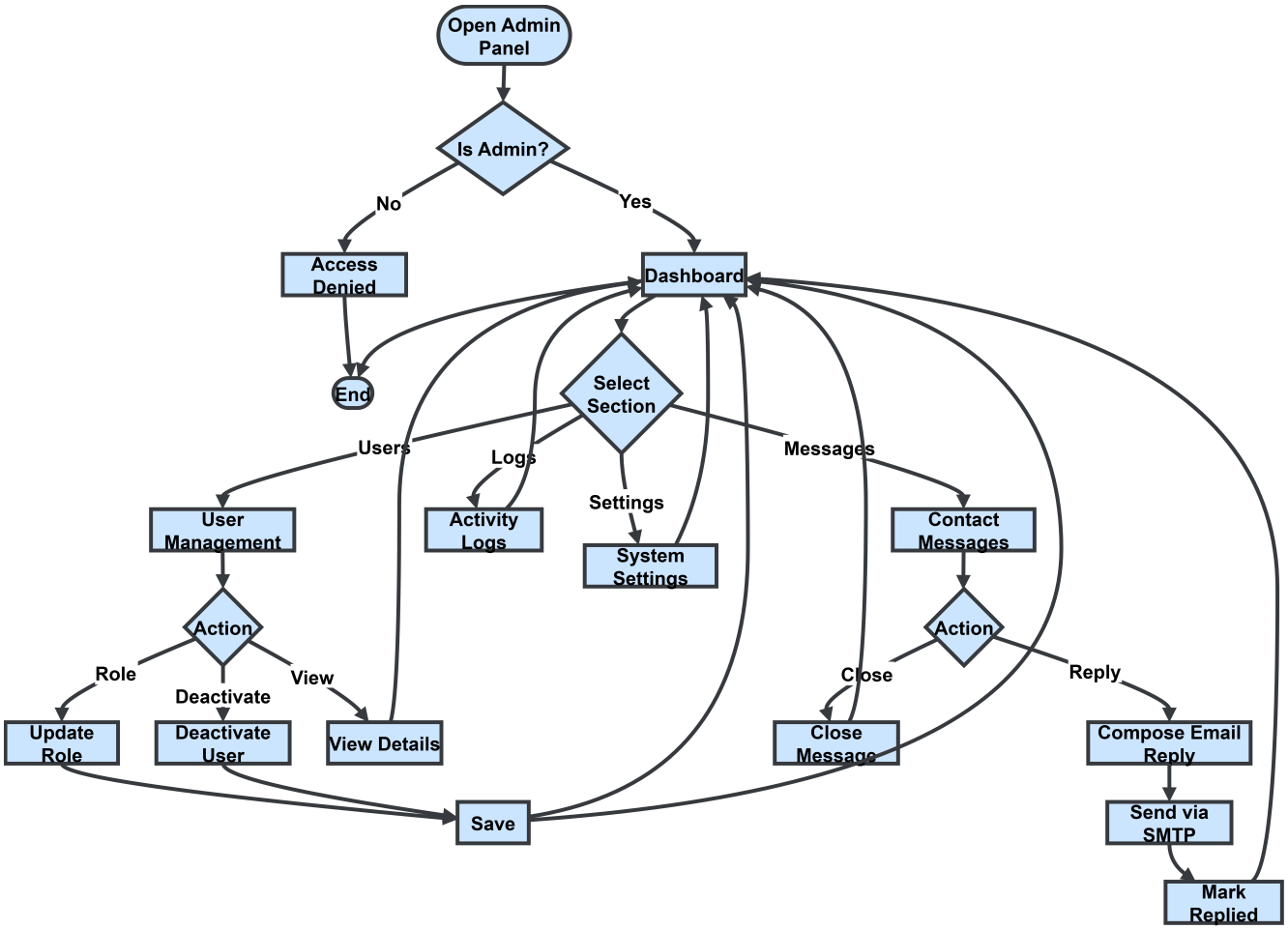

Figure 4.11: Admin Panel Workflow Diagram

Application Workflow

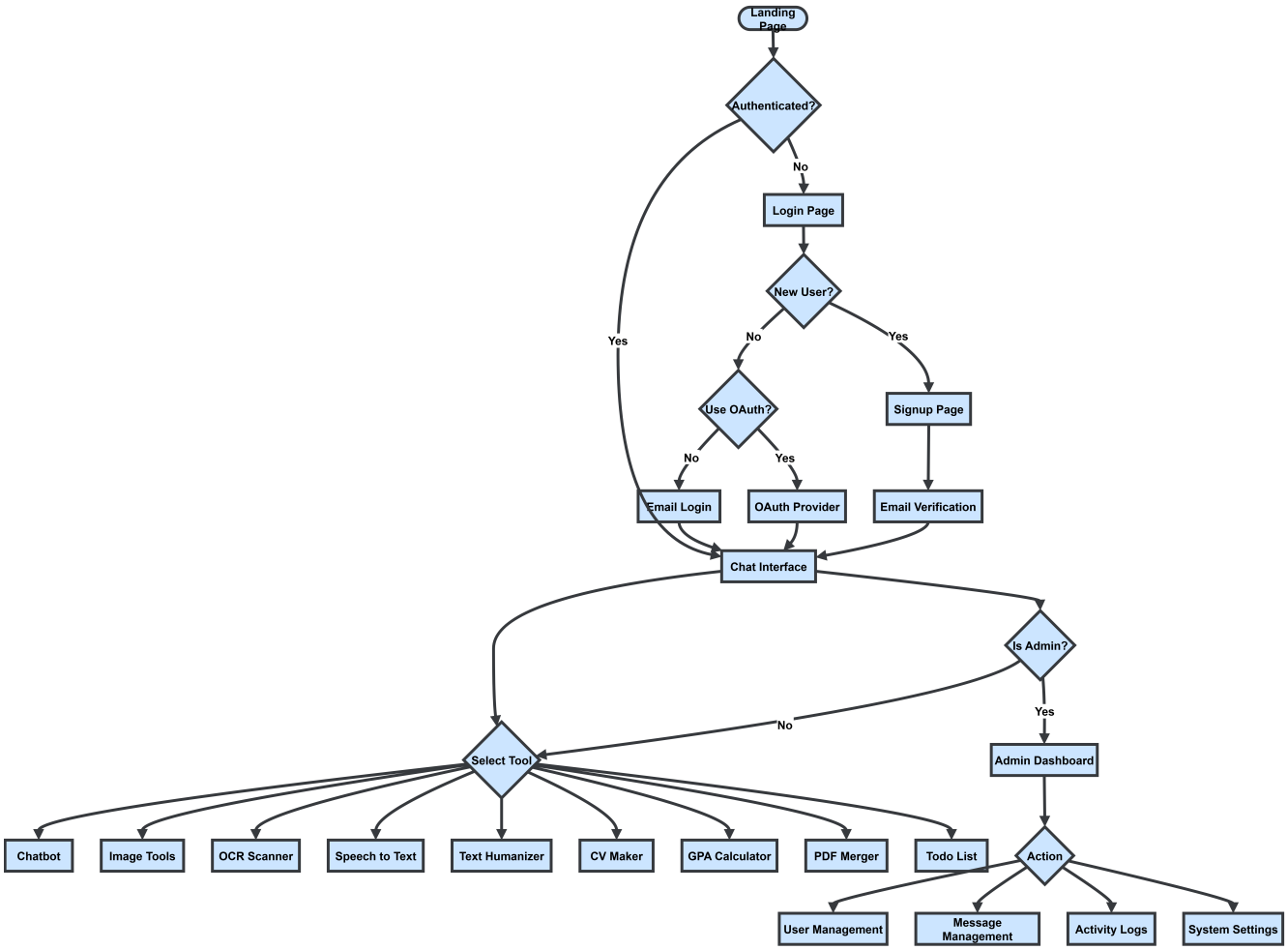

Figure 4.12: Application Workflow Diagram

4.4 Sequence Diagrams

Login Sequence

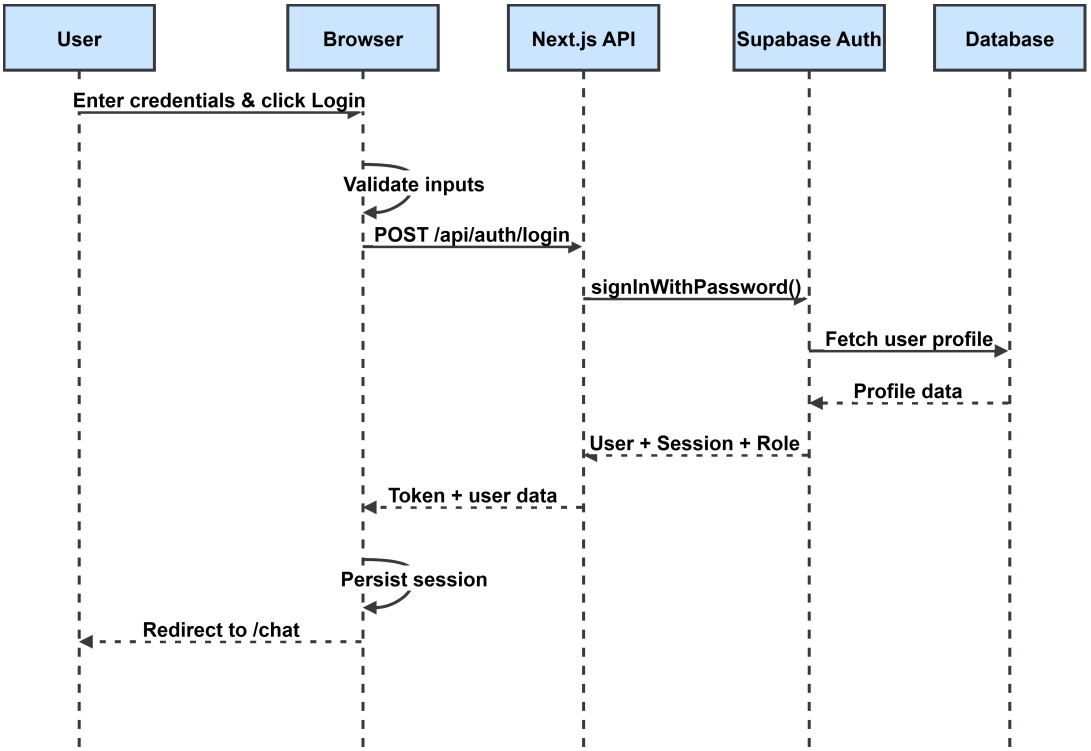

Figure 4.13: Login Sequence Diagram

Chatbot Sequence

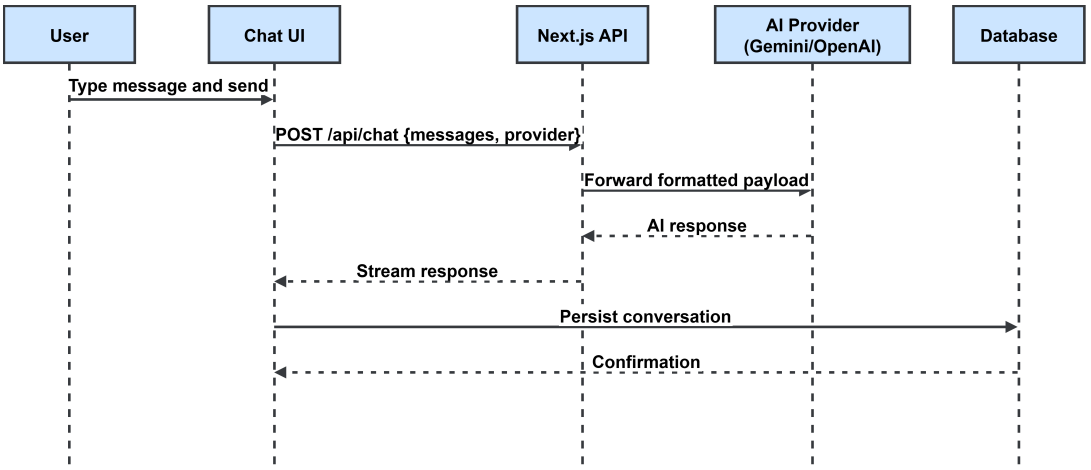

Figure 4.14: Chatbot Sequence Diagram

Image Tools Sequence

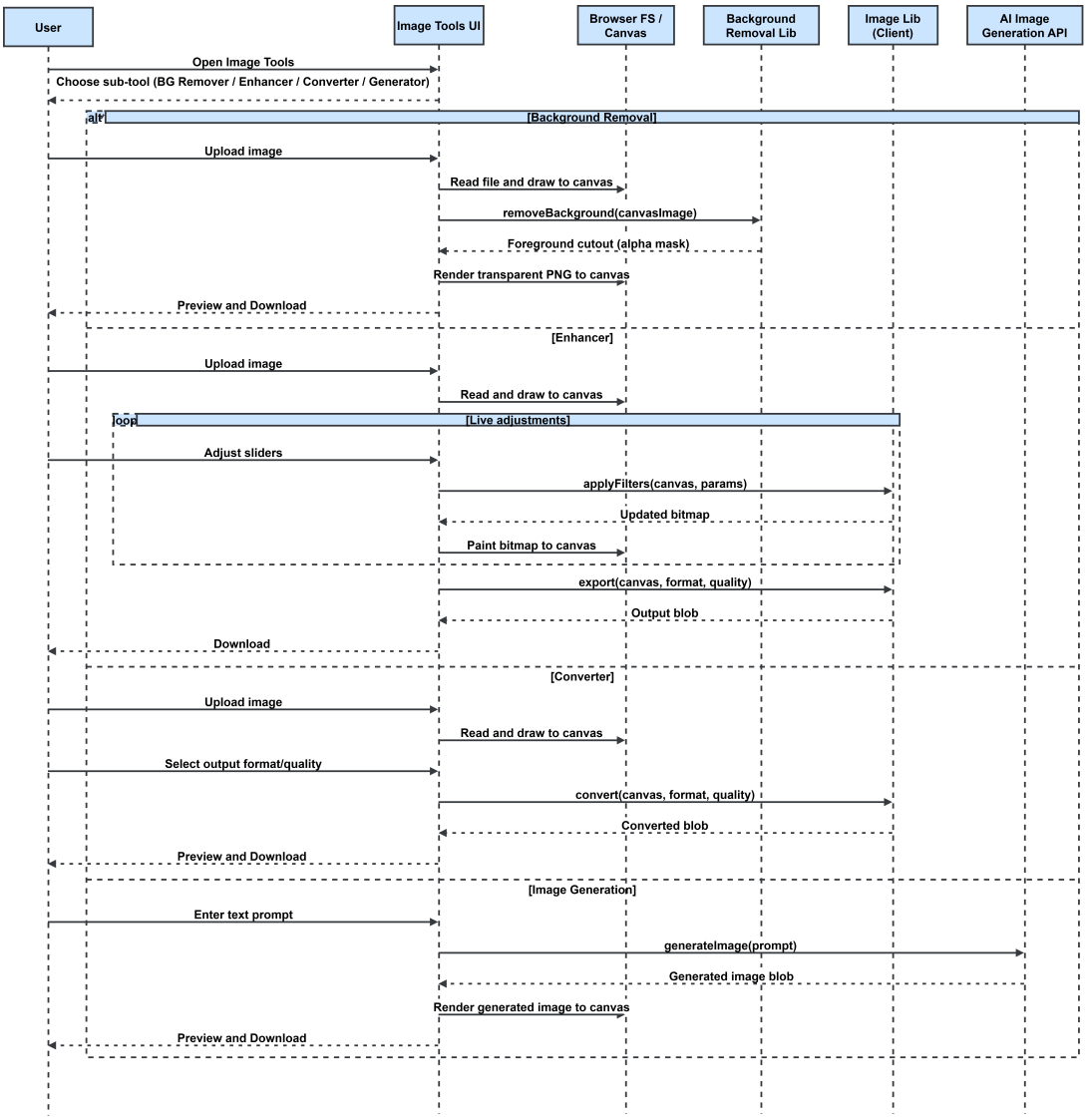

Figure 4.15: Image Tools Sequence Diagram

OCR Sequence

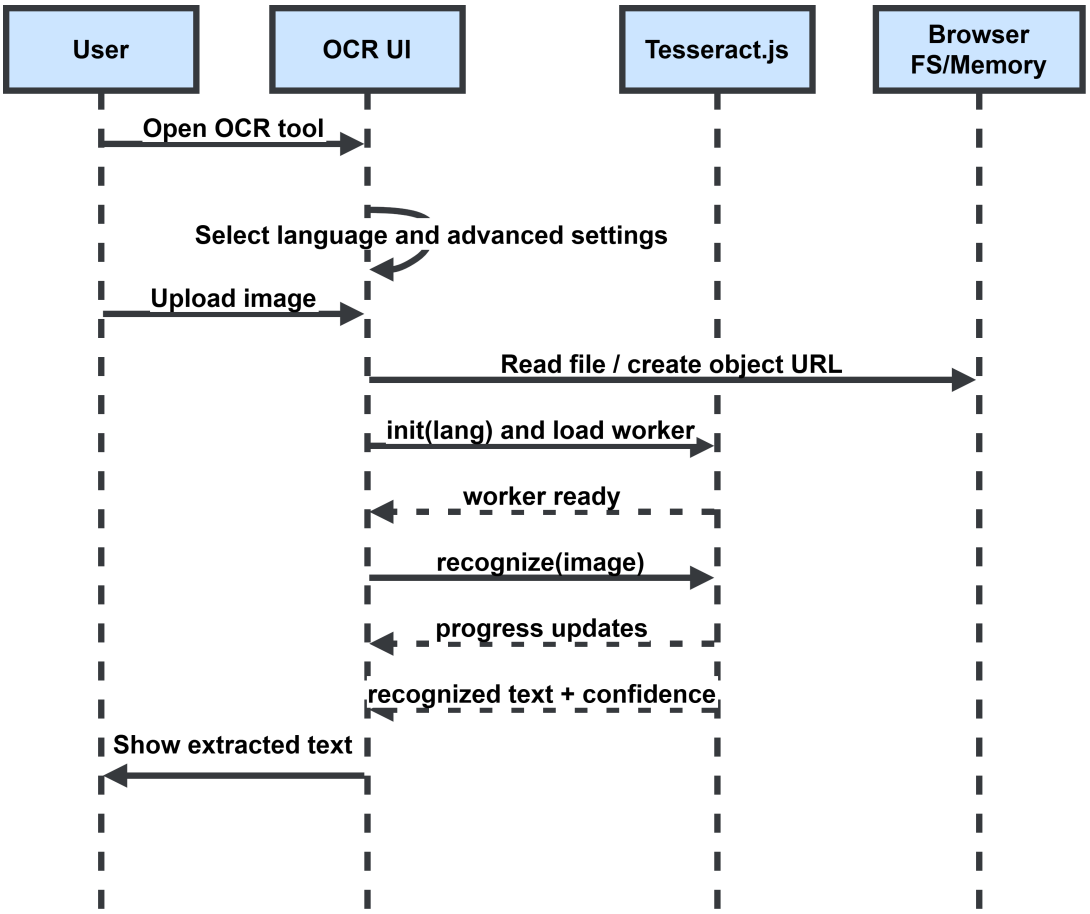

Figure 4.16: OCR Sequence Diagram

Speech-to-Text Sequence

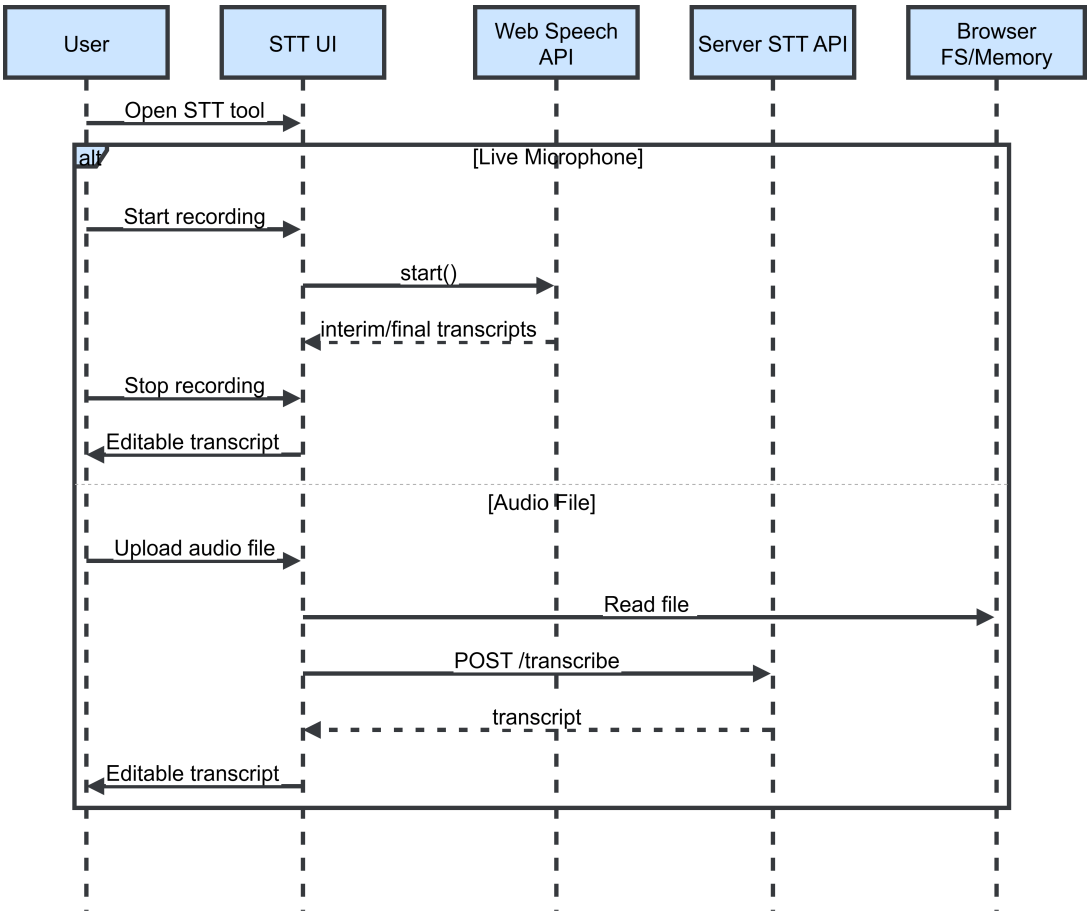

Figure 4.17: Speech-to-Text Sequence Diagram

Humanizer Sequence

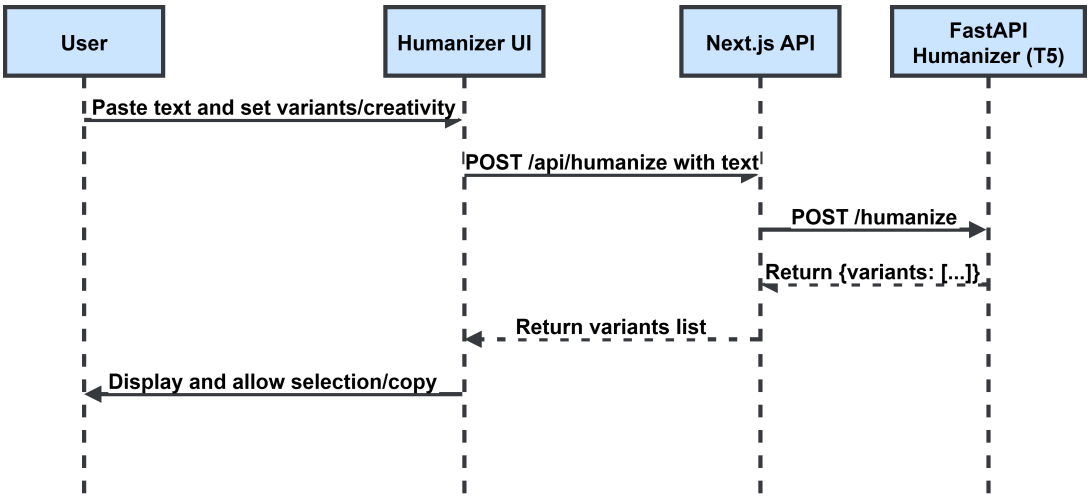

Figure 4.18: Humanizer Sequence Diagram

GPA Calculator Sequence

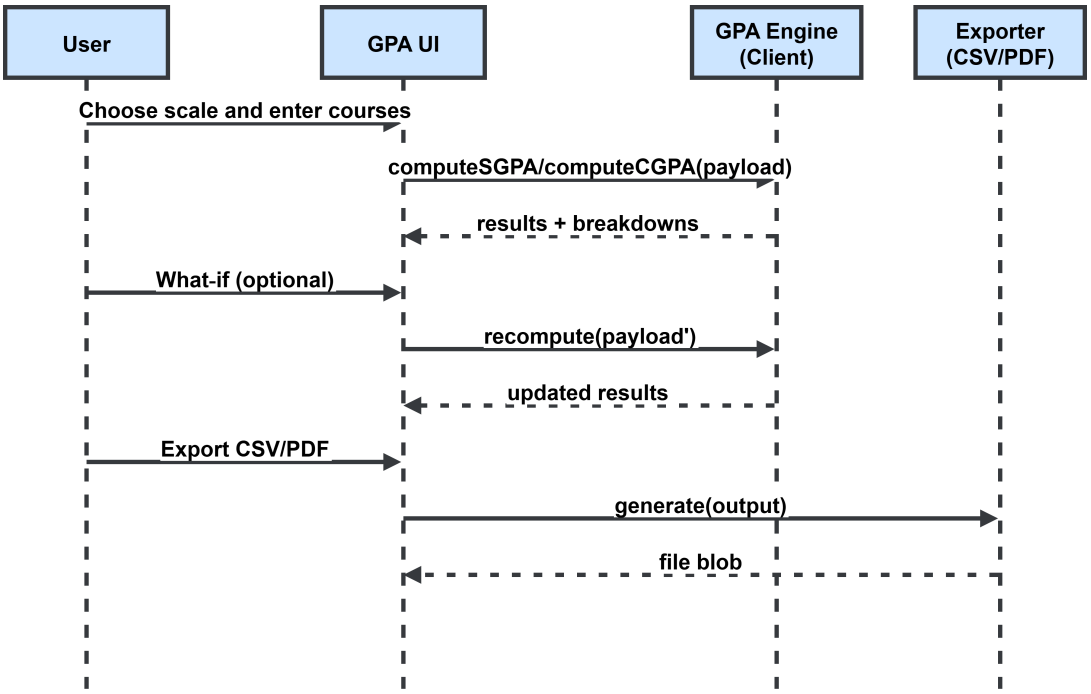

Figure 4.19: GPA Calculator Sequence Diagram

CV Maker Sequence

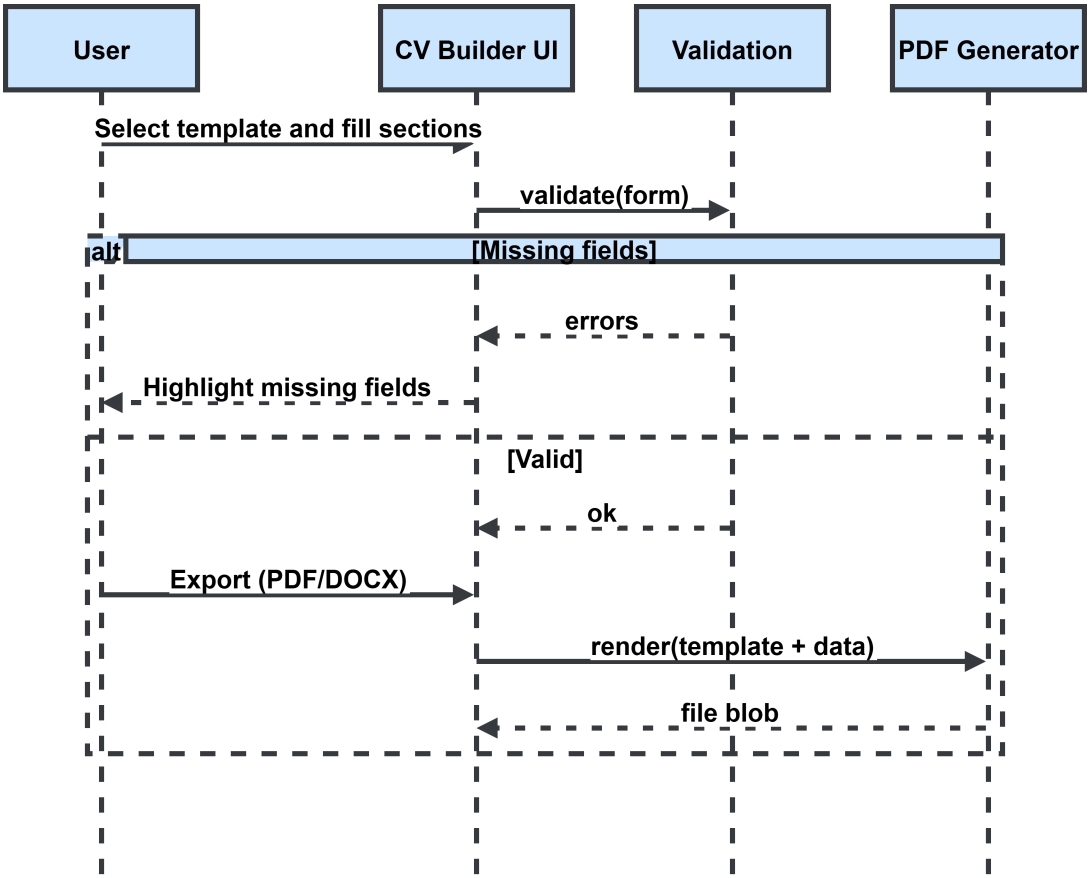

Figure 4.20: CV Maker Sequence Diagram

PDF Merger Sequence

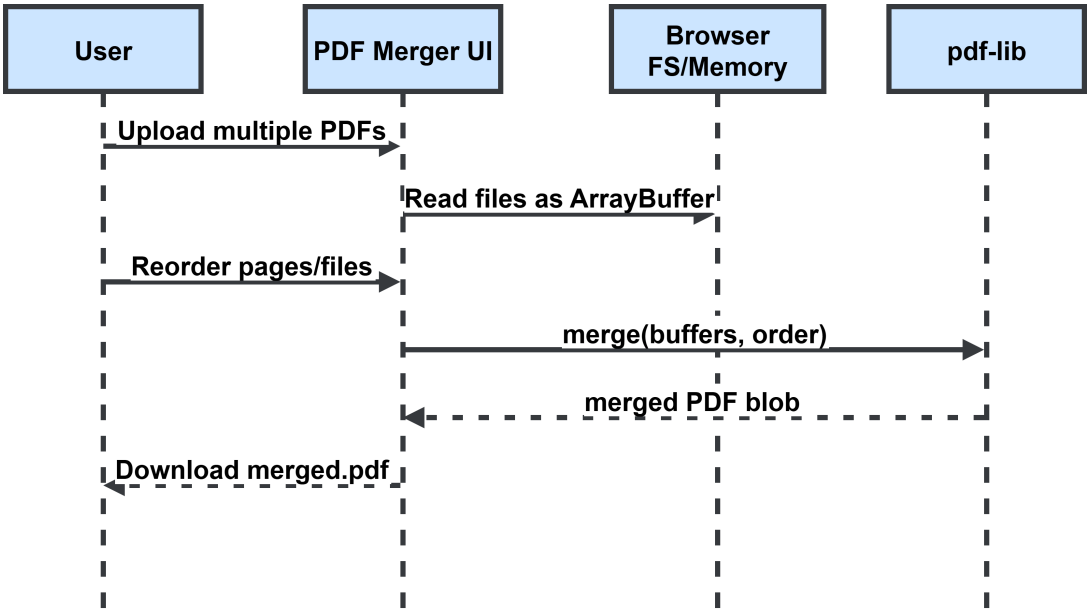

Figure 4.21: PDF Merger Sequence Diagram

TODO List Sequence

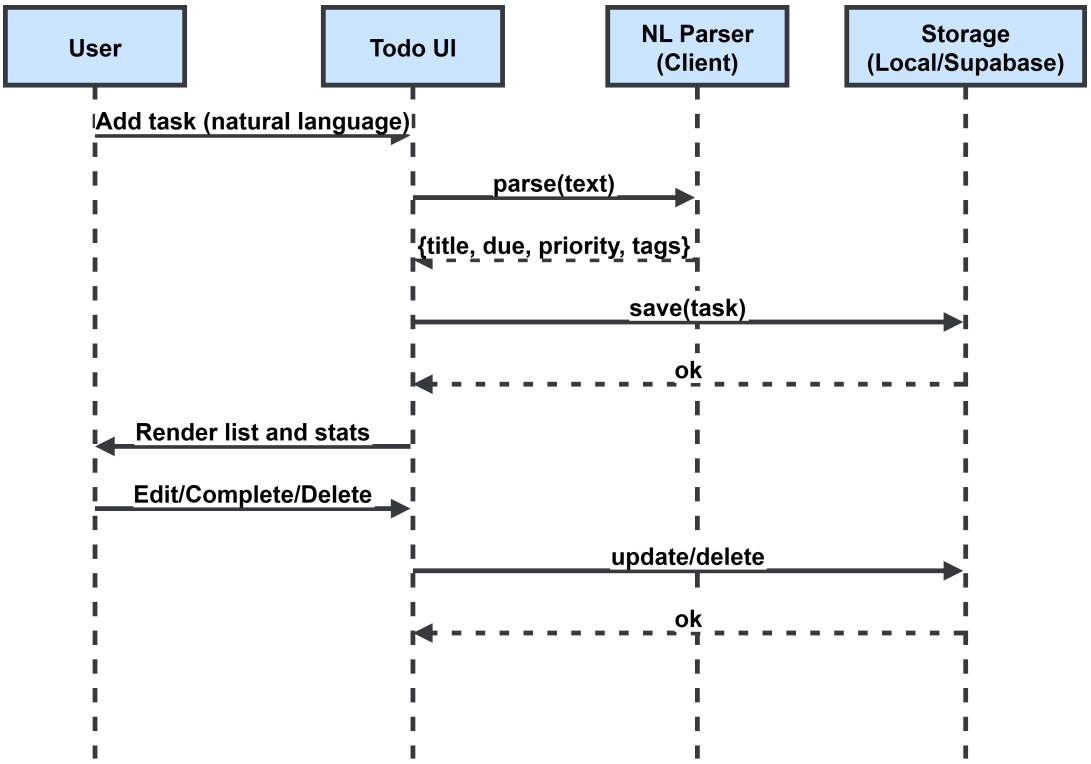

Figure 4.22: TODO List Sequence Diagram

API Routes and Services

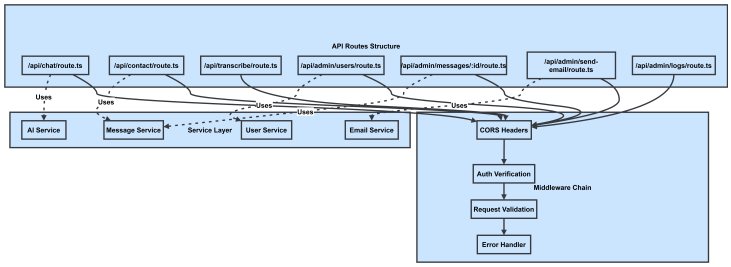

Figure 4.23: API Routes and Service Interaction

4.5 High Level Design

Logical View

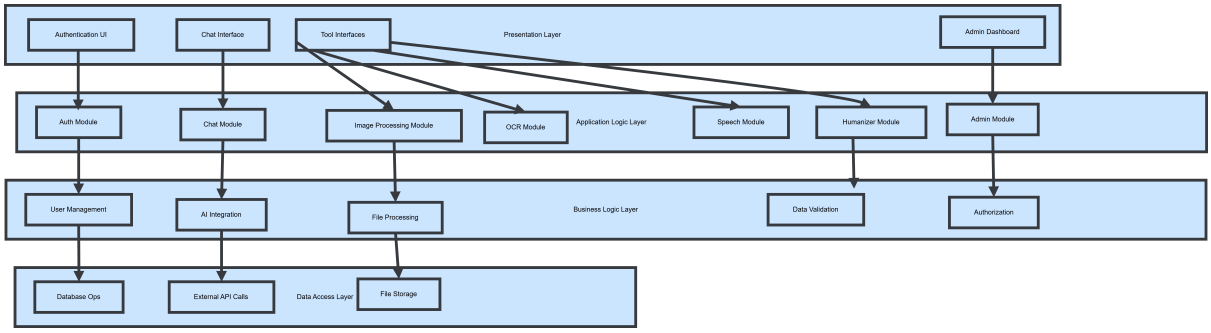

Figure 4.24: Logical View

Process View

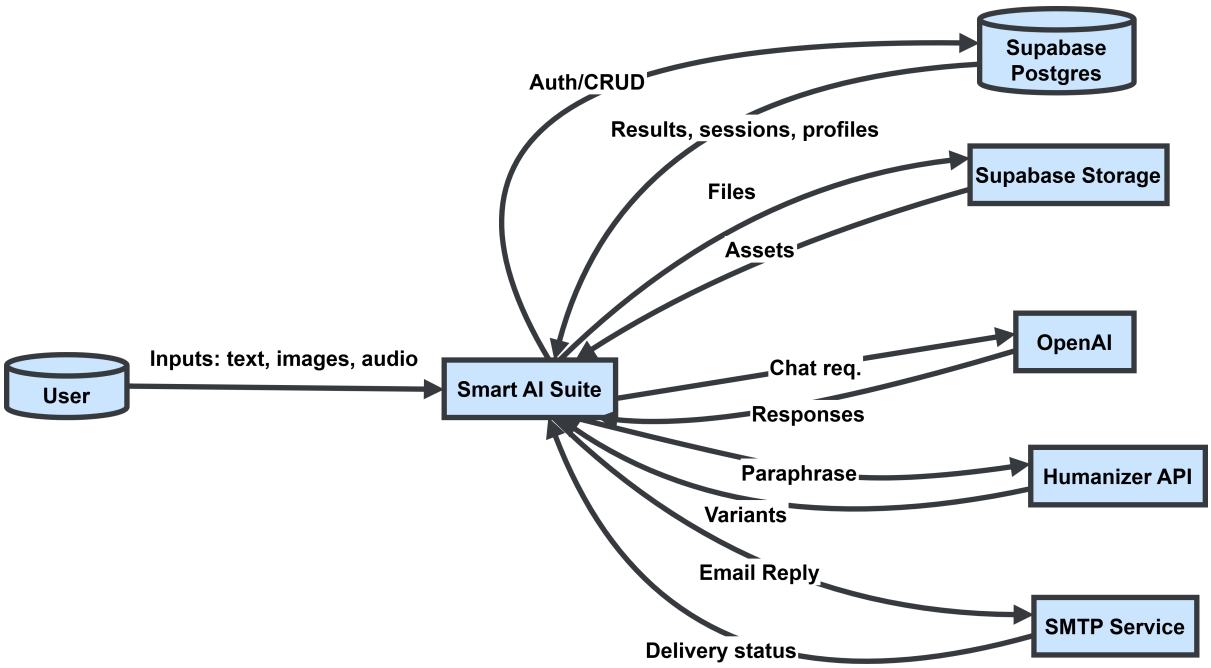

Figure 4.25: Process View

Physical View

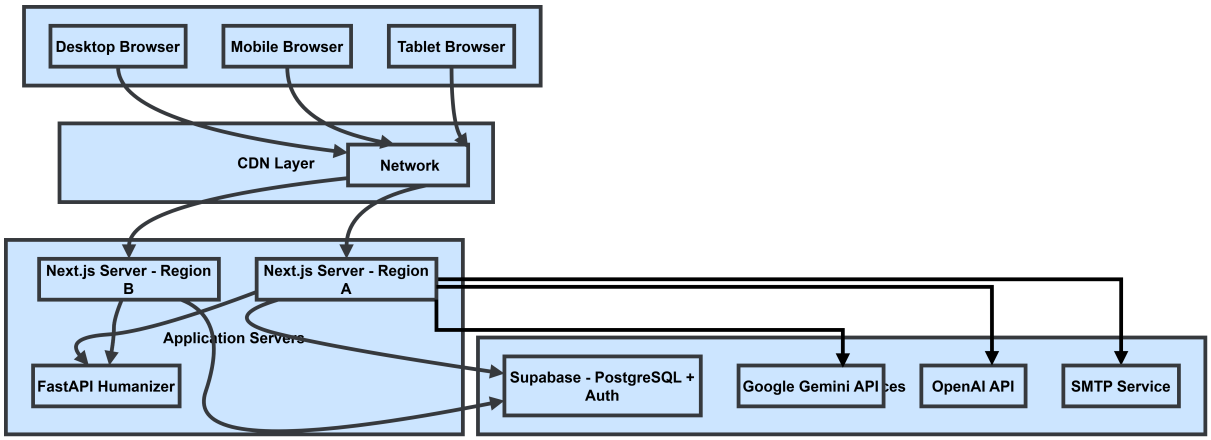

Figure 4.26: Physical View

Module View

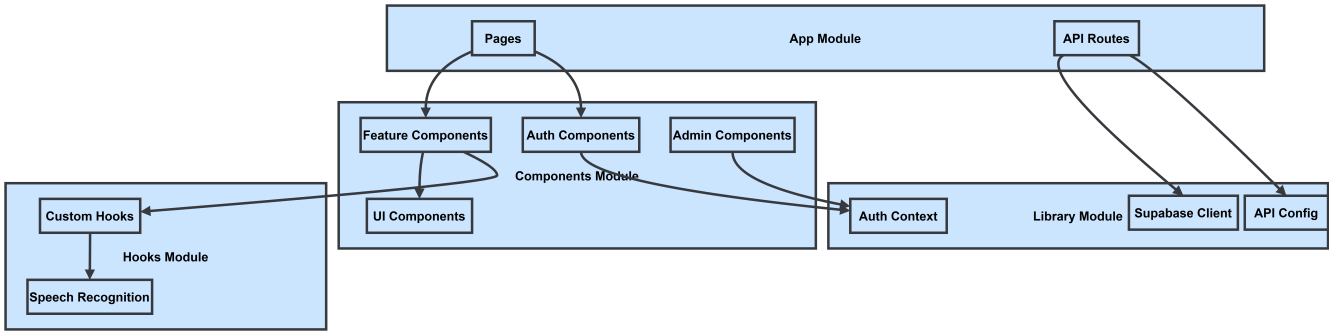

Figure 4.27: Module View

Security View

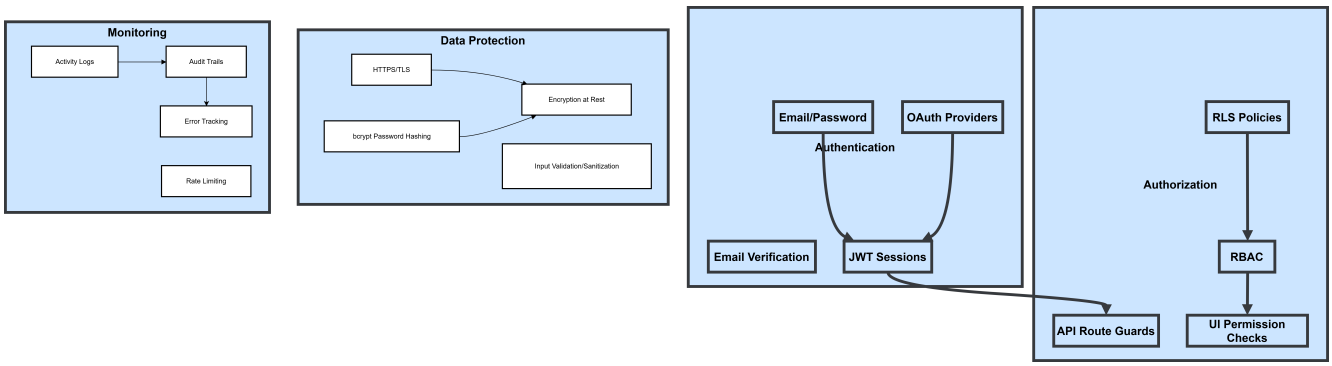

Figure 4.28: Security View

4.6 Low Level Design

4.6.1 Source Code Directory Structure

The project uses a modular Next.js 15 structure with pages and serverless route handlers under the `app` directory. Reusable UI components are stored in `components`, while `lib` contains configuration, utilities, API clients, and Supabase helpers [13]. Public assets reside in the `public` folder. The FastAPI-based Humanizer microservice is located in a separate Python module. Supabase authentication, RLS, and RPCs are handled through `lib/supabase.ts`, while provider-based AI routing is implemented in `lib/api-config.ts` [14].

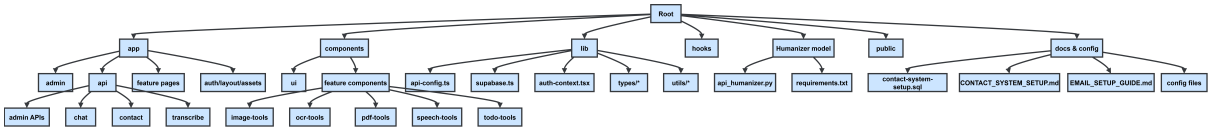

Figure 4.29: Project Folder Structure (Overview)

4.6.2 API and Backend Processing Flow

Serverless API routes authenticate users, validate input, call external APIs or database RPCs, and return structured or streamed responses [15]. Admin routes are protected by RLS policies [5][14]. Image generation and processing is performed on the client side where possible [7][8].

4.6.3 Frontend Architecture

The frontend uses reusable UI components [3]. Heavy tools like background removal and image generation are dynamically imported to reduce initial bundle size [7]. Context providers store authentication and tool state, while hooks provide speech recognition, layout behavior, and other reusable logic [16].

4.6.4 Database Schema and ERD

Supabase uses PostgreSQL with RLS to implement least-privilege access control [5]. Anonymous users may insert contact messages while only admins can read or update them. Table indexes are created for high-use queries.

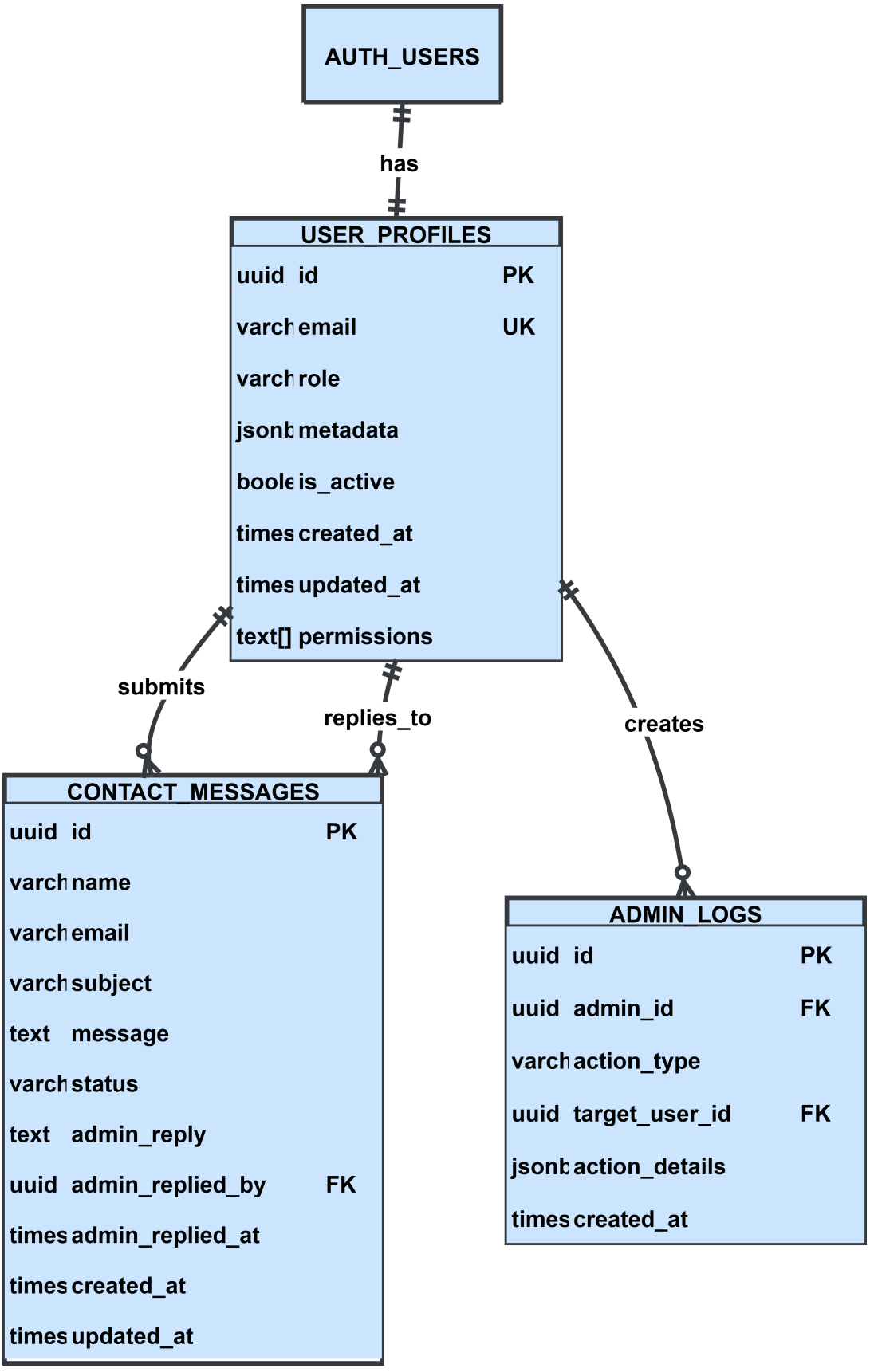

Figure 4.30: Entity Relationship (ER) Diagram

4.7 GUI Design and Screens

The interface follows accessibility standards for spacing, contrast, and responsiveness [17]. Tools follow an upload → configure → process → preview → download flow. Forms perform early validation and display clear error messages.// Sign up page:

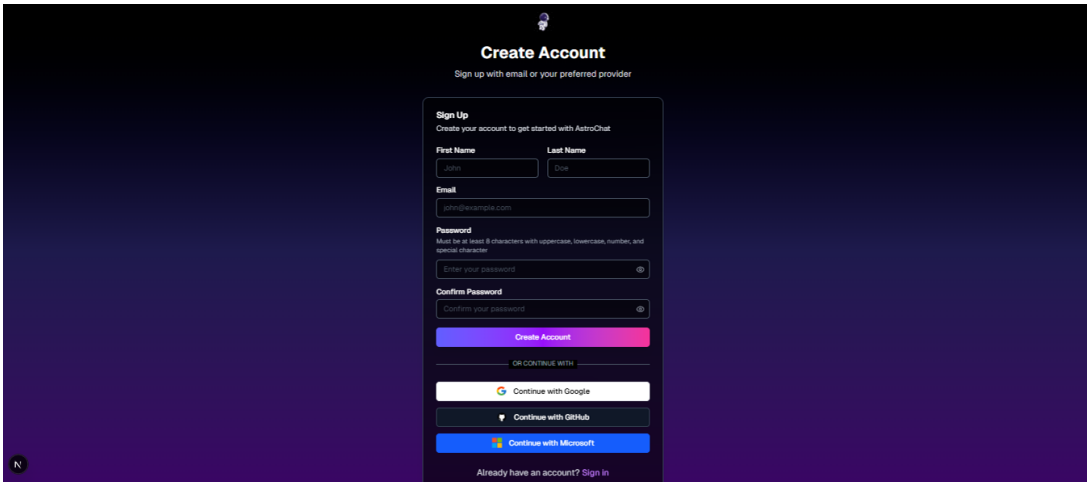

Figure 4.31: Sign up page

Sign in page:

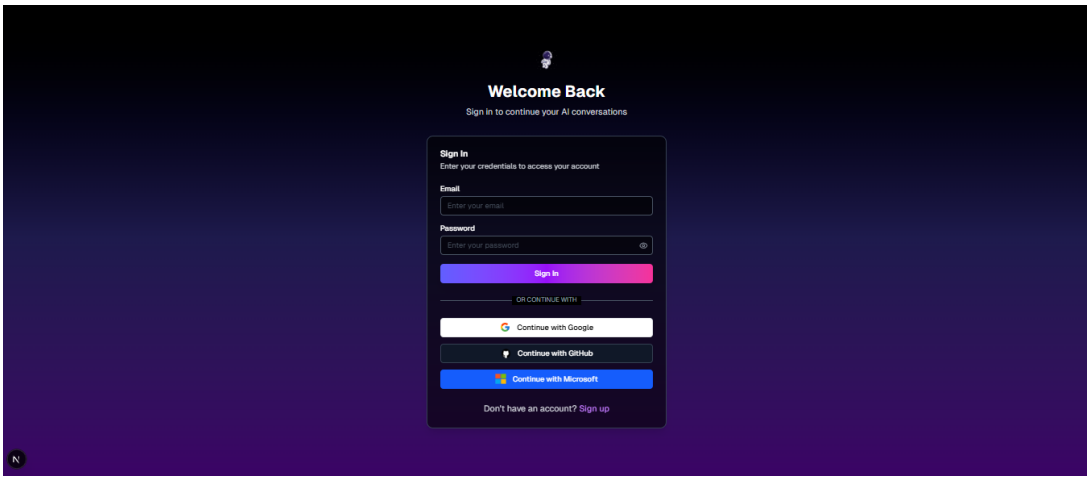

Figure 4.32: Sign in page

Landing page:

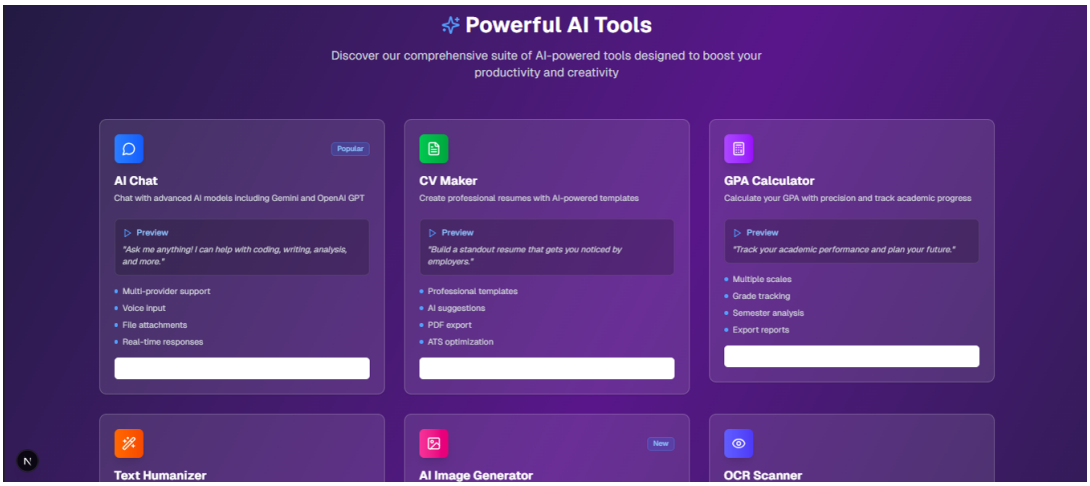

Figure 4.33: Landing page

Privacy Policy page:

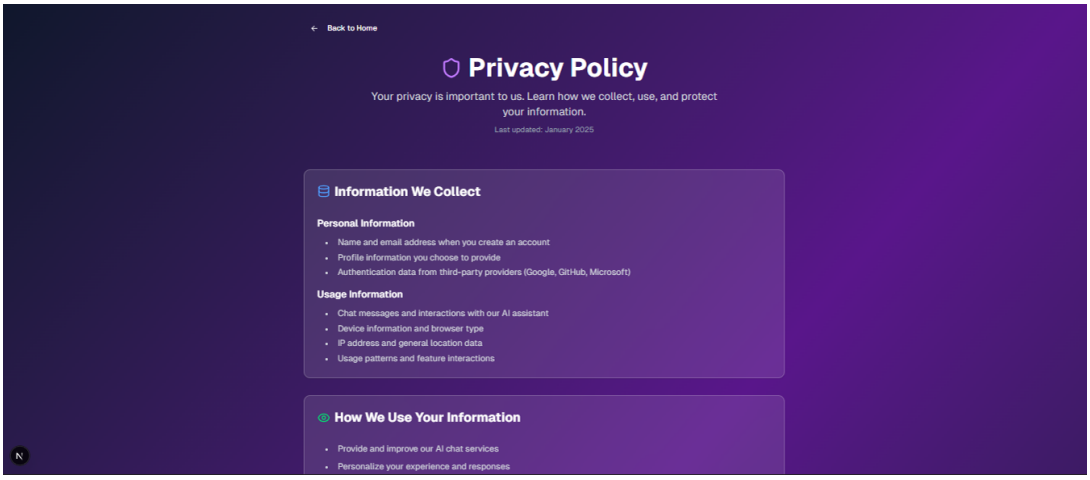

Figure 4.34: Privacy Policy page

Reach Out To Us page:

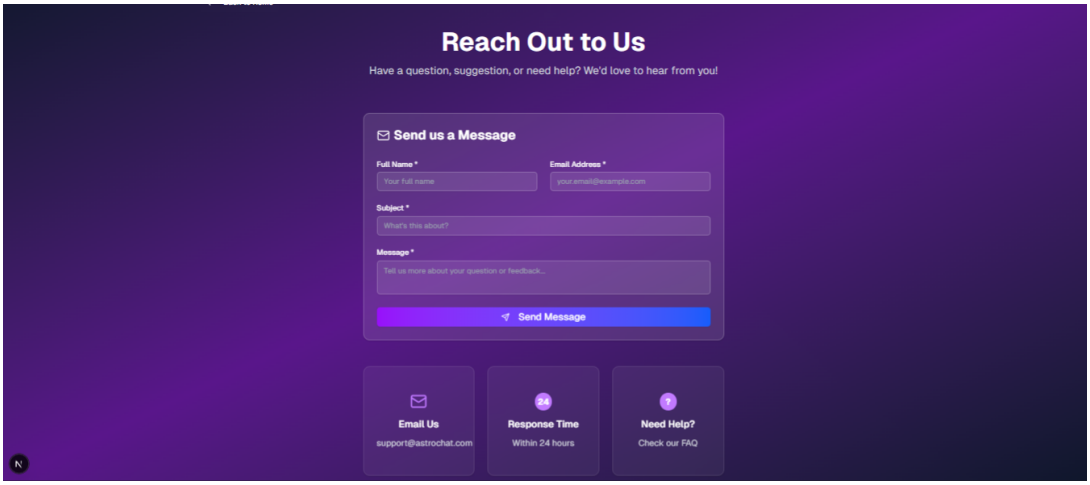

Figure 4.35: Reach Out To Us page

Terms OF Service page:

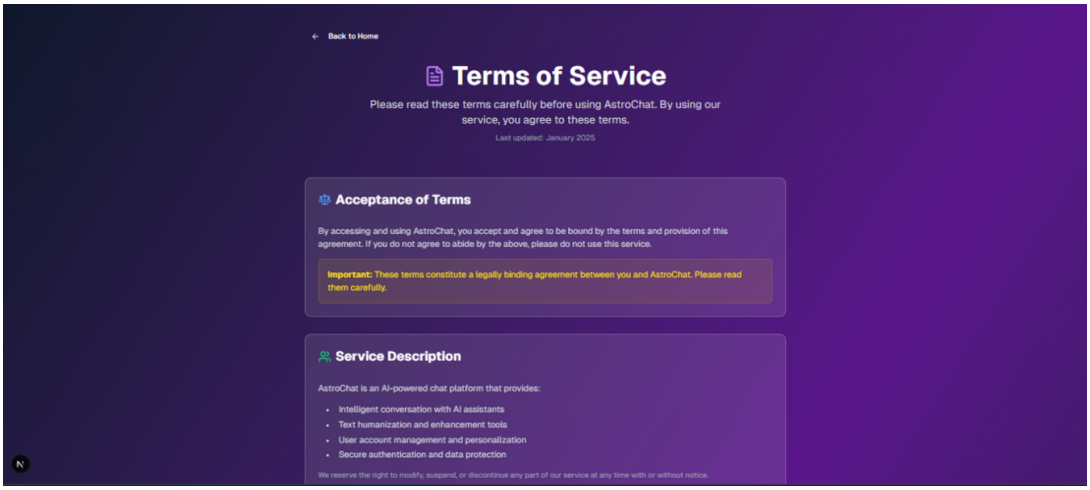

Figure 4.36: Terms Of Service page

Settings page:

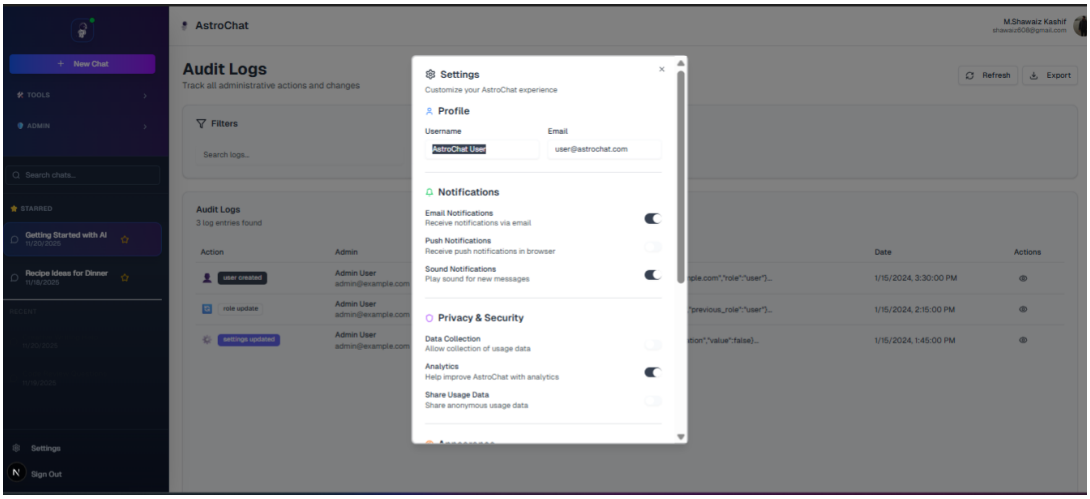

Figure 4.37: Settings page

Admin Dashboard page:

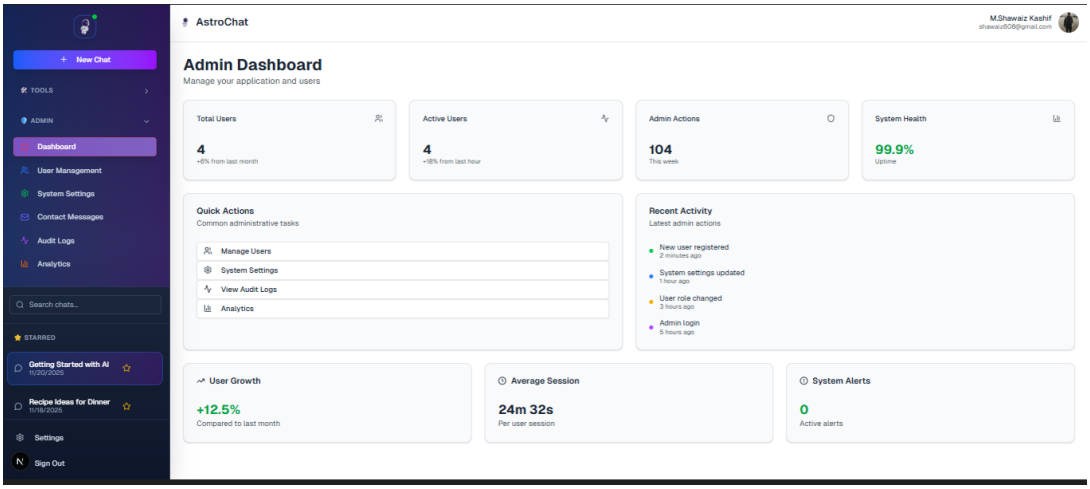

Figure 4.38: Admin Dashboard page

User Management page:

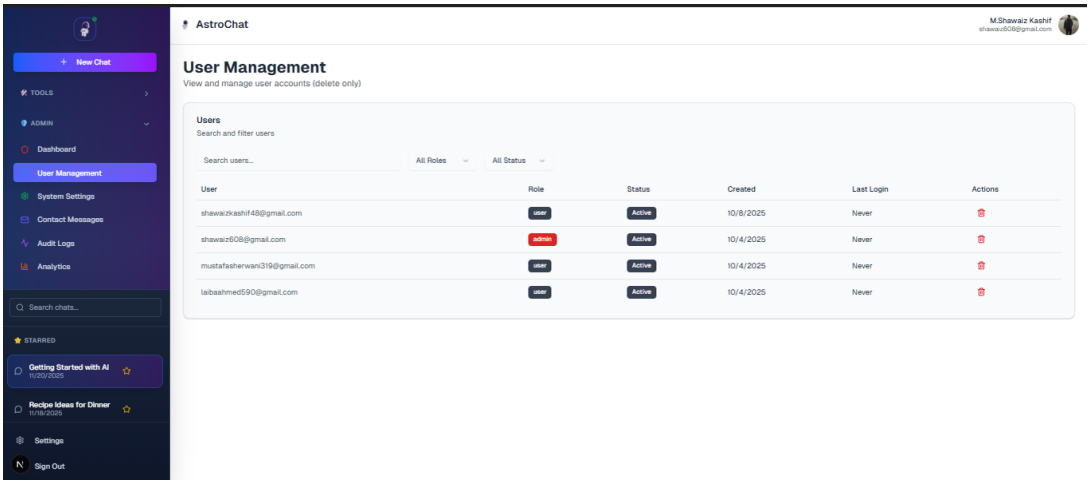

Figure 4.39: User Management page

System Settings page:

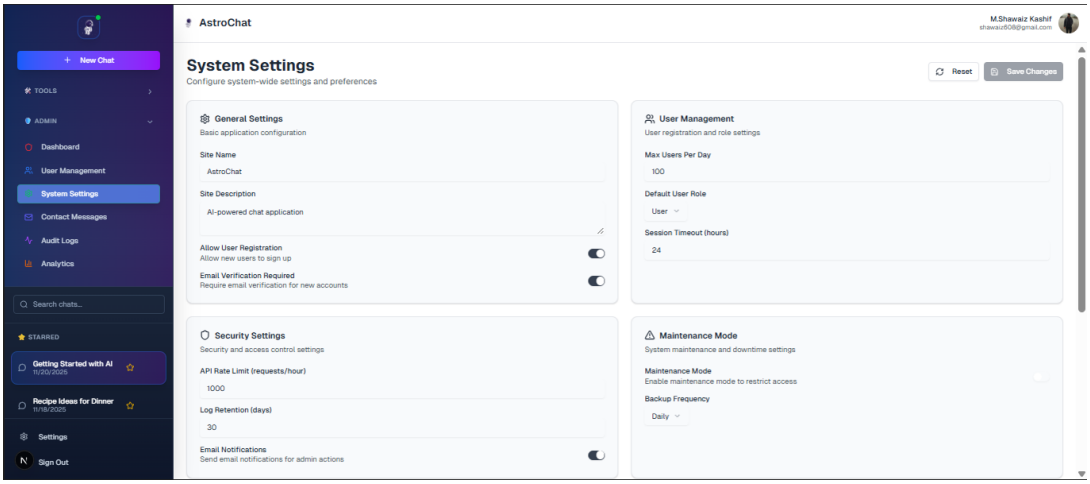

Figure 4.40: System Settings page

Audit Logs page:

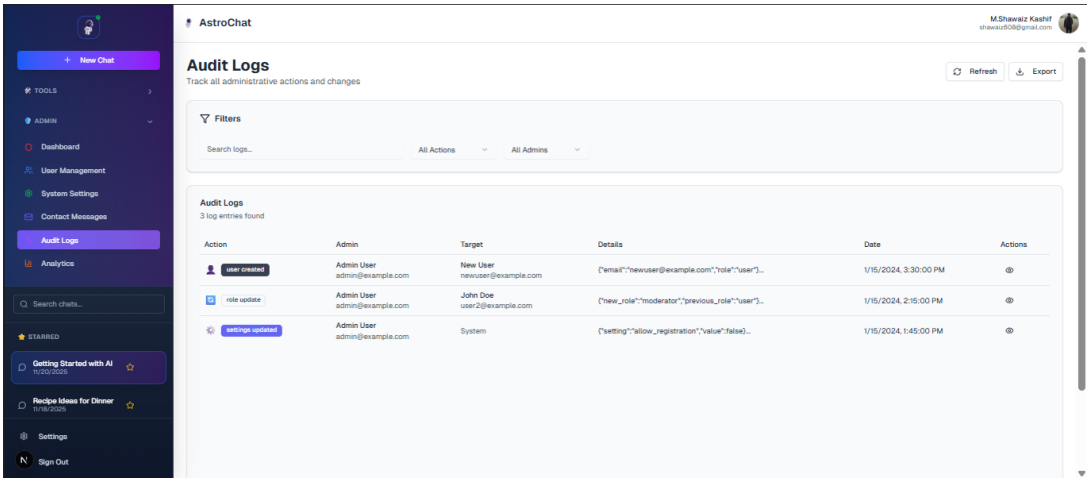

Figure 4.41: Audit Logs page

Feedback page:

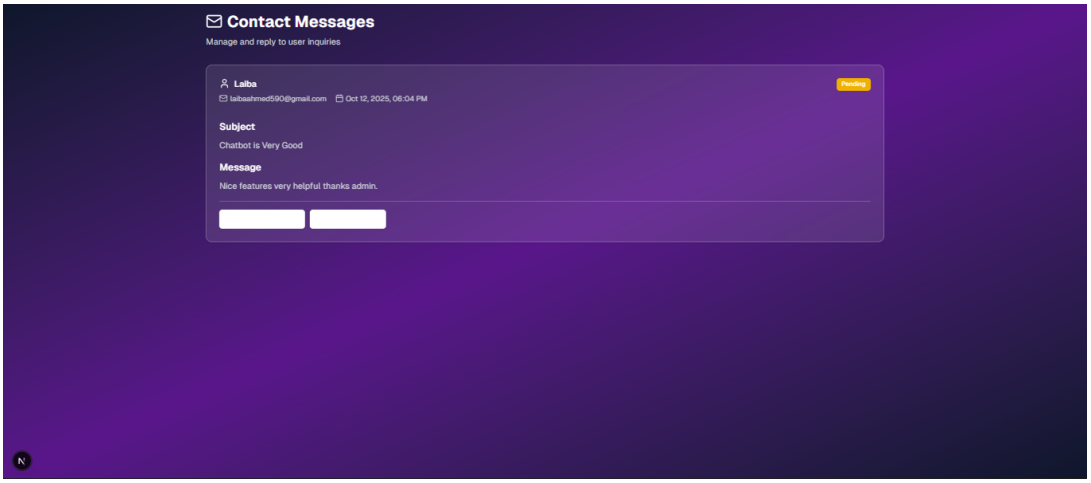

Figure 4.42: Feedback page

Chatbot UI:

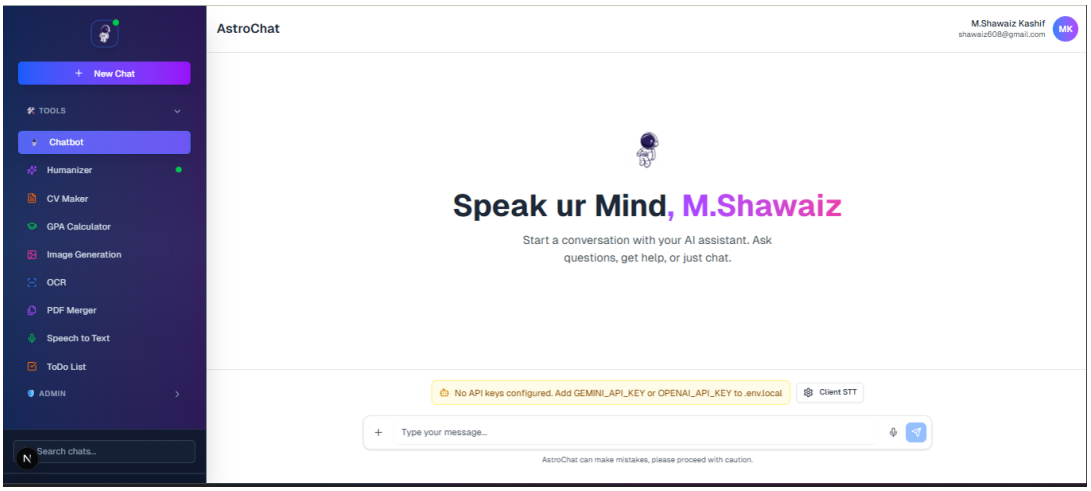

Figure 4.43: Chatbot UI

CV Maker UI:

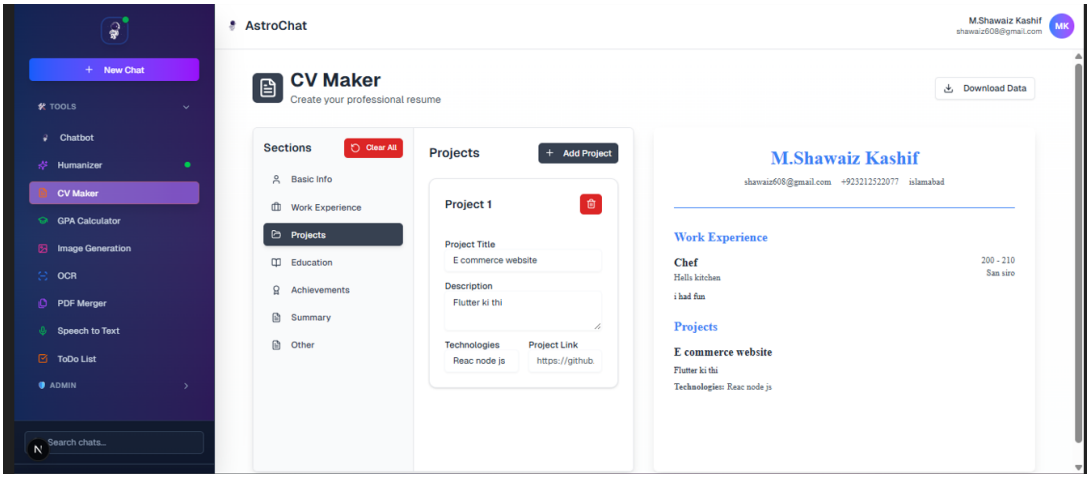

Figure 4.44: CV Maker UI

GPA Calculator UI:

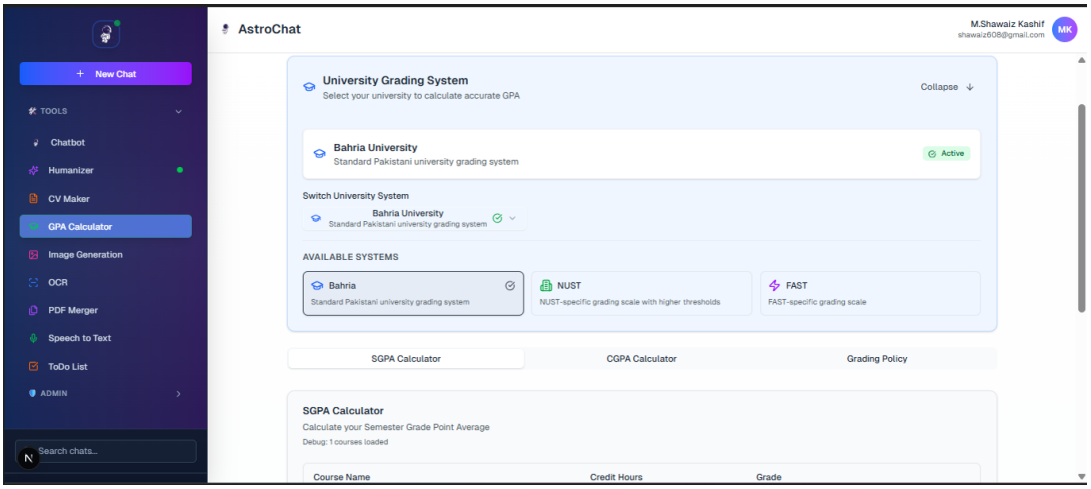

Figure 4.45: GPA Calculator UI

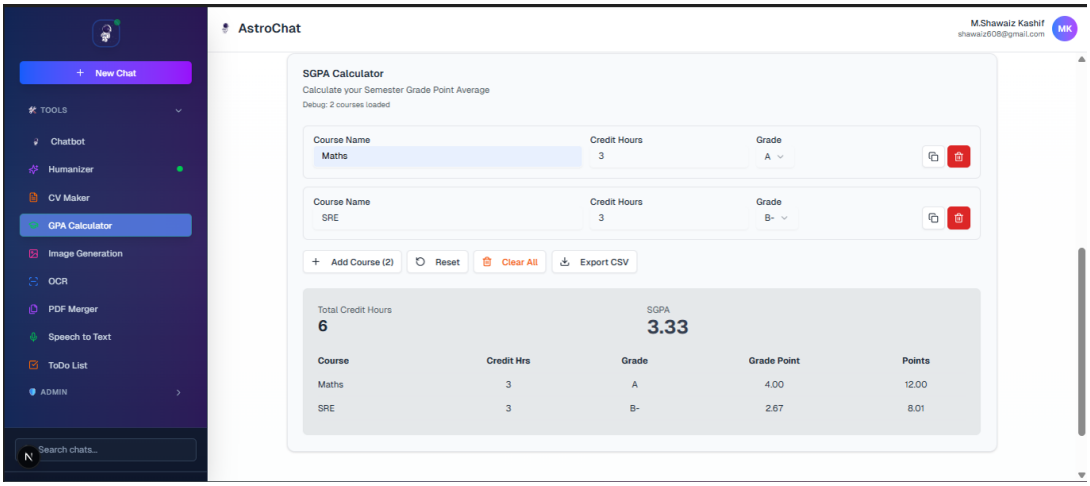

Figure 4.46: GPA calculation with course addition

Humanizer UI:

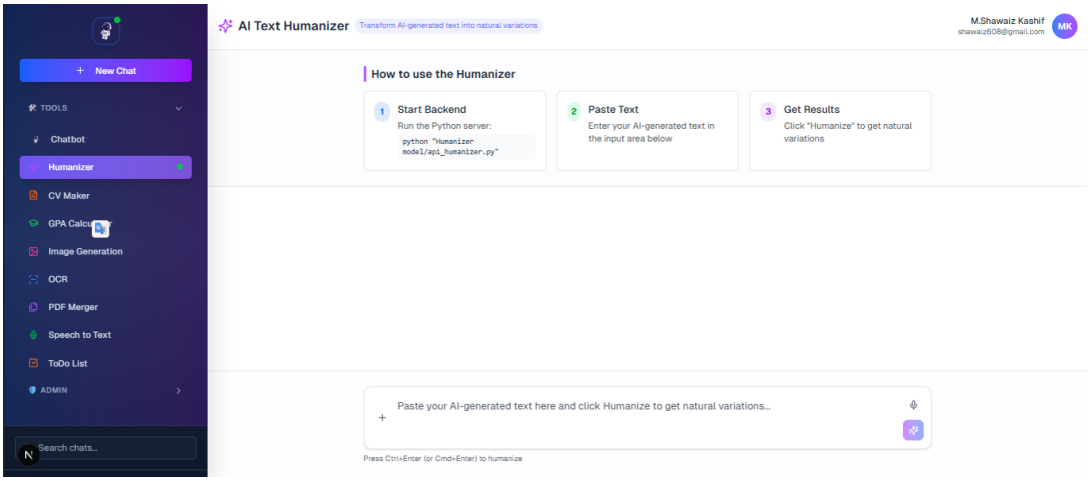

Figure 4.47: Humanizer UI

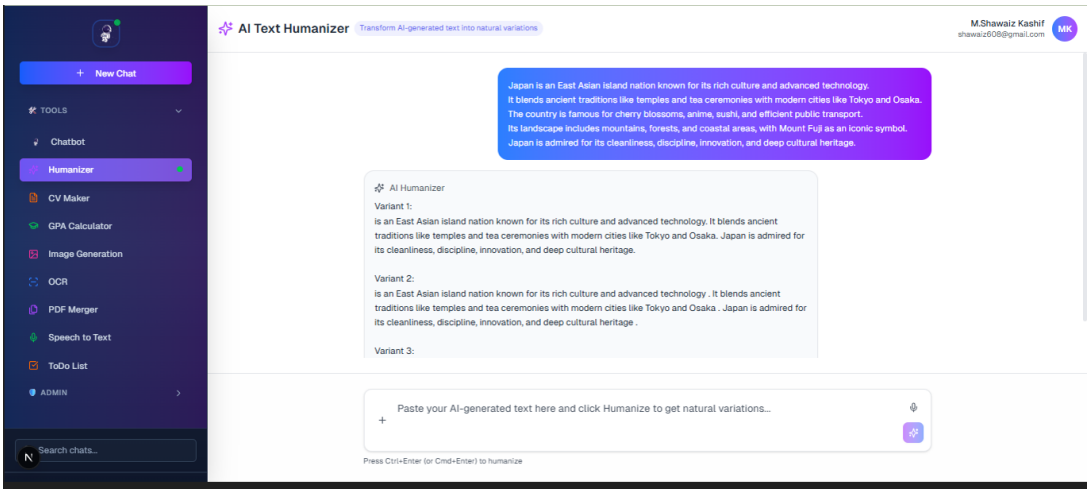

Figure 4.48: Humanizer responses

Image Tools UI:

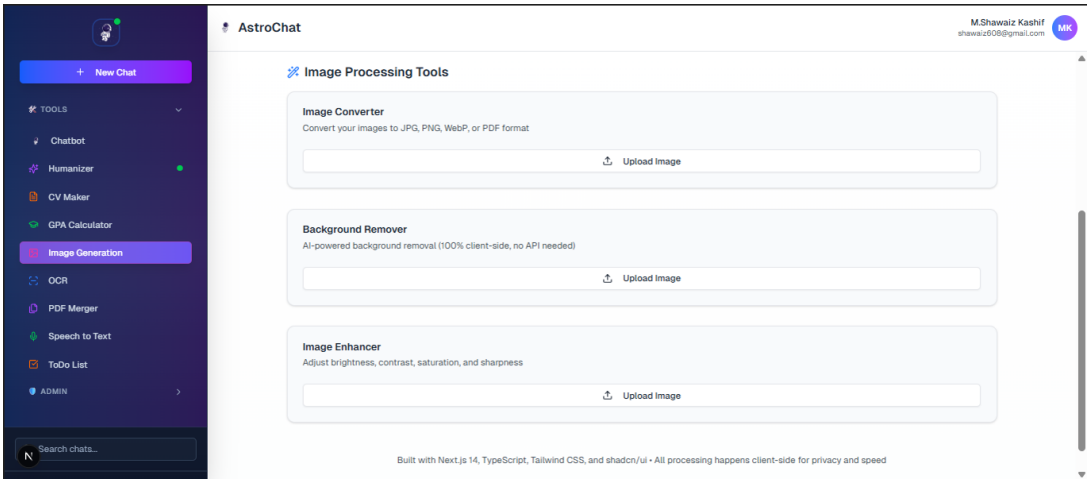

Figure 4.49: Image Tools UI

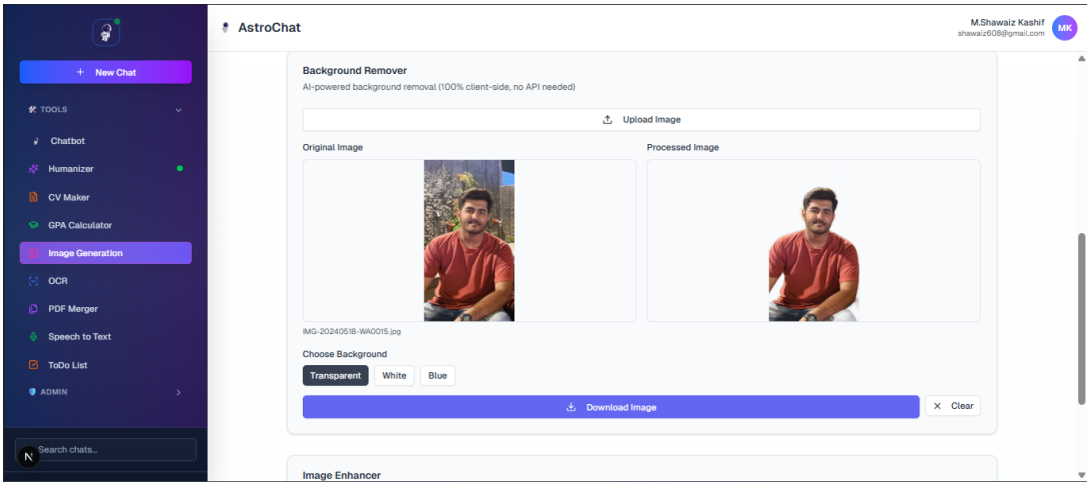

Figure 4.50: Background Removal

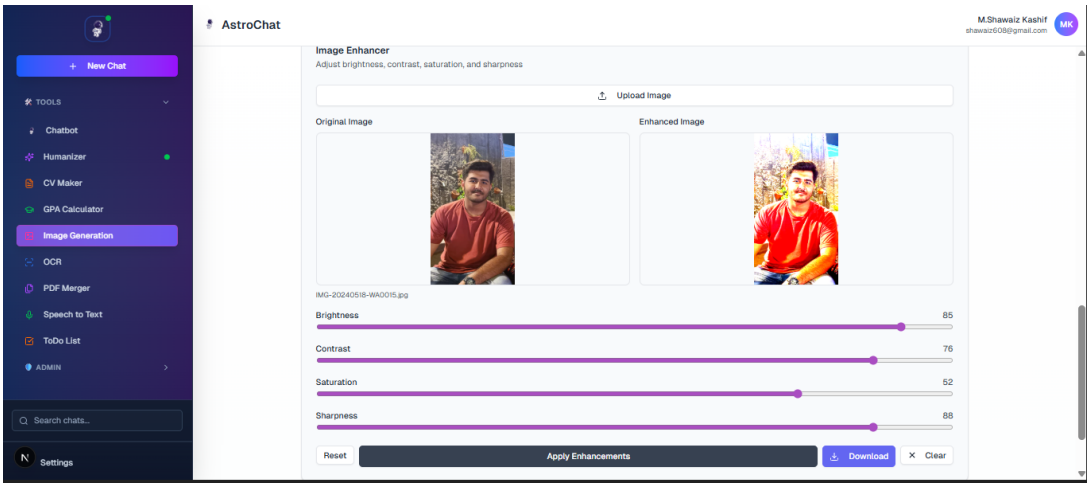

Figure 4.51: Image Enhanced

OCR UI:

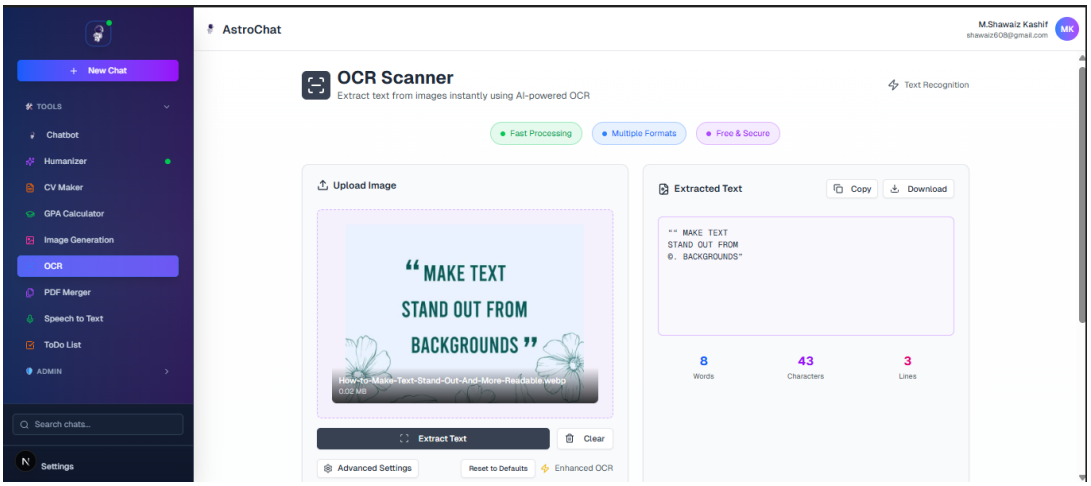

Figure 4.52: OCR UI

PDF Merger UI:

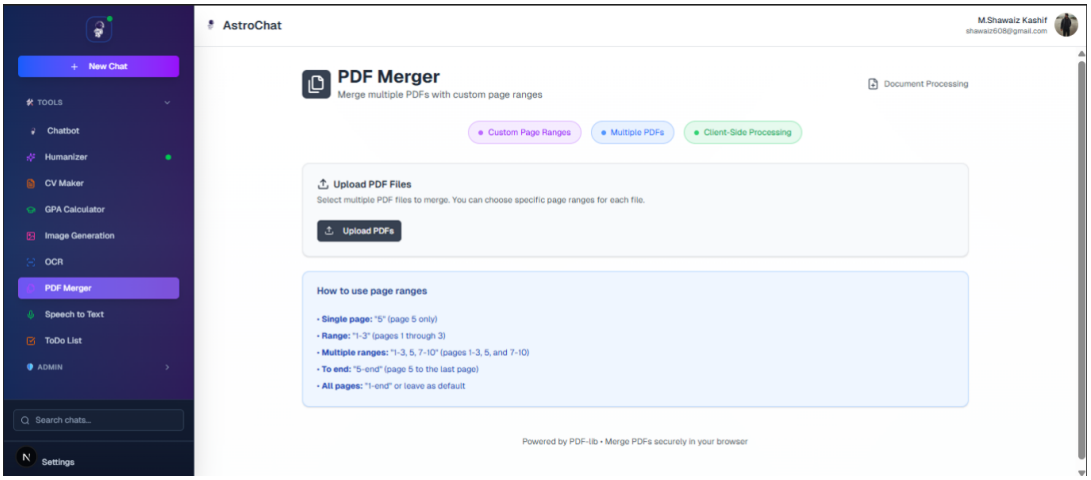

Figure 4.53: PDF Merger UI

Speech To Text UI:

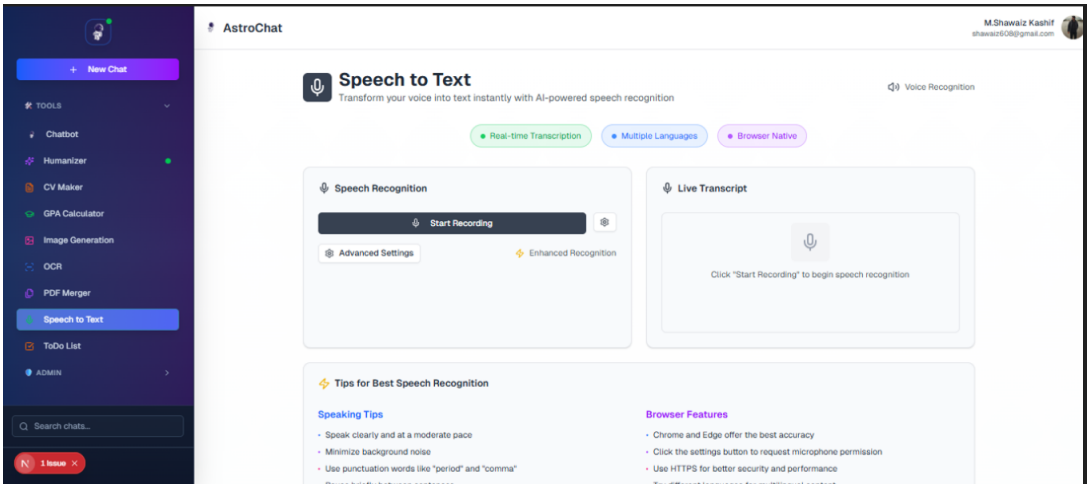

Figure 4.54: Speech To Text UI

TODO List UI:

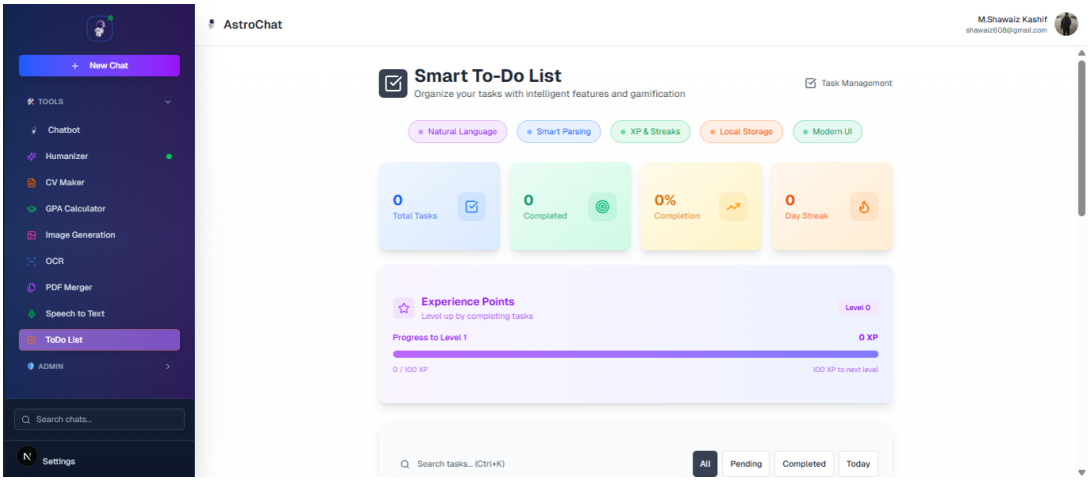

Figure 4.55: TODO List UI

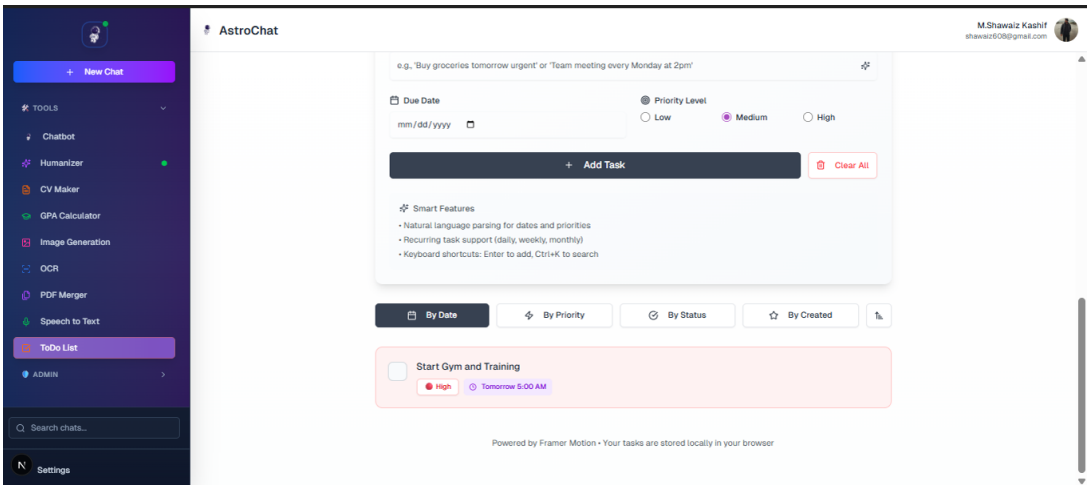

Figure 4.56: Task addition with date, time and priority

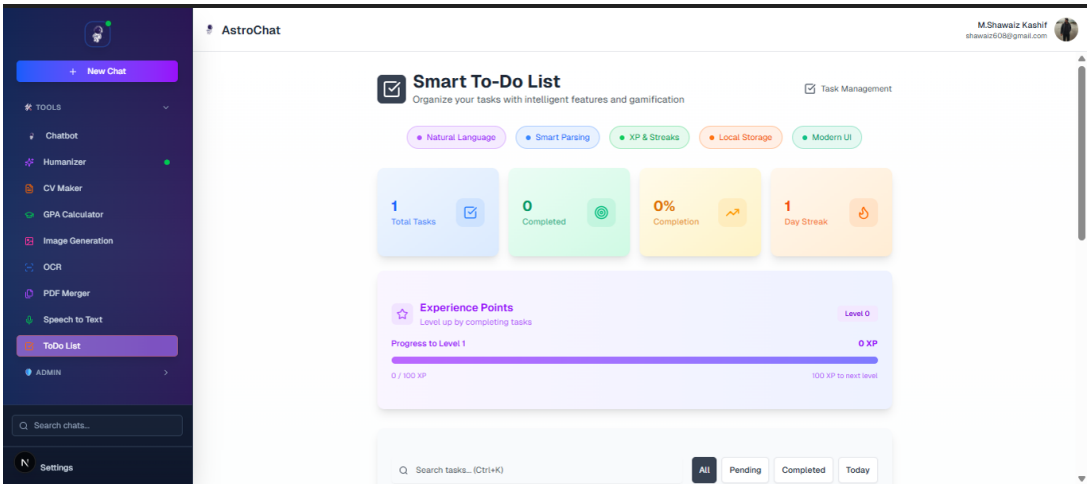

Figure 4.57: Task tracking

4.8 External Interfaces

Examples of external interfaces would be the Gemini and OpenAI conversational response interfaces [1][2], the FastAPI humanizer conversation response variants paraphrasing interface [6], SMTP email delivery interface and Supabase auth and relational storage interface [5]. The client libraries offer localized execution of the OCR, image tools and image generation where feasible to reduce the amount of data transport and charges [7][8].

Chapter 5

System Implementation

5.1 Implementation Overview

The implementation of the Smart AI Suite follows a modular monorepo-style structure. The Next.js application contains pages and API routes inside the `app/` directory, React components inside `components/`, and shared logic inside `lib/` and `hooks/` folders [1][2].

The Humanizer microservice is implemented as an independent Python FastAPI module containing separate dependencies, environment variables, and execution scripts [3]. Environment variables are used to configure model providers, API keys, Supabase credentials, and Humanizer endpoints across development and production environments [4]. The image generator and image enhancement modules rely on browser-side libraries to support private, client-side processing [5][6].

5.2 System Architecture

The system follows a distributed architecture combining:

- Client-side rendering (CSR).
- API routes in Next.js and server components.
- Supabase database (PostgreSQL, Auth, RLS).
- An autonomously running FastAPI Humanizer service.

Selection of the providers is based on the environment, which means that Gemini or OpenAI can be dynamically selected or chosen at runtime [1][7]. The loading is dynamic for heavy modules such as OCR, image generation to compress the size of a bundle and enhance initial load performance [5][6].

5.3 Development and Integration of System Components

This section describes how various apps have been created and incorporated into a single integrated system called Smart AI Suite. It focuses on learning about the development of indivisual elements and their amalgamation into a system which shares authentication, interface and control.

5.3.1 Unified Platform Integration Approach

Smart AI Suite is created as one web-based platform in which AI and several utility tools have a common system architecture. Rather than constructing isolated. applications, all tools are based on the same frontend, authentication and system layout structure [9], [10], [12]. The integration is achieved by:

- A frontend interface that is centralized.
- Uniform input and output processing.
- Authentication and role based access.
- Combined client-server computing.

With such approach, various technologies and AI services can run as a single entity integrated, instead of discrete tools [6].

5.3.2 Development of Conversational AI Component

Conversational AI is created as a chat interface within the main platform. The frontend captures user messages and transmits them to the chosen AI provider with a unified request format [1], [2].

Rather than committing the system to a single AI vendor,OpenAI and Google Gemini are switched using enviornment-based configurations. This abstraction allows flexibility and less vendor lock-in and maintains same user interface.Returned responses are displayed in the chat interface and rendered in real time.

Returned responses are processed and rendered in real time in the chat interface.

5.3.3 Development of OCR and Text Extraction Component

OCR feature is built on client-side processing in order to ensure the privacy of the users.Once a user uploads an image the OCR library is executed in the browser itself. Reads and retrieves text locally without transferring files to a remote server [5].

This design:

- Minimizes thw workload of the server.
- Enhances the response time.
- Protects data from unauthorized and external usage.

The text that is extracted is automatically shown in the interface and can be copied in other tools of the platform.

5.3.4 Development of Image Processing Tools

Background removal and basic editing are the image processing features constructed with the help of browser-based image manipulation libraries.Images are loaded, processed and previewed,the entire execution is done on the client side and then the final result is downloaded [13].

Smart AI Suite eliminates reliance on external design software by processing images on a local basis and enabling the users to handle regular image tasks in the same platform.

5.3.5 Development of Utility-Based Applications

Utility applications, including calculators, form-based helpers, and text utility applications are implemented directly in the frontend by logical computation and validation. These tools are not needs of AI models but will be embedded in the system to enhance usability and productivity.

All utilities are authenticated in the same way and have the same UI structure which helps in a unified user experience.

5.3.6 Development of Text Humanization Microservice

Text humanization feature is a backend microservice because of its computational requirements.The T5 language pretrained model is loaded by a Python based Fast API which processes text requests received from the frontend. The processing flow includes:

- Texts are entered by the user on the frontend.
- Call made to FastAPI service.
- The model produces text that is paraphrased, or humanized.
- The results are returned and presented to the user.

This division enhances maintainability and enables the service to scale on its own.

5.3.7 Integration and Coordination Between Components

All the elements, such as chat, OCR, image tools, utilities, and humanizer, are synchronized with common routing logic and common data handling.Some components run completely within the browser, though some of them depend on the services of the back-end, yet they are all linked using the same platform infrastructure [6], [12]. With this hybrid integration approach, Smart AI Suite can be made to work like a unified entity system that is predictable in its behavior and has a central control.

5.4 Tools and Technologies Used

Table 5.1 is a list of the key tools and technologies applied to the implementation of the Smart AI Suite.

Table 5.1: Technology Stack Used in Smart AI Suite

Layer	Technology	Purpose
Frontend	Next.js 15, React 18, TypeScript	UI, routing, SSR/SSG.
Styling	Tailwind CSS, shadcn/ui	Design system, UI components, responsive styling.
Auth/DB	Supabase (PostgreSQL, Auth, RLS)	Authentication, database storage, row-level security policies.
AI Chat	Google Gemini, OpenAI GPT	Conversational intelligence, multi-provider chatbot support.
OCR	Tesseract.js	Client-side OCR with multilingual support.
Image Processing	@imgly/background-removal, Canvas API	Client-side background removal, enhancement, and image generation workflows.
PDF Tools	pdf-lib	Client-side PDF merging, editing, and processing.
Humanizer	FastAPI, Transformers (T5)	Text paraphrasing and rewriting through a dedicated microservice.
Email System	Nodemailer + SMTP	Admin replies, email notifications, and communication.

5.5 Development Environment

Development is done with Node.js LTS and either NPM or PNPM as the package manager.The primary application is written in TypeScript, whereas the Humanizer microservice is written in Python 3.10+ [1][3].

Environment variables configure:

- Provider keys and model names.
- Supabase URL and service key.
- SMTP credentials.
- Humanizer API endpoint.

Local development involves running the Next.js development server and the Python FastAPI service concurrently.Image generation modules are tried on browser to validate correct execution [5][6].

5.6 Algorithmic and Logical Flow

Chat endpoint formats messages according to provider specifications and streams back responses [8]. ackground removal loads an alpha model and calculates alpha masks in real-time [5]. OCR loads language packs on demand and processes image tiles while displaying progress [9].Humanizer service produces text transformations with the help of T5 models depending on tone, count of variations and their maximum output length [3].Admin functions run Supabase stored procedures with RLS protection [7].

5.7 Interaction Diagrams

Frontend and Backend Interaction

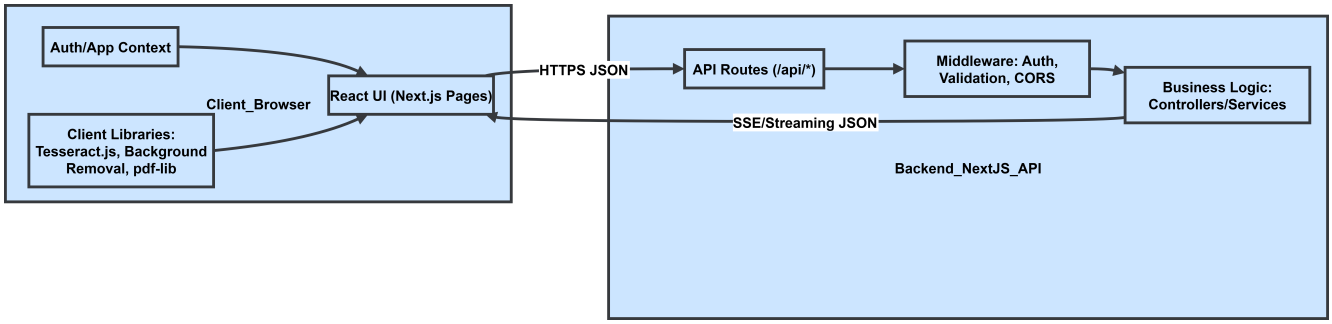

Figure 5.1: Frontend and backend interaction diagram

Backend and Database Interaction

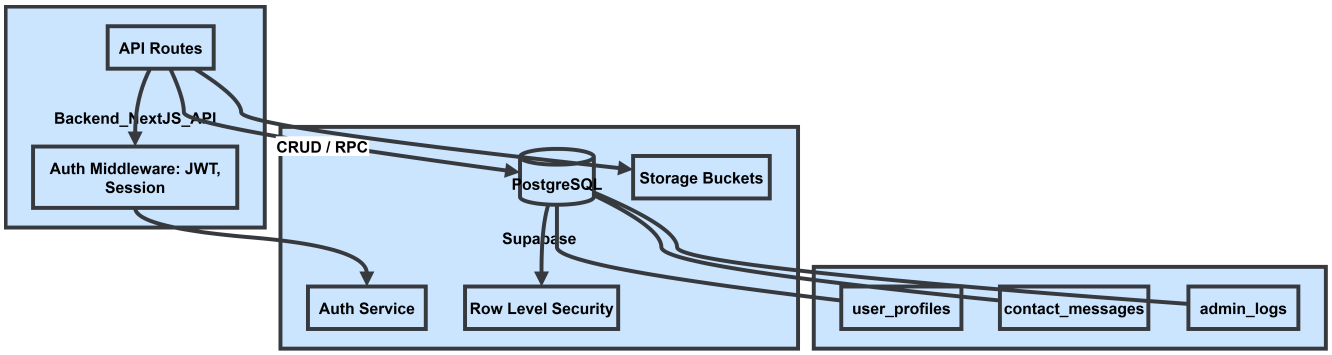

Figure 5.2: Backend and database interaction diagram

Backend and External Services Interaction

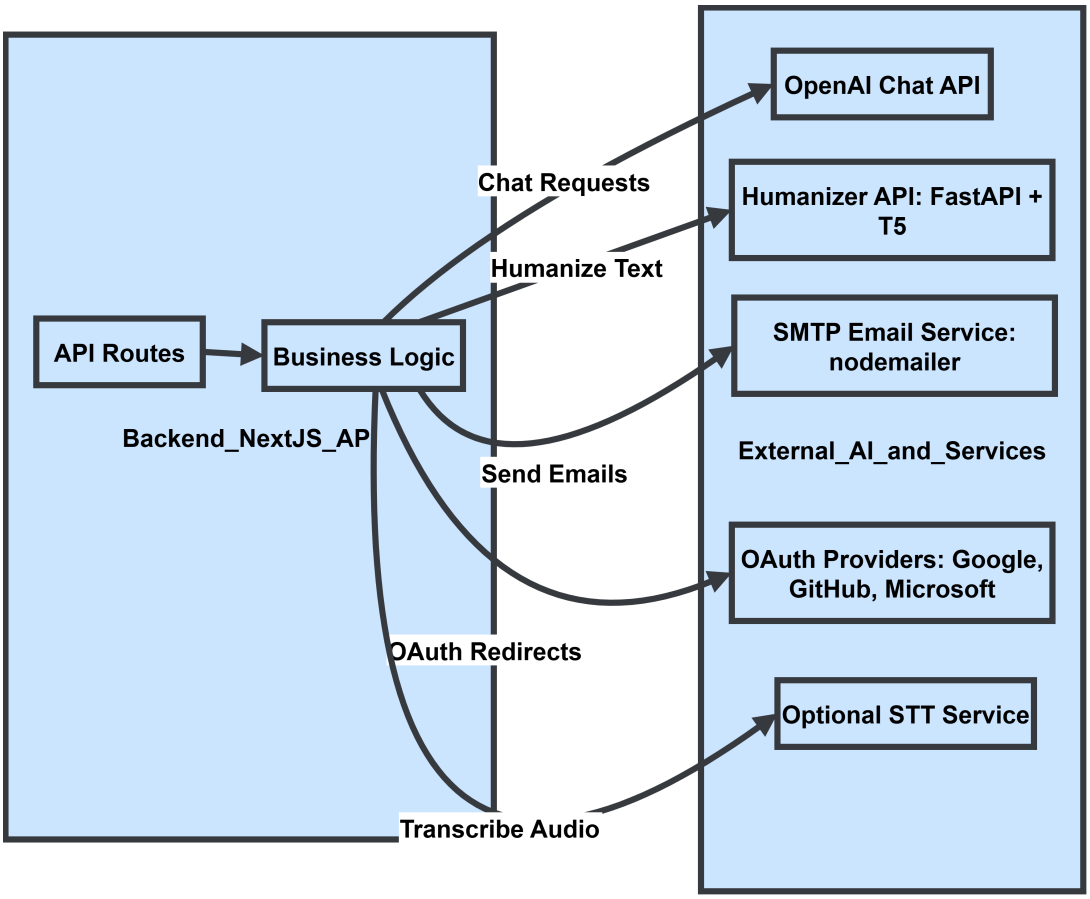

Figure 5.3: Backend and external services interaction diagram

5.8 Security and Performance Optimization

Security is enforced through:

- HTTPS across all endpoints.
- JWT-based session handling.
- Supabase Row-Level Security (RLS).
- Role-based route protection.
- Structured input validation and sanitation [10].

Optimization of performance is attained with:

- Dynamic imports,
- Lazy loading and memoization,
- Client-side OCR and image processing,

- The heavy module suspense limits,Database indexing on administrative queries [5][6][9].

Fallback mechanisms can be used to maintain operation in case external AI providers are out of service or their service is down[8].

Chapter 6

System Testing and Evaluation

System testing is used to ensure that the Smart AI Suite is able to deliver the required functional and nonfunctional requirements, such as correctness, performance, security, and usability. This chapter describes how the tests were made, what kind of tests were made, and how they were evaluated. and important observations, which gives a full picture of system adherence to design specifications [1]–[7].

6.1 Testing Methodology

The testing methodology comined automated and structured manual validation to guarantee reliability and accuracy of system in a variety of situations. The methodology targeted test of all key system functionality, including user authentication, GPA calculation, AI service processes, and React user interface elements [4]–[6]

- **Objective**:Verify functionality, integration, reliability and usability of system under defined conditions.
- **Approach:**Used automated testing (Jest, Testing Library) and structured test cases and manual checking of component behavior and integration processes.
- **Test Environment:**The tests were run on the local development environment with demo modules on OCR, STT and external AI providers .

Table 6.1: Test Inventory and Tools Configuration

Area	**Tools/Config**	**Location**
Test Runner	Jest + ts-jest (TypeScript)	jest configured at root
DOM Env	jest-environment-jsdom	Implicit via Jest config
React Testing	@testing-library/react, @testing-library/jest-dom	devDependencies
Setup	Custom setup (matchers, globals)	Testing/test-cases/setup.ts
Coverage	lcov + HTML + text	Testing/test-results/coverage/
Reports	HTML / Markdown / Text / PDF gen	Testing/reports/
Test Suites	unit, component, integration	Testing/test-cases/

6.2 Testing Pipeline

Figure 6.1 depicts the pipeline from commit to reports and coverage artifacts.

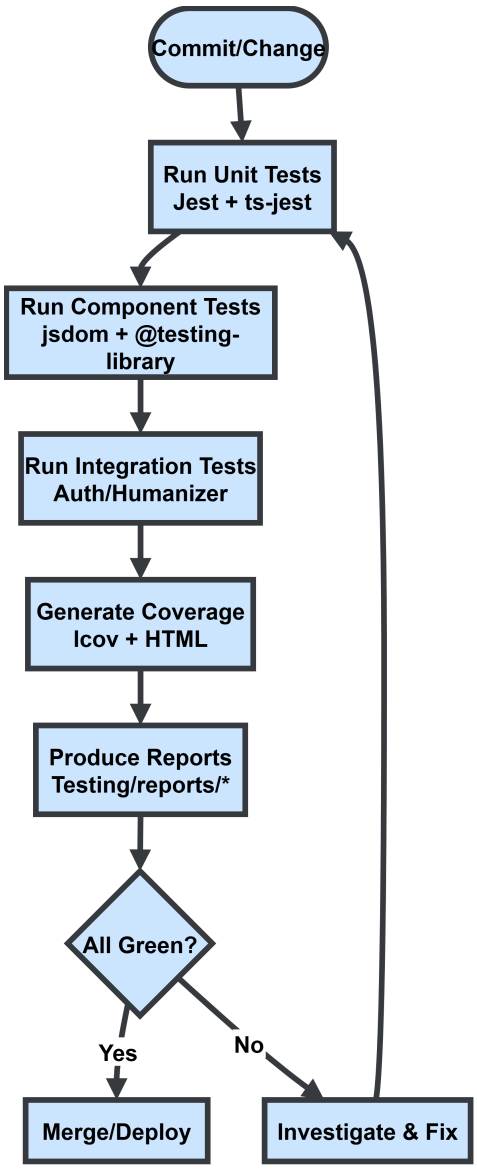

Figure 6.1: Testing Pipeline

6.3 Test Types

The sections below outlines the nature of tests undertaken, their purpose, and outcomes [1]–[9].

6.3.1 Unit Testing

Objective: Ensure that the main algorithms and logic are correct.

- **Test Case:**GPA computation of Bahria, NUST and FAST grading system, with edge cases of invalid grades, no credits and empty entries [8].

- **Results:**All tests passed with 100 percent line,branch, and function coverage [6].

Table 6.2: Test Inventory

File	Type	Primary Coverage
grading.test.ts	Unit	GPA logic: getGradePoint, getGradingPolicy, calculateSGPA, calculateCGPA
humanizer-integration.test.tsx	Integration	Humanizer pipeline request/response handling and output contracts
image-generator.test.tsx	Integration	Image generation workflow: upload, preview, generation, and download
auth-system.test.tsx	Integration	Authentication state setup, guards, redirect/role gating
simple-button.test.tsx	Component	React component rendering and interaction correctness
setup.ts	Harness	Jest/jsdom setup and test environment initialization

6.3.2 Component Testing

Objective: Check that the individual React components render and responds to user interactions [12].

- **Test Case:**Tested buttons, forms, and UI components on the basis of being correctly rendered, accessibility, and interactions [2], [8], [16].
- **Results:**The components got rendered as they were expected along with accessibility and attributes validated.

6.3.3 Integration Testing

Objective: Validate inter-module interactions and workflows.

- **Test Case:**
  - **Humanizer Module:**Validated FastAPI endpoint responses, variant generation, and error handling [3], [11], [21].
  - **Image Generator:**Image upload, preview, image generation, background removal, image enhancer and downloading capabilities tested and approved [5], [7], [10], [20].
  - **Authentication System:**Validated login, role-based access control, route guarding, and redirects [4], [19], [24].
- **Results:**Proper execution of workflow with anticipated results and the error handling was done as designed.

Table 6.3: Test Inventory and Tools Configuration

Area	Tools/Config	Location
Test Runner	Jest + ts-jest (TypeScript)	jest configured at root
DOM Env	jest-environment-jsdom	Implicit via Jest config
React Testing	@testing-library/react, @testing-library/jest-dom	devDependencies
Setup	Custom setup (matchers, globals)	Testing/test-cases/setup.ts
Coverage	lcov + HTML + text	Testing/test-results/coverage/
Reports	HTML / Markdown / Text / PDF gen	Testing/reports/
Test Suites	unit, component, integration	Testing/test-cases/

6.3.4 Performance Testing

Objective: Determine the system responsiveness to essential operations [1], [20].

- **Test Case:**Time of unit arithmetic, AI generation processes, and integration round-trips [5], [6], [28].
- **Results:**System passed sanity performance test and all operations done in under acceptable limits.

6.3.5 Security Testing

Objective: Validate authentication and access control mechanisms [17], [19], [23].

- **Test Case:**Attempted unauthorized role bypass and access [4], [24]
- **Results:**System blocked unauthorized actions and imposed role based restrictions.

6.3.6 Coverage Analysis

Objective: Make sure that tests are complete throughout the codebase [6].

- **Results:** The line, branch and functional coverage was one hundred percent in all tested modules.

Table 6.4: Test Coverage Metrics

Metric	Result	Source
Line Coverage	100%	Testing/test-results/coverage/index.html
Branch Coverage	100%	Testing/test-results/coverage/index.html
Function Coverage	100%	Testing/test-results/coverage/index.html
Files Measured	lib/grading.ts	Coverage HTML / LCOV

6.4 Evaluation

- **Strengths::**
  - Functional correctness checked on GPA computed values, authentication, and AI. workflows.

  - Components and integration modules are reliable within the normal circumstances.
  - Full test coverage guarantees high confidence in core logic.

- **Weaknesses:**
  - Additional testing is required for the OCR, STT, and Chat components.
  - Full E2E automations is pending because the end-to-end browser flows are partially tested
  - Performance load testing limited to sanity checks.

Table 6.5: Requirements Traceability Matrix (observed)

Req ID	Feature	Test(s)
FR1	Authentication	auth-system.test.tsx (role/redirect)
FR2	RBAC & Guarding	auth-system.test.tsx (guarded routes/roles)
FR4	Image Tools	image-generator.test.tsx (generation, background, enhancement)
FR7	Humanizer	humanizer-integration.test.tsx (variants, constraints)
FR9	GPA Calculator	grading.test.ts (SGPA/CGPA/policies)
UI (General)	Components	simple-button.test.tsx
NFR1	Performance (sanity)	Unit arithmetic, image generator timings, integration round-trip stubs
NFR2	Security (UX boundary)	auth-system.test.tsx (guards/redirects)

6.5 Coverage and Results

The test suite claims to be completely covered and pass all the test cases.

Table 6.6: Test Coverage Metrics

Metric	Result	Source
Line Coverage	100%	Testing/test-results/coverage/index.html
Branch Coverage	100%	Testing/test-results/coverage/index.html
Function Coverage	100%	Testing/test-results/coverage/index.html
Files Measured	lib/grading.ts	Coverage HTML / LCOV

6.6 Future Testing Plan

- **OCR and Image Tools:** There should be unit tests added for pre/post-processing and component tests for end user workflows [5][7][9][27].
- **Speech-to-Text (STT):**live Mic transcription and File based tests with export verification[15].

- **Chat Module:** Component and integrations tests for streaming, error handling and multi provider support.
- **End-to-End (E2E):** Playwright/Cypress for full user flows .
- **Load/Resilience:** k6/Artillery to showcase concurrent users, provider failures, and UI inconsistancies [5], [7].

Chapter 7

Conclusion and Future Work

Smart AI Suite shows that there are several image AI modalities conversational AI image generation and enhancement, OCR, speech-to-text transcription, humanization and. utility tools (e.g., resume generation, GPA runner, PDF combining)can be integrated into a single unified and secure platform. This integration assists the users increase efficiency ,availability and mitigate common challenges in the contemporary AI workflows, such as tool fragmentation, multiple subscriptions, privacy concerns, and the high learning curve involved with a variety of AI services [1][2][5].

The suite is built using Next.js and React on the frontend, with the usage of component-based architecture for responsive design, and Supabase with postgresSQL as the backend for services like authentication and role-based access control (RLS) [3][4]. Clientside implementations of sensitive operations like image processing and OCR to minimize data transfer to third party servers thus enhancing privacy and reducing operational costs. There are server-side services, including humanizer based on FastAPI and multiprovider AI routing using OpenAI and Google Gemini, ensure performance while remaining extensible [5][6][7].

7.1 Major Achievements

The most important achievements of the Smart AI Suite are:

- **Single Access:** It is possible for users to use all significant AI services through a single interface, removing mental load and multiple logins.
- **Flexible Provider Support:**Multi-provider AI ensures provides service continuity and can dynamically use model strengths.
- **Privacy-Conscious Design:**Sensitive processes such as image, OCR and PDF. processing are running on the client side, exposing data to cloud services less.
- **Modular Architecture:** All the AI components and utility are maintainable, scalable, and it can accommodate future modalities of AI.
- **Administrative Oversight:** Role-based access and logging enable management and adherence in institutions.

The test plan was aimed at testing on various levels, such as unit tests on deterministic logic,integration testing for AI service and workflow, and component testing for frontend interaction.Complete coverage report verifies the integrity and correctness of the modules [6][7].

7.2 Future Work

Even though the Smart AI Suite is founded on a well-grounded foundation, but several more enchancements can improve usability, accessbility and performance.

- **UI/UX Improvements and Localization:** Add multi-language support and accessibility improvements (WCAGAA/AAA). Customizable themes and responsive device layouts (i.e. tablets and mobile devices) will enhance user experience and acceptance [2][3].
- **Offline-First and PWA Features:** Progressive Web App with services providers and caching systems would allow offline handling of tasks such as OCR, CV editing, and PDF combining [3][5].
- **Expanded AI Modalities:** Add new features on services like speech synthesis (text-to-speech), high-resolution image generation and video summarization.Integration with open-sourec models will reduce dependency on commerical APIs. [5][7].
- **Collaboration and Team Features:** Use shared workspaces, access control, subscriptions, and multi-user management to permit institutional or enterprise deployment [4][6].
- **Advanced Analytics and Reporting:** Analytics dashboards are capable of monitoring user behavior, AI activity, and workflow effectiveness, which makes it possible to use the data-driven operations and user instructions [5].
- **Security and Compliance Enhancements:** 24/7 surveillance, audit logging. and compliance with GDPR/CCPA-complaint framework will empower user trust and business utilization [4][6].

7.3 Summary

Smart Ai Suite solves the fragmentation of AI solutions with a secure, performant, and privacy-aware platform. Modularity, client-side execution of sensitive tasks, and extensibility will ensure continuous evolution with emerging AI technologies. The suite addresses not only current workflow challenges and approaches to solving them but also a roadmap to future improvements in addressing more complex workflows and collaborative features as well as additional AI modalities.

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