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TherapEase

Physiotherapy made easy



TherapEase

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1 PROBLEM STATEMENT

1.1 Overview

The services related to Physiotherapy in large hospitals (such as AIIMS), generally face overcrowding and logistical challenges, which makes it difficult for the patients to receive care on time. Most of the patients live far away from the hospital, and require repeated travels for therapy sessions, which can negatively affect their treatment and recovery.

1.2 Challenges in the Current System

1. **Overcrowded Hospitals:** Physiotherapists handle a large number of patients, which further leads to longer waiting times and also reduces one-on-one attention towards certain patients with critical conditions.
2. **Limited Accessibility:** A patient who lives at a far distance from hospitals, faces difficulty in attending regular sessions, which causes interruptions in their therapy.
3. **No Proper Monitoring System:** Performance of exercises at home is not tracked properly (like poses, incorrect rep count), hence, it makes hard for the doctor to assess progress between every visits.
4. **Delayed Feedback:** Any errors in exercise execution go unnoticed until the patient visits the hospital again along with their progress reports, which may delay recovery.
5. **Inadequate Reporting:** There is no systematic way to generate detailed reports on patient adherence, progress, or exercises' pose correctness.
6. **Lack of Remote Consultation:** Patients cannot easily consult doctors remotely for changes in therapy, resulting in repeated hospital visits.

These challenges often create a hurdle for efficient treatment, patient convenience, and effective monitoring. A new system is required to be introduced which provides real-time tracking and progress reporting both patients and doctors.

1.3 Proposed Solution

To solve these common challenges, a new At-Home Physiotherapy Monitoring App named as TherapEase is proposed. It uses modern mobile and web technologies to make therapy easier, more accessible, and trackable in real time. The main features of this app include:

1. **Exercise Pose Tracking:** The app will monitor patients' exercises through camera or sensor input, providing feedback on their performances and progressions.
2. **Automated Progress Reports:** All exercise data will be automatically collected and converted into a clear, structured PDF report. Doctors can quickly review the patient's progress, consistency, and performance.
3. **Remote Prescription Updates:** Doctors can review the reports and adjust exercise plans, intensity, or frequency without needing an in-person visit. This keeps the treatment updated and personalized.
4. **Reduced Hospital Visits:** By enabling home based therapy, this app will greatly reduce the need for frequent hospital travel, easing overcrowding and avoid unnecessary financial burden on travel expenses.
5. **User-Friendly Interface:** The app will be designed for all the age groups, with simple and easy to learn navigation, exercise instructions, and reminders to improve their posture for speedy recovery and correct rep count.
6. **Data Security and Privacy:** All patient data will be stored securely and encrypted, complying with medical data privacy standards.
7. **Mobile and Web Accessibility:** Patients and doctors can access the platform from phones, tablets, or desktops. Everything—from exercise guidance to reports—is just one click away, making it highly convenient.

1.4 Conclusion

The current physiotherapy system struggles with overcrowding, limited accessibility, and the lack of proper monitoring tools, which directly affects patient recovery and overall treatment efficiency. The proposed TherapEase application addresses these issues by introducing a

modern, technology-driven approach that enables real-time tracking, automated reporting, and remote doctor–patient interaction.

By reducing unnecessary hospital visits, providing accurate feedback on exercises, and ensuring consistent monitoring from home, TherapEase enhances both patient convenience and treatment quality. Its secure data handling, user-friendly design, and accessibility across multiple devices make it a practical and scalable solution for hospitals and physiotherapy departments.

In summary, TherapEase has the potential to transform the traditional physiotherapy workflow into a smarter, more efficient, and patient-centric system—ultimately improving recovery outcomes and reducing the burden on healthcare facilities.

2. PROCESS MODEL : AGILE

Given the dynamic nature of our application and the need for constant improvements, the Agile Development Model is the most suitable approach for developing the TherapEase. Agile allows for iterative development, frequent feedback, and real-time changes based on user needs and feedback.

2.1 Phases of the Agile Process

2.1.1 Requirement Gathering & Analysis

- ✓ Gather detailed requirements from patients, physiotherapists, and hospital administration to understand the major challenges in the current physiotherapy workflow.
- ✓ Collect feedback through surveys to identify the essential features needed in the system, such as exercise pose tracking, automated progress reporting, remote prescription updates, and appointment management.
- ✓ Analyze the need for monitoring, offline accessibility (e.g., downloadable PDF reports), secure data storage, and seamless doctor–patient communication to ensure the system meets practical and clinical expectations.

2.1.2 Planning

- ✓ Divide the project into ‘sprints’, with each sprint focusing on delivering specific features.
- ✓ Create a product backlog to manage priorities and ensure mandatory features.

2.1.3 Design

- ✓ Create mockups for the patient and doctor interface, ensuring user-friendly navigation.
- ✓ Design a machine learning model that supports reliable verification of different exercises.
- ✓ Initially for mobile accessibility.

2.1.4 Development

- ✓ Development to be carried out incrementally, with each sprint focusing on completing a functional part of the system.
- ✓ Regular meetings to track progress.
- ✓

2.1.5 Testing

- ✓ Each feature is tested individually as it's developed.
- ✓ Testing includes ensuring that the model can filter out exercises correctly and able to produce feedback on each exercise session.
- ✓ Perform user testing to ensure the interface is clear and easy to use.

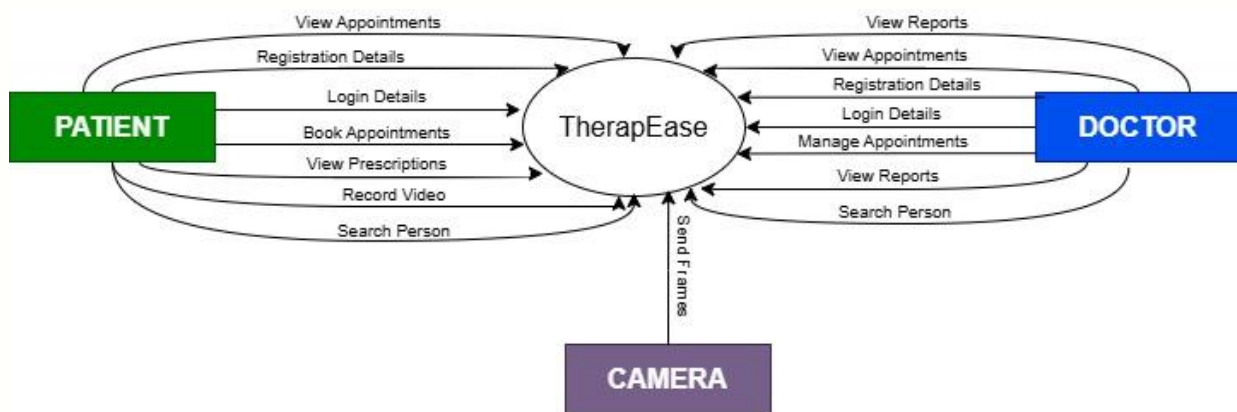
2.1.6 Deployment

- ✓ Once testing is complete, the system is deployed incrementally, with new features being rolled out after each sprint.
- ✓ A feedback loop to address any bugs or errors.

3 SEQUENCE AND DATA FLOW

3.1 Data Flow Diagram Level 0

The DFD Level 0 for the Physiotherapy Monitoring App provides a high-level overview of the system, showing how patients, physiotherapists, and doctors interact with the system to track exercises, receive feedback, and update prescriptions.



3.2 External Entities:

- **Patient:** Performs exercises at home and receives feedback.
- **Doctor/Physiotherapist:** Monitors patient progress, reviews reports, and updates therapy prescriptions.

3.3 Major Processes:

- **Exercise Tracking:** Captures patient's exercise performance data.
- **Feedback Generation:** Analyzes exercise performance and provides feedback to the patient.
- **Report Generation:** Compiles exercise performance information into a structured report for doctor.
- **Prescription Update:** Allows the allotted doctor to modify therapy instructions based on the patient's progress.

3.4 Data Stores

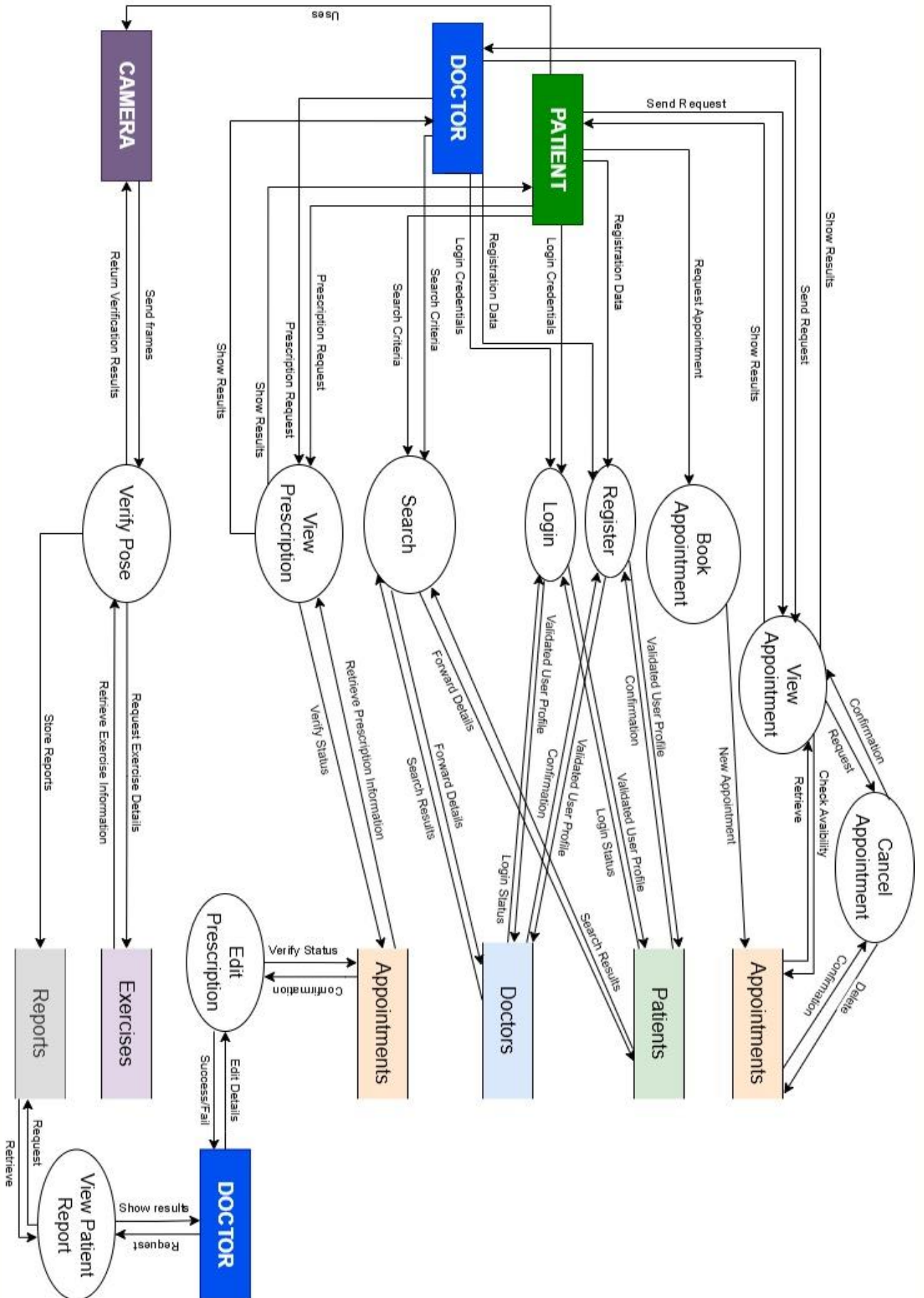
- **Patient:** Contains patient profiles, physical details, and login credentials.
- **Doctor:** Stores doctor profiles, qualifications, availability, and credentials.
- **Exercises:** Holds exercise names, types, and pose-related information.
- **Appointments:** Keeps track of scheduled dates, times, and assigned exercises.
- **Reports:** Saves feedback and performance results from each exercise session.

3.5 Interactions

- Patients enter their exercise data → the Exercise Tracking system analyzes it → feedback is immediately returned to the patient.
- Doctors view the generated reports → update or modify prescriptions → updated details are stored in the Appointments data store.

3.6 DFD Level 1

On the next page, DFD Level 1 offers a clearer and more detailed breakdown of how our Physiotherapy App, TherapEase, functions behind the scenes. It expands the high-level processes into specific subprocesses to show exactly how information moves through the system at each stage. It shows how patients begin by recording their exercises through our app, after which the system captures posture data, analyze their movements, and evaluate performance accuracy and structured progress reports.



3.7 Detailed Processes:

1. Exercise Tracking Subprocesses:

- a. Capture Video/Sensor Data
- b. Analyze Movements Against Prescribed Exercise
- c. Detects Error and Pose deviations

2. Feedback Generation Subprocesses:

- a. Generate Reports
- b. Provide the exercise form feedback to the patient
- c. Log Feedback into Reports Data Store

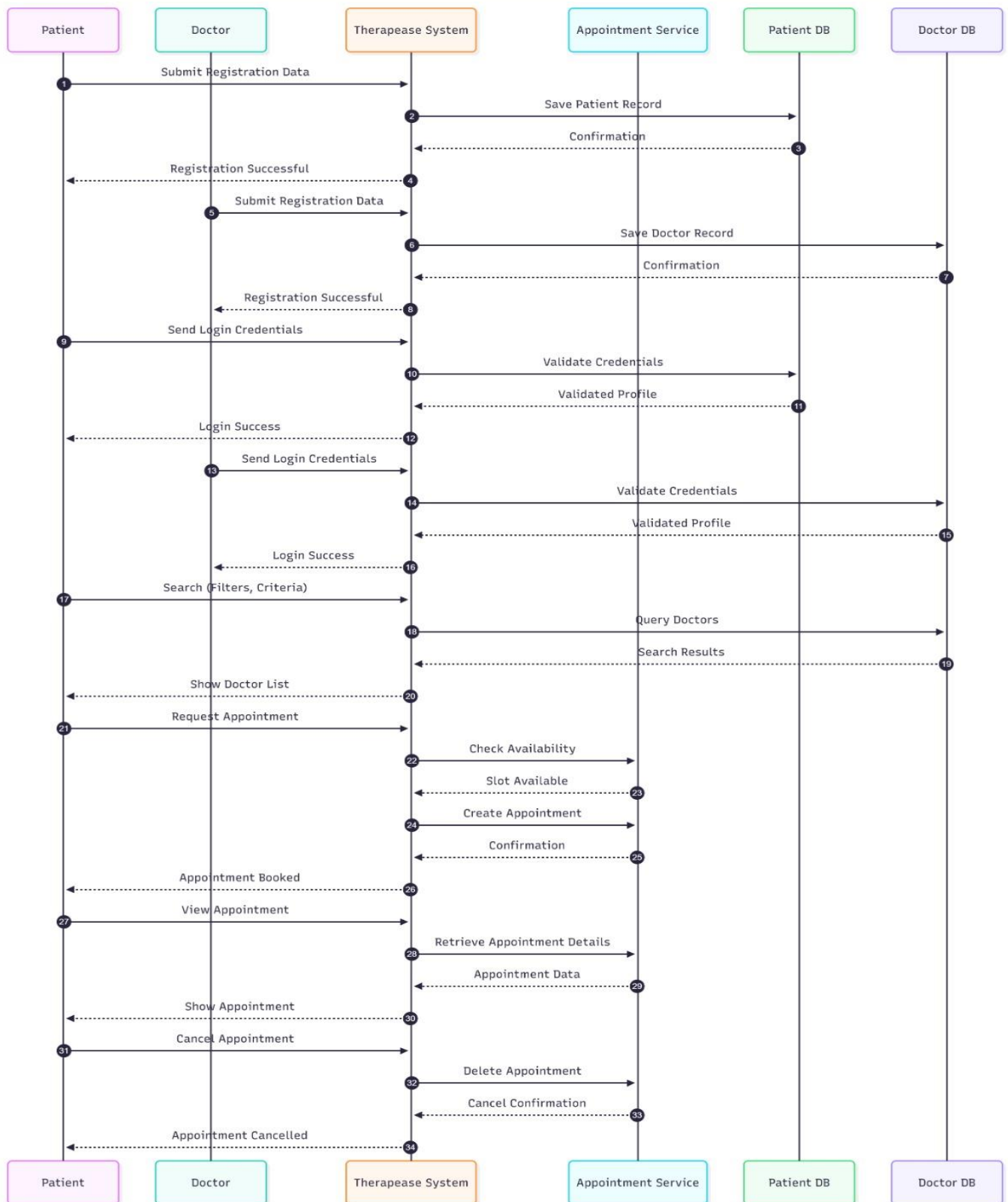
3. Report Generation Subprocesses:

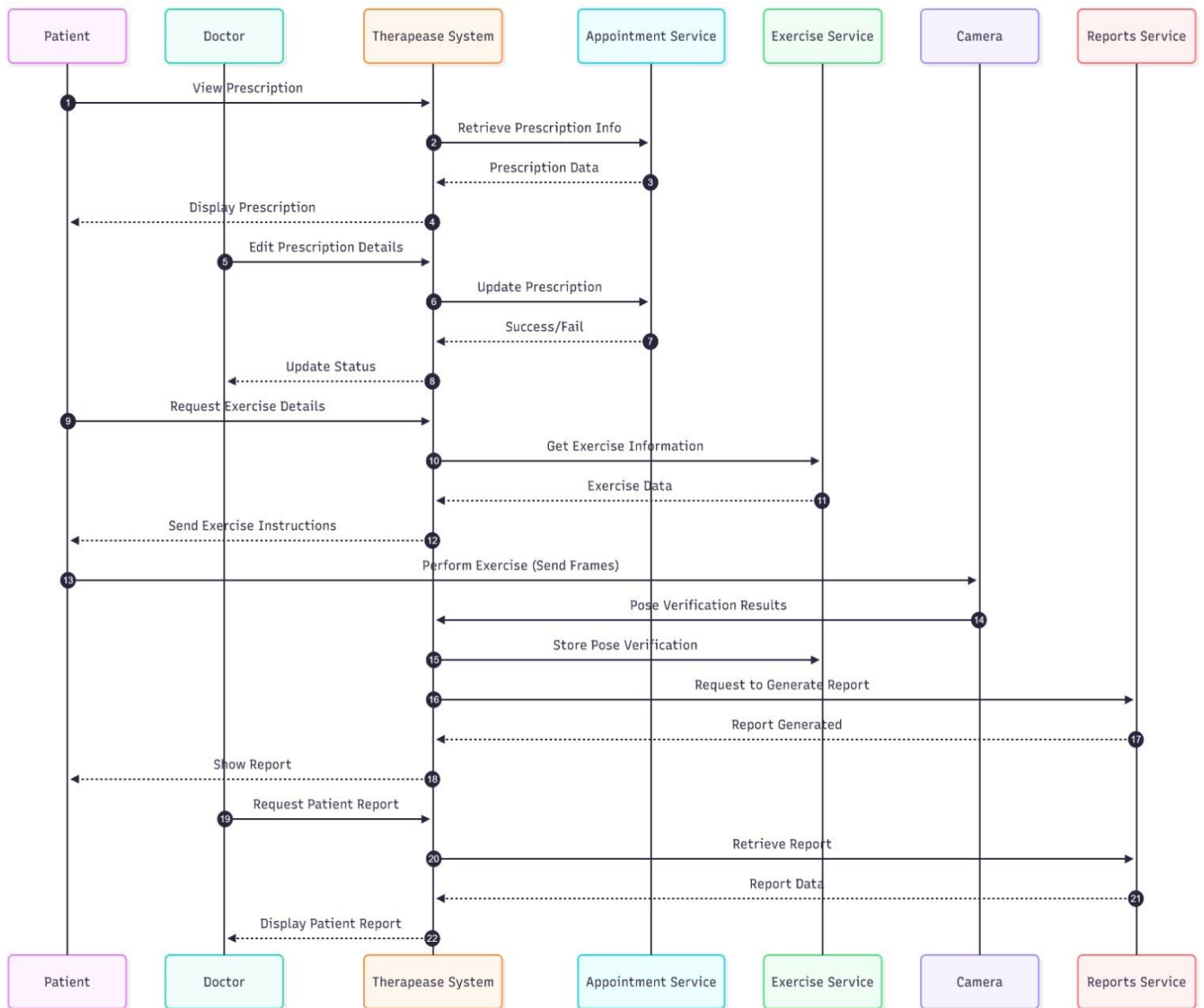
- a. Compile Exercise Logs
- b. Calculate Pose Correctness and Performance Scores
- c. Send Reports to the allotted doctor

4. Prescription Update Subprocesses:

- a. Doctor Reviews Report
- b. He/She modifies Therapy or Exercises
- c. Writes a personal feedback based on the reports provided
- d. Stores Updated Prescription in Appointments Data Store

3.8 Sequence Diagram





- This sequence diagram explains the flow for patient and doctor registration, authentication, searching for doctors, and booking appointments. It highlights how the Therapease System communicates with backend services such as the Appointment Service, Patient Database, and Doctor Database.

4 DATA DICTIONARY

4.1 ENTITY: PATIENTS

PATIENTS = id + email + password + name + dob + height_cm + weight_kg + location + activity + bio + badges_id + gender + joined_at

Attribute	Description	SQL Data Type	Example
id	Unique patient identifier	INT PRIMARY KEY	1024
email	Email ID	VARCHAR(100)	riya@example.com
password	Encrypted password	VARCHAR(255)	34\$2328AJDK3##
name	Full name of patient	VARCHAR(50)	Riya Sharma
dob	Patient's birth date	DATE	2005-05-02
height_cm	Height in centimeters	INT	167
weight_kg	Weight in kilograms	INT	55
location	Location/address.	TEXT	Delhi
activity	Activeness scale	ENUM	minimal
bio	A little bit of profile enhancement	TEXT	I love football!
badges	Awards to signify achievements	TEXT	100 REPS
gender	Gender of the patient	ENUM	female
joined_at	Date on which patient joined the app	DATE	2025-25-11

4.2 ENTITY: EXERCISES

EXERCISES = id + name

Attribute	Description	SQL Data Type	Example
id	Unique report identifier	INT PRIMARY KEY	0006
appointment_id	Appointment identifier	INT	001
patient_id	Patient identifier	INT	123
doctor_id	Doctor generating/reviewing report	INT	112
exercise_id	Exercise identifier	INT	2025-10-07
feedback	Feedback provided by the system	TEXT	Form can be better
score%	Overall score for the session	INT	65
created_at	Report generation date	DATE	2025-12-01

4.3 ENTITY: DOCTORS

DOCTORS = id + email + password + name + age + specialty +
experience + location + availability + bio + gender + joined_at

Attribute	Description	SQL Data Type	Example
id	Unique doctor identifier	INT PRIMARY KEY	11
email	Email ID	VARCHAR(100)	anil3433@gmail.com
password	Encrypted password	VARCHAR(255)	4\$\$HELL032##RE
name	Full name of doctor	VARCHAR(50)	Anil Kumbal
specialty	Area of expertise	TEXT	Shoulder
experience	Years of experience.	INT	3
dob	Doctor's date of birth	DATE	1990-11-11
location	Address	TEXT	Faridabad
availability	When doctor is active	ENUM	weekdays
bio	Doctor profile text	TEXT	An apple a day :(
gender	Gender of the doctor	ENUM	Male
joined_at	Date on which doctor joined the app	DATE	2025-11-11

4.4 ENTITY: APPOINTMENTS

APPOINTMENTS = id + doctor_id + patient_id + description_patient + description_doctor + appointment_date + appointment_time + exercise_id + reps + days

id	Unique identifier for appointment	INT PRIMARY KEY	002
doctor_id	Doctor allotted	INT	211
patient_id	Patient involved	INT	100
description_pation	Patient-provided notes for appointment.	TEXT	I am suffering from asthma.
description_doctor	Doctor's notes or diagnosis for the appointment.	TEXT	Do it before lunch.
appointment_date	Scheduled date	DATE	2025-11-20
appointment_time	Scheduled time	TIME	15:30
exercise_id	Prescribed exercise for this session	INT FOREIGN KEY	2
reps	Number of repetitions prescribed.	INT	30
days	For how many days prescribed for	INT	5

4.5 ENTITY: REPORT

REPORTS = id + appointment_id + patient_id + doctor_id + exercise_id + feedback + score + created_at

Attribute	Description	SQL Data Type	Example
id	Unique report identifier	INT PRIMARY KEY	0006
appointment_id	Appointment identifier	INT	001
patient_id	Patient identifier	INT	123
doctor_id	Doctor generating/reviewing report	INT	112
exercise_id	Exercise identifier	INT	2025-10-07
feedback	Feedback provided by the system	TEXT	Form can be better
score	Overall score for the session	TEXT	65%
created_at	Report generation date	DATE	2025-12-01

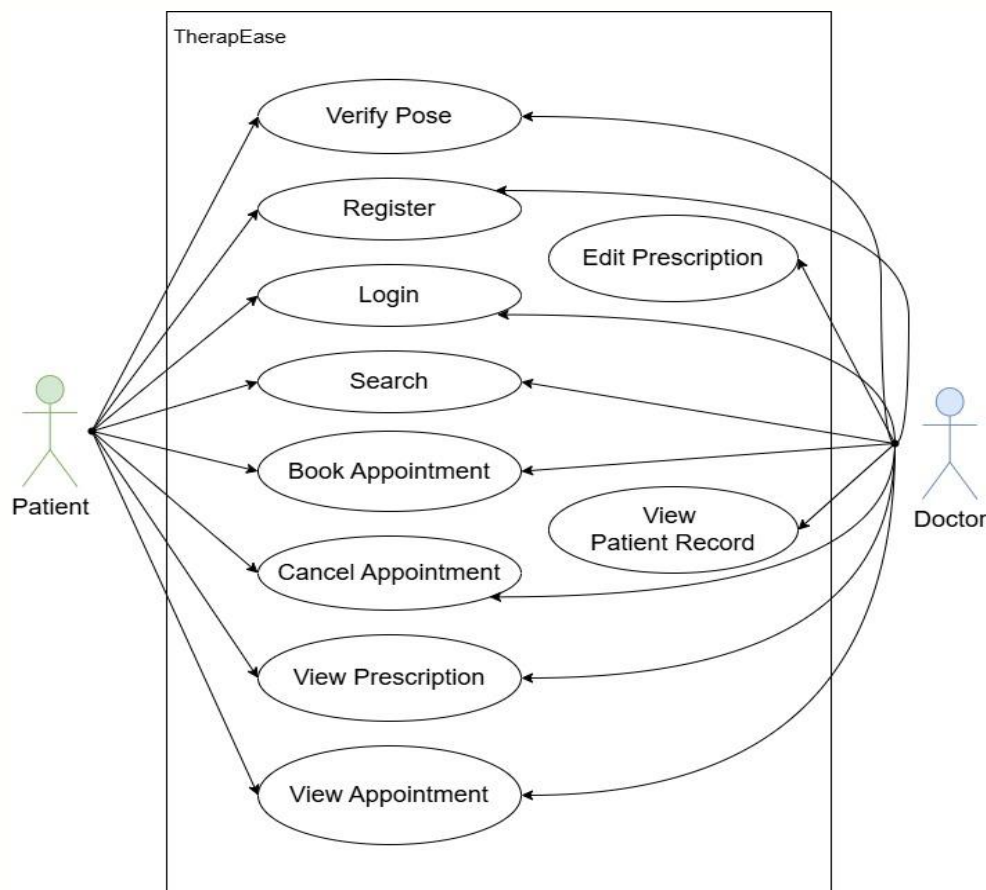
5 USE CASE DIAGRAM

5.1 Use Case Diagram: TherapEase System

5.1.1 Description

The Use Case Diagram for the TherapEase system represents the interaction between different types of users and the clinical functionalities they can access. The primary actors identified are:

- **Patient:** Uses the system to register, log in, search doctors, book and manage appointments, view prescriptions, perform guided exercise sessions, and track progress through reports.
- **Doctor:** Uses the system to manage their profile, view patient information, create and update prescriptions, define exercise plans, and review patient progress and reports.
- **TherapEase Admin:** Manages users and system configurations, ensuring that the platform remains secure, consistent, and up to date.



The diagram highlights how these actors interact with the TherapEase system to support end-to-end physiotherapy workflows, from appointment booking to exercise tracking and reporting.

5.1.2 Main Features and Functionalities

1. Registration and Authentication:
 - Patients, doctors, and admins can register and log in to the system.
 - Users can manage their profile information after authentication.
2. Appointment Management:
 - Patients can search for doctors and view doctor details.
 - Patients can book appointments after checking doctor availability.
 - Patients can view and cancel their upcoming appointments.
3. Prescription and Exercise Plan Management:
 - Doctors can view and update patient prescriptions.
 - Doctors can define or modify exercise plans based on the patient's condition.
 - Patients can view the latest prescribed exercises and related instructions.
4. Exercise Tracking and Posture Evaluation:
 - Patients can start a guided exercise session using the system.
 - The system evaluates exercise form (e.g., posture and angles) during the session.
 - The system updates internal data such as repetition counts, stages, and form quality.
5. Progress and Reporting:
 - Both patients and doctors can view progress and performance reports.
 - The system generates reports using tracked exercise data and past sessions.
6. Administration and System Management:
 - The admin manages user accounts (patients and doctors).
 - The admin configures system settings and monitors overall system behavior.

Figure 5.5: Use Case Diagram: TherapEase System

5.1.3 Actors and Their Roles

- Patient: Registers, logs in, searches for doctors, books and manages appointments, views prescriptions and exercise instructions, performs exercise sessions, and reviews progress reports.
- Doctor: Registers, logs in, manages their profile, views patient prescriptions, updates prescriptions and exercise plans, and reviews patient performance reports.
- TherapEase Admin: Logs in to manage users (patients and doctors), maintain system settings, and ensure smooth operation of the platform.

5.2 Use Case 1: Book Appointment

Use Case Name: bookAppointment

Actors:

- Patient
- (Doctor – as a notified/affected actor)

Description:

This use case defines the process of booking an appointment with a doctor. The patient searches for doctors, views doctor details, checks available time slots, and confirms a suitable appointment. The system ensures that only free slots are booked and stores the appointment details.

Preconditions:

- The patient is registered and logged into the TherapEase system.
- Doctor profiles and availability information are already stored in the system.

Postconditions:

- An appointment is created with a specific doctor, date, and time.
- Appointment details are stored and visible to both the patient and the doctor.

Flow of Events:

1. The patient logs into the TherapEase system.
2. The patient selects the option to search for doctors.
3. The system displays search filters (specialization, location, availability, etc.).
4. The patient enters search criteria and submits the request.
5. The system retrieves and displays a list of matching doctors.
6. The patient selects a doctor to view detailed information.
7. The patient chooses the “Book Appointment” option.
8. The system checks available appointment slots for the selected doctor.
9. The patient selects a preferred date and time slot.
10. The system verifies that the selected slot is still available.
11. The system creates an appointment entry and stores it in the appointment database.
12. A confirmation is shown to the patient, and the doctor’s schedule is updated.

Alternative Flows:

- If no doctors match the search criteria, the system displays an appropriate message and suggests modifying filters.

- If the selected time slot becomes unavailable during booking, the system notifies the patient and prompts them to choose another slot.

Exceptions:

- Failure to fetch doctor list due to backend or network error.
- Failure to create an appointment record due to database error.

5.3 Use Case 2: performExerciseSession

Use Case Name: performExerciseSession

Actors:

- Patient
- (Doctor – indirectly benefits by later viewing reports)

Description:

This use case describes how a patient performs a guided physiotherapy exercise session using TherapEase. The system uses the camera feed, tracks the patient's movements, evaluates the exercise form, counts repetitions, and stores session data for later reporting.

Preconditions:

- The patient is registered and logged into the TherapEase system.
- The patient has an active prescription or exercise plan defined by a doctor.
- The patient's device has a functioning camera and a stable internet connection.

Postconditions:

- Exercise session data (angles, counts, stages, timestamps, quality indicators) is stored.
- The system updates the patient's progress, which can be used for reporting and analysis.

Flow of Events:

1. The patient opens the TherapEase app and navigates to the exercise section.
2. The patient selects an exercise from the prescribed list (e.g., bicep curl, squat).
3. The patient starts the session by choosing "Start Exercise Session".
4. The system sends a request to start a new session on the backend.
5. The backend activates the tracking process and starts reading frames from the camera.
6. As the patient performs the exercise, pose landmarks are detected on each frame.
7. The system calculates joint angles and applies exercise-specific logic to determine stage and count (e.g., "up", "down", repetitions).
8. The system continuously updates session data, including angle, count, stage, and form quality.

9. The patient can see live feedback (such as current count and form status) on the app.
10. When finished, the patient selects “Stop Session”.
11. The backend stops tracking and finalizes the session data.
12. The session results are stored and made available for future viewing in reports.

Alternative Flows:

- If pose landmarks cannot be detected reliably (poor lighting or camera angle), the system may show an instruction message asking the patient to adjust position or camera.
- If the session is interrupted (e.g., network loss), partial data may be stored and an error message is shown to the user.

Exceptions:

- Failure to access the camera or permission denied on the device.
- Backend tracking thread not starting or stopping correctly due to server error.

5.4 Use Case 3: viewProgressReports

Use Case Name: viewProgressReports

Actors:

- Patient
- Doctor

Description:

This use case defines how patients and doctors access detailed progress and performance reports generated from past exercise sessions. Reports may include repetition counts, session dates, average angles, and form quality indicators.

Preconditions:

- Exercise session data has been previously recorded for the patient.
- The patient or doctor is logged into the TherapEase system with appropriate access rights.

Postconditions:

- The requested report is generated (if needed) and displayed to the user.
- The user can review progress over time and, if implemented, export or share the report.

Flow of Events:

1. The user (patient or doctor) logs into the TherapEase system.
2. The user navigates to the “Reports” or “Progress” section.
3. The system prompts the user to select a time range or specific sessions (optional).
4. The user selects the desired filters and submits the request.
5. The system gathers stored exercise session data for the selected patient and time range.

6. The system processes the data and generates a structured report (e.g., tables, charts, summary statistics).
7. The generated report is displayed to the user.
8. Optionally, the user may choose to download, export, or share the report (if such functionality is supported).

Alternative Flows:

- If there is no recorded data for the selected period, the system displays a message indicating that no sessions are available for reporting.

Exceptions:

- Failure to retrieve stored session data due to database or network errors.
- Error in report generation logic, resulting in incomplete or invalid output.

6 SRS

6.1 Introduction

The Introduction section provides an overview of the project, defining its goals, scope, and terminology. This section serves as a foundation to understand the document's purpose and its relevance to all stakeholders involved in the system.

6.1.1 Purpose

The purpose of this document is to define the Software Requirements Specification (SRS) for the **Physiotherapy Exercise Tracking System (PETS)**.

This document outlines:

- The functional requirements of the system, including exercise tracking, posture analysis, and repetition counting.
- The non-functional requirements such as performance, reliability, usability, and security.
- The interface requirements for users, software components, and hardware such as cameras and mobile devices.

The PETS aims to assist physiotherapists and patients by providing a system that uses pose estimation to monitor physiotherapy exercises. It tracks joint angles, counts repetitions, and provides visual feedback using a skeleton overlay. The system enables real-time monitoring using a webcam (for the backend) and a mobile application for interaction and display.

6.1.2 Scope

The **Physiotherapy Exercise Tracking System (PETS)** is designed to address the challenges of unsupervised physiotherapy at home and basic exercise monitoring in clinics. The system's primary objectives are:

- **Exercise Tracking:** Monitor specific physiotherapy exercises like bicep curls, squats, shoulder abductions, knee extensions, leg raises, and side bends.
- **Pose Analysis:** Use pose estimation to calculate joint angles and determine the stage of movement (e.g., up/down, bent/extended).
- **Repetition Counting:** Automatically count exercise repetitions based on movement

patterns.

- **Real-Time Feedback:** Display ongoing exercise metrics such as angle, count, stage, and basic form quality.
- **Media-Based Analysis:** Allow users to upload exercise videos or capture frames for analysis.

Key Users:

- **Patients:** Perform exercises and view real-time feedback.
- **Physiotherapists:** Use the system to demonstrate exercises and review basic tracking.
- **Administrators/Developers:** Manage deployment, configuration, and system maintenance.

6.1.3 Definitions, Acronyms, and Abbreviations

Term	Definition
PETS	Physiotherapy Exercise Tracking System
SRS	Software Requirements Specification
API	Application Programming Interface
UI	User Interface
Pose Estimation	Technique for detecting human joint locations from images or video
Repetition (Rep)	One complete cycle of an exercise movement
Backend	Server-side component (FastAPI, MediaPipe, OpenCV)
Frontend	Client-side mobile application (React Native with Expo)

Table 6.1: Definitions, Acronyms, and Abbreviations

6.1.4 References

- IEEE 830-1998 Standard for Software Requirements Specifications
- MediaPipe Pose official documentation
- FastAPI official documentation
- OpenCV documentation
- React Native and Expo documentation
- Institutional/project-level guidelines for health-related software

6.1.5 Overview

The document is organized as follows:

- **Section 6 (SRS):** Provides the purpose, scope, overall description, and specific requirements of the system.
- **Section 9 (Testing):** Describes unit, system, and user acceptance testing with black box and white box approaches and executed test cases.
- **Section 10 (Risk):** Presents a risk table and mitigation strategies.
- **Section 11 (Feasibility Study):** Evaluates technical, operational, and financial feasibility.

This SRS document serves as a guideline for developers, testers, physiotherapists, and other stakeholders, ensuring clarity and consistency throughout the development lifecycle of PETS.

6.2 Overall Description

This section provides an overarching view of the **Physiotherapy Exercise Tracking System (PETS)**, describing its environment, interactions, and major characteristics. It outlines the product perspective, its users, constraints, assumptions, and requirement distribution.

6.2.1 Product Perspective

The PETS is a **client–server based application** that combines AI-based pose estimation and a mobile-friendly interface.

System Architecture:

- **Backend:** A FastAPI-based server processes frames captured from a webcam or uploaded media. It uses MediaPipe Pose and OpenCV to extract body landmarks, calculate joint angles, determine exercise stage, and count repetitions.
- **Frontend:** A React Native (Expo) mobile application acts as the client, allowing users to select exercises, start/stop sessions, upload or capture media, and visualize data including skeleton overlays.

Position in the Environment:

PETS operates as an independent monitoring tool but can be integrated in the future with:

- Hospital Information Systems
- Electronic Health Record (EHR) systems
- Cloud storage or analytics dashboards

System Interfaces:

PETS interacts with the following systems and components:

- **Camera/Webcam:** For live video input to the backend.
- **Mobile Device Hardware:** For video/image capture and display.
- **Network Services:** For HTTP communication between mobile app and backend.

User Interfaces:

The system provides a simple, interactive UI for:

- **Patients:**
 - Choose an exercise from a list
 - Start and stop sessions
 - Upload videos or capture frames
 - View real-time values (angle, count, stage, form) and visual skeleton overlay
- **Physiotherapists:**
 - Demonstrate exercises
 - Observe counts and angles for basic evaluation
- **Administrators/Developers:**
 - Configure backend IP, monitor logs, and maintain the system

UI Design includes:

- A **dashboard-like screen** showing selected exercise and live metrics.
- Buttons for **start session**, **upload video**, **capture frame**, and **stop session**.
- A preview area with video/image and skeleton overlay.

Hardware Interfaces:

- **Client Devices:** Android smartphones (and optionally iOS) running the React Native app.
- **Server Machine:** Laptop or desktop with webcam support to run FastAPI backend.
- **Network Equipment:** Routers/switches for communication between phone and server.

Software Interfaces:

- **Operating Systems:** Android for mobile; Windows/Linux/macOS for server.
- **Libraries:** FastAPI, MediaPipe, OpenCV, NumPy, Axios, React Native, Expo.
- **APIs:** RESTful endpoints for `/start_session`, `/stop_session`, `/data`, `/analyze_frame`.

Communication Interfaces:

- HTTP/HTTPS for API calls between mobile and backend.
- Local network (e.g., Wi-Fi) using IP address like <http://192.168.x.x:8000>.

6.2.2 Product Functions

The primary functions of PETS include:

- **Exercise Selection:** Allow users to choose between supported physiotherapy exercises.
- **Session Management:** Start and stop tracking sessions using the backend webcam.
- **Pose Detection and Angle Calculation:** Use pose estimation to compute angles at key joints (shoulder, elbow, hip, knee, ankle).
- **Repetition Counting:** Apply exercise-specific logic to count repetitions based on angle thresholds and stage transitions.
- **Live Data Streaming:** Provide current values (angle, count, stage, form, keypoints) through /data endpoint.
- **Video/Image Analysis:** Accept uploaded videos or frames and return analysis results.
- **Skeleton Visualization:** Provide keypoint locations so the frontend can draw a skeleton overlay.

6.2.3 User Characteristics

The system is intended for users with varied technical backgrounds:

- **Patients:**
 - Basic smartphone proficiency.
 - Able to follow on-screen instructions and stand in front of a camera.
- **Physiotherapists:**
 - Moderate to advanced technology usage.
 - Interested in understanding basic numeric feedback (angle, count, stage).
- **Administrators/Developers:**
 - Familiar with networking, deployment, and debugging.

6.2.4 Constraints

- **Environment Constraints:**
 - Requires sufficient lighting and clear visibility of the user's body.
 - Camera must capture the full body or relevant limb for accurate detection.
- **Technical Constraints:**
 - Backend and mobile must share the same network (at least in development).
 - Performance limited by CPU/GPU of the backend machine.

- **Regulatory and Ethical Constraints:**

- Although this is an academic prototype, care must be taken if used on real patients.
- Data privacy and consent practices must be respected.

6.2.5 Assumptions and Dependencies

- Users have access to a smartphone and a stable Wi-Fi connection.
- Only one active user/session at a time (global `current_data` structure).
- Pose estimation model (MediaPipe) works reliably under typical home/clinic lighting.
- The backend IP is correctly configured in the mobile app.

6.3 Specific Requirements

This section provides a breakdown of the functional, external interface, performance, design, and software attribute requirements for PETS.

6.3.1 Functional Requirements

Exercise Management

- The system shall display a list of exercises (`bicep_curl`, `squat`, `shoulder_abduction`, `knee_extension`, `leg_raise`, `side_bend`).
- The system shall allow the user to select exactly one exercise at a time.

Session Control

- The system shall start a new session when the user selects an exercise and initiates start.
- The system shall stop the current session upon user request and release the webcam.

Pose Detection and Analysis

- The system shall capture frames from the webcam during an active session.
- The system shall detect pose landmarks using MediaPipe Pose for each processed frame.
- The system shall calculate joint angles required for the selected exercise.

Repetition and Stage Logic

- The system shall maintain a `stage` value (e.g., “up”, “down”, “bent”, “extended”).
- The system shall increment `count` whenever a complete cycle of motion is detected based on angle thresholds.

Live Data Provisioning

- The system shall expose the current `angle`, `count`, `stage`, `form`, `exercise`, and `keypoints` to the frontend through the `/data` endpoint.

Media Upload and Analysis

- The system shall accept uploaded video/image files through `/analyze_frame`.
- The system shall return a JSON response including at least `form`, `angle`, `count`, `stage`, and `exercise` (current implementation uses placeholder logic).

Visualization Support

- The system shall provide normalized (x, y) coordinates of detected landmarks so the frontend can render a skeleton.

6.3.2 External Interface Requirements

User Interfaces

- A mobile interface shall show:
 - Selected exercise name.
 - Metrics (angle, count, stage, form).
 - Media preview (video/image).
 - Buttons for starting/stopping sessions, uploading video, and capturing frames.

Software Interfaces

- The frontend shall interact with the backend via RESTful APIs (`/start_session`, `/stop_session`, `/data`, `/analyze_frame`).
- The backend shall use MediaPipe and OpenCV libraries for pose estimation and frame processing.

Communication Interfaces

- All API calls shall use HTTP over the local network.
- The system should be configurable to use HTTPS in production setups.

6.3.3 Performance Requirements

- The `/data` endpoint should respond within **500 ms** under normal load.
- The system should function acceptably with a single active user on a standard laptop.

6.3.4 Design Constraints

- The backend must be implemented using Python with FastAPI.
- Pose detection must be done using MediaPipe Pose.
- The frontend application must be developed using React Native with Expo.
- The solution must run on mid-range consumer hardware (no GPU dependency assumed).

6.3.5 Software System Attributes

Security

- Only devices that know the backend IP should be able to access the APIs in the current setup.
- For future production use, authentication and HTTPS should be added.

Reliability

- The system shall handle missing detections gracefully (no crash when no person is in frame).
- The system shall reset **count** and **stage** correctly when a new session starts.

Usability

- The UI shall be simple enough for non-technical users (patients).
- All important actions should be available via clearly labeled buttons.

6.4 Glossary

- **Physiotherapy Exercise:** A prescribed physical movement intended for rehabilitation.
- **Joint Angle:** Angle formed between bones at a joint; used to quantify movement.
- **Stage:** A label indicating current phase of motion in an exercise (e.g., “up”, “down”).
- **Skeleton Overlay:** Visual representation of joints and segments drawn over a video or image.

7 FUNCTION POINT ANALYSIS

7.1 Identify and classify functions

External Inputs (EI) — user-originated transactions that update the system:

- Register (patient details entry) – EI
- Login (credentials entry) – EI
- Book Appointment (request/enter details) – EI
- Cancel Appointment (request to delete/cancel appointment) – EI
- Edit Prescription (request to change) – EI
- Generate Report (request to generate) – EI
- Video Upload (entry for pose verification) – EI

External Inquiries (EQ) — interactive input + output with no persistent update

- Search (search doctors/patients/appointments) — EQ
- View Appointment (retrieve/display appointment details) — EQ
- View prescriptions (retrieve/display prescription) — EQ

External Outputs (EO) — outputs/reports containing derived or formatted data (from system to user):

- Appointment confirmation / status output — EO
- Report.pdf — EO
- Show prescription – EO

Internal Logical Files (ILF) — logical data stores maintained by the application

- Patients
- Doctors

- Appointments
- Reports
- Exercises

External Interface Files (EIF) — None

7.2 Complexity / Weight assumptions

- EI: Low=3, Avg=4, High=6
- EO: Low=4, Avg=5, High=7
- EQ: Low=3, Avg=4, High=6
- ILF: Low=7, Avg=10, High=15
- EIF: Low=5, Avg=7, High=10

For this estimate, our team will use *Average* complexity for transactions that interact with multiple data stores or perform some processing; *Low* for simple ones.

7.3 Count and weight each function

External Inputs (EI)

- Register — *Average* → 4
- Login — *Low* → 3
- Book Appointment — *Average* → 4
- Cancel Appointment — *Average* → 4
- Edit Prescription — *Low* → 3
- Generate Report — *Low* → 3
- Video Upload — *Average* → 4

Subtotal = 4 + 3 + 4 + 4 + 3 + 3 + 3 = 25

External Inquiries (EQ)

- Search — *Low* → 3

- View Appointment — *Average* → 4
- View prescriptions — *Average* → 4

Subtotal = 3 + 4 + 4 = 11

External Outputs (EO)

- Appointment confirmation — *Average* → 5
- Prescription display — *Low* → 4
- Report Generation — *Average* → 5

Subtotal = 5 + 4 + 5 = 14

Internal Logical Files (ILF)

- Patients — *Average* → 10
- Doctors — *Average* → 10
- Appointments — *Average* → 10
- Reports — *Average* → 10
- Exercises — *Average* → 10

Subtotal = 10 + 10 + 10 + 10 + 10 = 50

External Interface Files (EIF) = 0

7.4 Unadjusted Function Points (UFP)

$UFP = EI + EO + EQ + ILF + EIF$

$UFP = 25 + 11 + 14 + 50 + 0 = 100$

7.5 Value Adjustment Factor

The final, adjusted FP = $UFP \times VAF$, where $VAF = 0.65 + (0.01 \times \Sigma_{Fi})$ and Σ_{Fi} is the sum of 14 General System Characteristic ratings (0–5 each).

Because the DFD does not contain GSC ratings, here are two straightforward scenarios:

- **No adjustment / unknown GSCs** (treat VAF = 1.0 for simplicity):

$$\mathbf{VAF} = 0.65 + (0.01 \times 14) = 0.65 + 0.14 = 0.79$$

$$\mathbf{FP} = 100 \times 0.79 = 79$$

- **Typical moderate adjustment** (assuming average GSC rating of 3 for each of the 14 characteristics)

$$\mathbf{VAF} = 0.65 + (0.01 \times (14 \times 3)) = 0.65 + 0.42 = 1.07$$

$$\mathbf{FP} = 100 \times 1.07 = 107$$

7.6 Result

- Unadjusted Function Points (UFP) = 100
- Adjusted (example with average GSCs) = 107

8 GANTT CHART

8.1 Introduction

The Gantt chart provides a visual representation of the project schedule for **TherapEase**, outlining all major phases, tasks, and their corresponding durations. It highlights the sequence of development activities, dependencies between tasks, as well as the overall flow from planning to deployment. Each phase is allocated adequate time to ensure smooth progress of the mobile application and Streamlit prototype development, with milestones marked for phase completion.

8.2 Project Timeline

The project timeline has been divided into multiple phases, each consisting of clearly-defined tasks with specific start and end dates. The schedule spans from **10 September 2025 to 11 November 2025**, covering the complete development lifecycle of TherapEase.

Each phase concludes with a major milestone, ensuring that progress is evaluated before moving on to the next stage. The durations are approximate but realistic, ensuring that adequate time is allotted for research, development, integration, and testing.

The timeline is structured into the following phases:

- **Phase 1 – Requirements & Planning**

Activities include requirement gathering and feasibility analysis. This phase ensures a clear understanding of system expectations before development begins.

- **Phase 2 – Architecture & UX Design**

High-level architecture is designed, followed by UX flow creation and interface wireframing for both the mobile app and prototype.

- **Phase 3 – Streamlit Prototype Development**

A working prototype is built to demonstrate the concept and provide a testable interface for pose detection and feedback.

• **Phase 4 – React Native Core Development**

Core mobile application components are implemented using Expo, including UI screens, navigation, and camera integration.

• **Phase 5 – Backend & Pose Analysis Service**

Backend APIs, pose detection logic, and feedback rules are developed and integrated to support the mobile app.

• **Phase 6 – Integration**

Both the frontend and backend are connected, ensuring smooth video upload, frame analysis, and real-time feedback flow.

• **Phase 7 – Testing & QA**

Unit testing and device-level testing are conducted to validate functionality, correctness, and user experience.

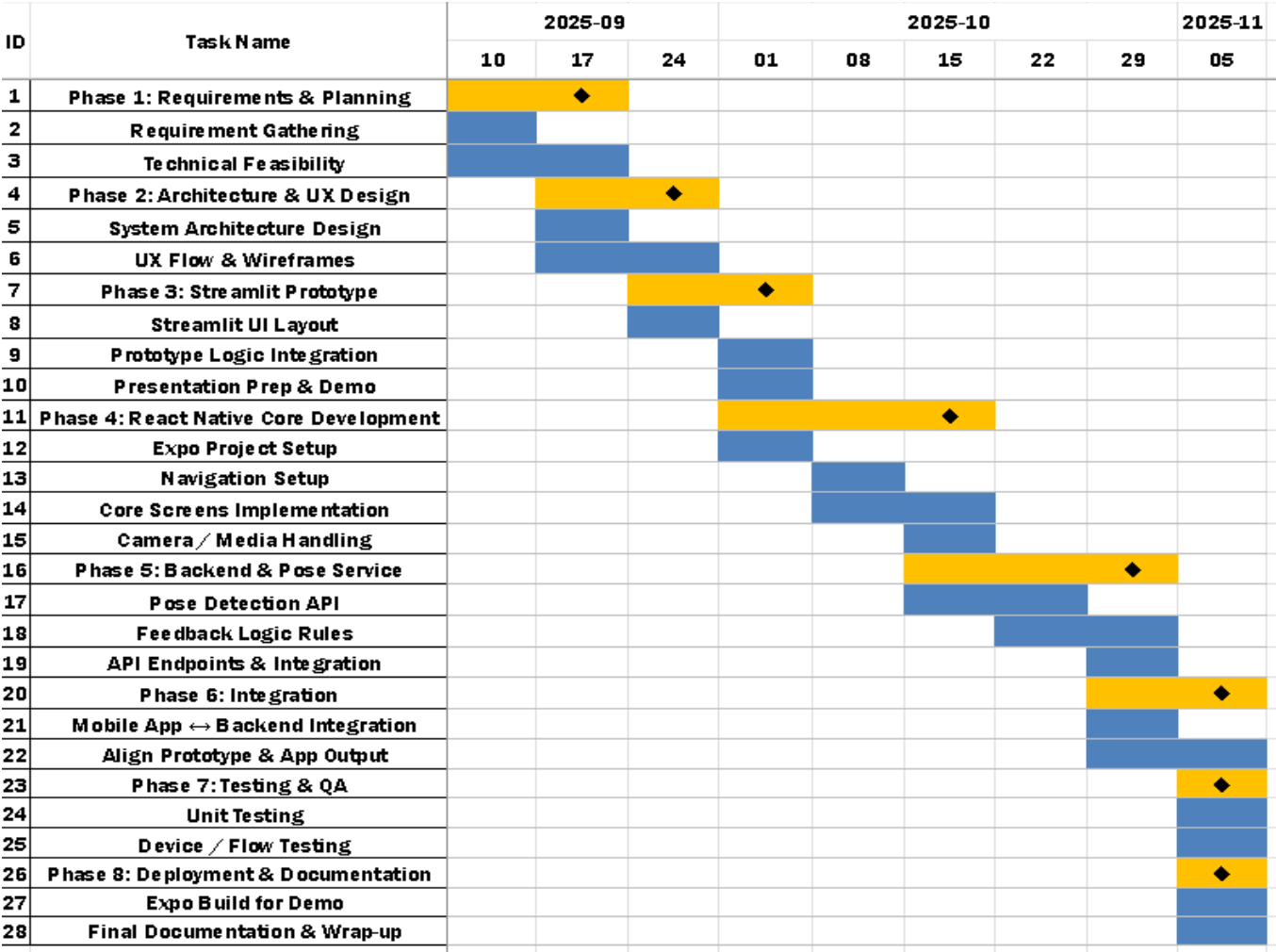
• **Phase 8 – Deployment & Documentation**

The final build is produced, and complete documentation is prepared for submission and demonstration. This structured timeline ensures an organized, step-by-step progression through the entire project, minimizing risks while maintaining development quality and consistency.

TherapEase – Project Timeline Table

ID	Phase / Task	Start Date	End Date	Duration	Completion (%)
1	Phase 1: Requirements & Planning	2025-09-10	2025-09-17	8 days	100
2	Requirement Gathering	2025-09-10	2025-09-13	4 days	100
3	Technical Feasibility	2025-09-14	2025-09-17	4 days	100
4	Phase 2: Architecture & UX Design	2025-09-18	2025-09-26	9 days	100
5	System Architecture Design	2025-09-18	2025-09-21	4 days	100
6	UX Flow & Wireframes	2025-09-22	2025-09-26	5 days	100
7	Phase 3: Streamlit Prototype	2025-09-27	2025-10-05	9 days	100
8	Streamlit UI Layout	2025-09-27	2025-09-30	4 days	100
9	Prototype Logic Integration	2025-10-01	2025-10-03	3 days	100
10	Presentation Prep & Demo	2025-10-04	2025-10-05	2 days	100
11	Phase 4: React Native Core Development	2025-10-06	2025-10-20	15 days	100
12	Expo Project Setup	2025-10-06	2025-10-07	2 days	100

13	Navigation Setup	2025-10-08	2025-10-10	3 days	100
14	Core Screens Implementation	2025-10-11	2025-10-15	5 days	100
15	Camera / Media Handling	2025-10-16	2025-10-20	5 days	100
16	Phase 5: Backend & Pose Analysis Service	2025-10-21	2025-10-31	11 days	100
17	Pose Detection API	2025-10-21	2025-10-25	5 days	100
18	Feedback Logic Rules	2025-10-26	2025-10-29	4 days	100
19	API Endpoints & Integration	2025-10-30	2025-10-31	2 days	100
20	Phase 6: Integration	2025-11-01	2025-11-05	5 days	100
21	Mobile App ↔ Backend Integration	2025-11-01	2025-11-03	3 days	100
22	Align Prototype & App Output	2025-11-04	2025-11-05	2 days	100
23	Phase 7: Testing & Quality Assurance	2025-11-06	2025-11-09	4 days	100
24	Unit Testing	2025-11-06	2025-11-07	2 days	100
25	Device / Flow Testing	2025-11-08	2025-11-09	2 days	100
26	Phase 8: Deployment & Documentation	2025-11-10	2025-11-11	2 days	100
27	Expo Build for Demo	2025-11-10	2025-11-10	1 day	100
28	Final Documentation & Wrap-up	2025-11-10	2025-11-11	2 days	100



9 TESTING

9.1 Unit Testing Overview

Unit testing focuses on testing individual components such as angle calculation, exercise logic, and API handlers in isolation. It helps to ensure that each function behaves correctly before integrating it into the full system. In this project, unit testing was primarily applied to the backend functions of the Physiotherapy Exercise Tracking System (PETS), including:

- The `calculate_angle` function used to compute joint angles.
- The exercise logic used to determine stage and count (e.g., bicep curl, squat).
- The API endpoints responsible for starting/stopping sessions and returning live data.

Unit testing helped verify the correctness of the logic, detect defects early, and improve the reliability of the overall system.

9.2 Black Box Testing in Unit Testing

In black box unit testing, functions are tested purely based on input and output, without considering their internal implementation. The focus is on whether the function behaves as expected for given inputs.

Sample black box unit test cases:

- **Test Case 1: Angle Calculation with Known Points**
 - Input: Coordinates of three points representing a right angle at the elbow.
 - Expected Output: The function `calculate_angle` should return an angle approximately equal to 90°.
- **Test Case 2: Exercise Logic for Bicep Curl**
 - Input: Simulated pose landmarks where the arm moves from an extended position (angle > 160°) to a flexed position (angle < 40°).
 - Expected Output:
 - The `stage` should change from "down" to "up".
 - The `count` value should increment by 1 when a full curl is completed.

These tests verify that the core functionality behaves correctly for representative input data.

9.3 White Box Testing in Unit Testing

Cyclomatic Complexity of Backend Functions

Cyclomatic Complexity (CC) is used to measure the structural complexity of a function.

In this project, we calculate CC using the formula:

$$CC = D + 1$$

Where,

D = number of predicate (decision) nodes (e.g., if, elif, while, for).

This subsection presents the cyclomatic complexity of the main backend functions.

Cyclomatic Complexity of `calculate_angle()`

The `calculate_angle(a, b, c)` function computes the joint angle between three points and adjusts it if the value exceeds 180 degrees.

Decision points in `calculate_angle()`:

- if `angle > 180`: → 1 predicate node

Total predicate nodes:

$$D = 1$$

Cyclomatic Complexity:

$$CC = D + 1 = 1 + 1 = 2$$

Final CC for `calculate_angle()`: 2

Cyclomatic Complexity of `exercise_logic()`

The `exercise_logic(exercise, landmarks)` function contains the core logic for all exercises (bicep curl, squat, shoulder abduction, knee extension, leg raise, side bend). It selects the exercise using if/elif and then applies angle-based conditions to update stage and count.

The structure (simplified) is:

- if `exercise == "bicep_curl"`:
 - if `angle > 160`
 - if `angle < 40` and `stage == "down"`

- `elif exercise == "squat":`
 - `if angle > 160`
 - `if angle < 90 and stage == "up"`
- `elif exercise == "shoulder_abduction":`
 - `if angle < 40`
 - `if angle > 100 and stage == "down"`
- `elif exercise == "knee_extension":`
 - `if angle > 150`
 - `if angle < 100 and stage == "extended"`
- `elif exercise == "leg_raise":`
 - `if angle < 160`
 - `if angle > 170 and stage == "up"`
- `elif exercise == "side_bend":`
 - `if angle < 150`
 - `if angle > 175 and stage == "bend"`

For CC, each `if/elif` is treated as one predicate node. Compound conditions with AND are treated as a single decision (as per common academic simplification).

Decision points in `exercise_logic()`:

Outer exercise selection:

- `if exercise == "bicep_curl" → 1`
- `elif exercise == "squat" → 1`
- `elif exercise == "shoulder_abduction" → 1`
- `elif exercise == "knee_extension" → 1`
- `elif exercise == "leg_raise" → 1`
- `elif exercise == "side_bend" → 1`

Subtotal (outer): 6

Inner conditions per exercise:

- `bicep_curl:`
 - `if angle > 160 → 1`
 - `if angle < 40 and stage == "down" → 1`

Subtotal: 2

- `squat:`
 - `if angle > 160 → 1`

– if angle < 90 and stage == "up" → 1

Subtotal: 2

• shoulder_abduction:

– if angle < 40 → 1

– if angle > 100 and stage == "down" → 1

Subtotal: 2

• knee_extension:

– if angle > 150 → 1

– if angle < 100 and stage == "extended" → 1

Subtotal: 2

• leg_raise:

– if angle < 160 → 1

– if angle > 170 and stage == "up" → 1

Subtotal: 2

• side_bend:

– if angle < 150 → 1

– if angle > 175 and stage == "bend" → 1

Subtotal: 2

Total inner predicates: $2 + 2 + 2 + 2 + 2 + 2 = 12$

Total predicate nodes:

$D = \text{outer (6)} + \text{inner (12)} = 18$

Cyclomatic Complexity:

$CC = D + 1 = 18 + 1 = 19$

Final CC for exercise_logic(): 19

Cyclomatic Complexity of track_exercise()

The track_exercise(exercise) function continuously reads frames from the webcam and processes them while the session is active.

Structure (simplified):

• while not stop_thread:

– ret, frame = cap.read()

- if not ret:
continue
- if results.pose_landmarks:
update keypoints and call exercise_logic

Decision points in track_exercise():

- while not stop_thread → 1
- if not ret → 1
- if results.pose_landmarks → 1

Total predicate nodes:

$$D = 3$$

Cyclomatic Complexity:

$$CC = D + 1 = 3 + 1 = 4$$

Final CC for track_exercise(): 4

Cyclomatic Complexity of start_session()

The start_session() route initializes the session and starts the tracking thread. It contains no conditional logic.

Decision points in start_session():

- None → $D = 0$

Cyclomatic Complexity:

$$CC = D + 1 = 0 + 1 = 1$$

Final CC for start_session(): 1

Cyclomatic Complexity of analyze_frame()

The analyze_frame() route reads an uploaded file and returns a fixed JSON response (placeholder logic). It contains no decision statements.

Decision points in analyze_frame():

- None → $D = 0$

Cyclomatic Complexity:

$$CC = D + 1 = 0 + 1 = 1$$

Final CC for `analyze_frame()`: 1

Cyclomatic Complexity of `stop_session()`

The `stop_session()` route simply sets the stop flag and returns a response. It has no branching.

Decision points in `stop_session()`:

- None $\rightarrow D = 0$

Cyclomatic Complexity:

$$CC = D + 1 = 0 + 1 = 1$$

Final CC for `stop_session()`: 1

Cyclomatic Complexity of `get_data()`

The `get_data()` route directly returns the `current_data` dictionary. It contains no decision logic.

Decision points in `get_data()`:

- None $\rightarrow D = 0$

Cyclomatic Complexity:

$$CC = D + 1 = 0 + 1 = 1$$

Final CC for `get_data()`: 1

Summary of Cyclomatic Complexity for Backend Functions

- `calculate_angle()` $\rightarrow CC = 2$
- `exercise_logic()` $\rightarrow CC = 19$
- `track_exercise()` $\rightarrow CC = 4$
- `start_session()` $\rightarrow CC = 1$
- `analyze_frame()` $\rightarrow CC = 1$
- `stop_session()` $\rightarrow CC = 1$
- `get_data()` $\rightarrow CC = 1$

10 RISK

10.1 Risk Table

This section outlines potential risks specific to the **Physiotherapy Exercise Tracking System (PETS)** and their mitigation strategies.

10.1.1 Identified Risks

Risk ID	Risk Description	Probability	Impact	Risk Category
1	Inaccurate pose detection due to poor lighting or angle	3	2	Critical
2	Performance issues during live tracking (low FPS)	2	2	Critical
3	Network connectivity failure between mobile and backend	3	2	Critical
4	Placeholder logic in /analyze_frame not updated in time	2	2	Critical
5	Misinterpretation of data by users as medical diagnosis	2	3	Catastrophic
6	Single-session limitation due to global state	2	2	Critical
7	Camera permission denied on mobile device	2	1	High Priority
8	Security risks if backend is exposed on public network	2	3	Catastrophic

Table 10.1: Identified Risks for PETS

10.1.2 Mitigation Strategies

- **Risk 1: Inaccurate Pose Detection**

- Mitigation: Provide on-screen guidance for distance, orientation, and lighting. Include instructions in documentation.

- **Risk 2: Performance Issues (Low FPS)**

- Mitigation: Optimize frame processing by skipping frames, using efficient NumPy operations, and tuning MediaPipe settings.

- **Risk 3: Network Connectivity Failure**

- Mitigation: Clearly display connection errors, allow configuration of backend IP, and use retries where appropriate.

- **Risk 4: Placeholder Logic in /analyze_frame**

- Mitigation: Plan an enhancement milestone to implement real video analysis and clearly mention limitation in documentation.

- **Risk 5: Misinterpretation as Medical Diagnosis**

- Mitigation: Display strong disclaimers: “This system is a support tool, not a medical device or diagnostic system.” Encourage supervision by physiotherapists.

- **Risk 6: Single-Session Limitation**

- Mitigation: For academic scope, restrict demo to single user; plan a multi-session architecture as future work.

- **Risk 7: Camera Permission Denied**

- Mitigation: Use clear permission prompts and show an explanatory message when permission is denied. Provide option to retry.

- **Risk 8: Security Risks on Public Network**

- Mitigation: Restrict use to local network for demo, recommend using HTTPS and authentication for any wider deployment.

10.1.3 Explanation of Probability and Impact

- **Probability:**

- 1: Low – Unlikely to happen.
- 2: Medium – May occur.
- 3: High – Likely to occur.

- **Impact:**

- 1: Low – Limited disruption.
- 2: Medium – Noticeable but manageable.
- 3: High – Severe disruption or serious consequence

11 FEASIBILITY STUDY

11.1 Feasibility Study

The feasibility study examines whether the **Physiotherapy Exercise Tracking System (PETS)** is practical and viable from technical, operational, and financial perspectives.

11.1.1 Technical Feasibility

Key Considerations:

- **Technology Stack:**

- Backend: FastAPI (Python), MediaPipe Pose, OpenCV, NumPy.
- Frontend: React Native (Expo), Axios, React Native SVG, Expo Camera, Expo Image Picker.

- **Compatibility:**

- Can run on common laptops/desktops for backend.
- Mobile app can run on Android devices used by students/patients.

- **Scalability:**

- Designed initially for single user/single session, but architecture can be expanded with additional session management.

- **Security and Privacy:**

- Minimal data stored by default; images/videos can be processed in-memory.

Conclusion: Technical feasibility is **high**. All required technologies are stable, open source, and within the team's skill set.

11.1.2 Operational Feasibility

Key Considerations:

- **User Acceptance:**

- Patients can easily interact through simple buttons and visual feedback.
- Physiotherapists can understand angle and count metrics.

- **Ease of Use:**

- The mobile interface is designed to be intuitive, showing only essential information.
- No complex configuration is required for demonstration setups.

- **Training Needs:**

- A short demonstration is sufficient for end-users to understand core features.
- Basic user documentation or in-app tips can cover the rest.

- **Maintenance:**

- Backend and frontend are modular and can be updated independently.

Conclusion: Operational feasibility is **good**. The system integrates well into typical physiotherapy or academic demo workflows.

11.1.3 Financial Feasibility

Key Considerations:

- **Development Costs:**

- Uses free and open-source tools (FastAPI, MediaPipe, OpenCV, React Native).
- Requires only standard hardware (no dedicated server or paid libraries).

- **Operational Costs:**

- Primarily electricity and internet connectivity during demonstrations.
- Optional cloud hosting if extended, but not required for local use.

- **Cost–Benefit Perspective:**

- Provides educational value and demonstration of AI-based healthcare assistance.
- Could reduce manual effort in counting repetitions and observing form.

Conclusion: Financial feasibility is **high** for an academic project, as additional monetary investment is minimal.

11.2 Conclusion

The feasibility study concludes that the **Physiotherapy Exercise Tracking System (PETS)** is:

- **Technically feasible** using modern, open-source technologies.
- **Operationally feasible**, as it is easy to use and fits into practical demonstration and training scenarios.
- **Financially feasible**, with low development and operational costs.

Therefore, the project is viable and justified for development and presentation as an academic/portfolio-level system.