FITNESS-RELATED COACHING AND DIET PLANNING MOBILE APPLICATION USING IMAGE PROCESSING AND MACHINE LEARNING

R24-122

Project Proposal Report

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BSc (Hons) in Information Technology Specializing in Information Technology

Department of Information Technology

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Declaration

We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The supervisor/s should certify the proposal report with the following declaration.

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Supervisor: Prof. Koliya Pulasinghe	2024.02.28	
Co-Supervisor Ms. Jenny Krishara	2024.02.28	

Abstract

It can be difficult to prioritize health and fitness in today's fast-paced society due to busy schedules. Common mobile fitness applications and costly personal training online services sometimes do not offer customized solutions that cater to people specific requirements, such as body composition and physical condition. This study overcomes the constraints of conventional fitness methods by utilizing image processing and machine learning techniques to precisely evaluate and recognize different human body types.

Algorithms are created using a dataset of different body kinds to compute waist-to-hip ratio and classify users body types from provided images. The innovation is in tailoring algorithms to distinguish between various body types and offer individualized fitness suggestions.

This comprehensive strategy seeks to enable individuals to efficiently reach their fitness objectives while enhancing their entire wellbeing. This research provides a new solution to individualized exercise instruction from identified body type using image processing, addressing the growing importance of health in today's busy society.

This research brings about a significant change in the design and functionality of current fitness apps. The proposed solution diverges from the conventional one-size-fits-all approach commonly found in current fitness apps by utilizing advanced image processing and machine learning techniques. It provides users with a tailored experience, transforming how people engage with fitness and showcasing technology's ability to support individualized health and wellness paths.

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Introduction

In today's rapidly changing world, it can be difficult to prioritize health and fitness due to hectic schedules. Busy schedules hinder individuals from prioritizing healthy habits, making it challenging to sustain a well-rounded lifestyle. Many generic fitness apps worsen this issue by giving solutions that lack customization, offering just basic ideas that may not match users' specific needs and preferences. Consequently, consumers frequently encounter restricted advancement and may even suffer health problems or injuries as a result of inadequate direction.

Generic fitness applications often do not consider the wide variety of body shapes and fitness levels of their users, which is a significant limitation. Every person has a distinct physique characterized by differences in body composition, metabolism, and fitness objectives. Traditional fitness methods fail to account for individual differences, providing standard workout plans and food advice that may not be suitable or safe for everyone. The absence of customization reduces the efficacy of fitness programs and obstructs consumers' capacity to get their intended results.

One viable method to tackle this difficulty is the merging of image processing and machine learning techniques. Fitness mobile applications may now accurately evaluate and identify users' body types by utilizing modern technologies. This component, titled "Human Body-Type Analysis and Identification using Image Processing and Machine Learning Techniques," is essential for improving the efficiency and significance of fitness applications.

The main body types, commonly classified as ectomorph, mesomorph, and endomorph, depict specific physiological characteristics with individual advantages and difficulties. Fitness apps can customize workout programs and nutritional suggestions for users by analyzing their body types using waist-to-hip ratio data from input photographs.

Moreover, including human body-type analysis and identification into fitness mobile apps allows for immediate feedback and personalized adjustments throughout exercise sessions. Users are provided with tailored advice and modifications according to their body type and performance, enhancing the efficiency of their workout plans. Furthermore, this component can be used to

generate dynamic exercise routines and dietary plans that adjust to users' evolving requirements and objectives as time progresses.

Overall, integrating human body analysis and identification using image processing and machine learning approaches is a major leap in fitness mobile applications. These apps empower individuals to take control of their health and fitness journey by providing customized solutions that cater to users' unique body types and fitness levels. By utilizing personalized exercise routines, nutritional suggestions, and immediate feedback, individuals can reach their goals more efficiently and securely, resulting in enhanced general health.

1.1 Background & Literature survey

1.1.1 Background

Technological advancements, changing customer preferences and a growing acknowledgement of the need of tailored well-being approaches are all driving a significant transformation in the modern health and wellness. The change is based on recognizing that general fitness criteria often do not meet the diverse needs and preferences of individuals. Consequently, personalized fitness assistance has become more prominent. Customize workout and diet routines to meet the specific demands and goals of each person according to their body type.

Understanding user’s body type is essential in creating effective workout schedules and diet plans in physical fitness. Body types, classified as ectomorph, mesomorph and endomorph have certain physiological characteristics that come with their own advantages and disadvantages. Ectomorphs usually have a lean physique and find it challenging to increase their muscle mass, whereas Mesomorph are known for their strong and athletic build. Endomorphs typically have a greater body fat percentage and may struggle with weight loss.

Utilizing machine learning and image processing techniques to identify user’s body types is highly beneficial for workout planning. Fitness programs can customize workout routines for individuals by classifying them into Technological advancements, changing customer preferences, and a growing acknowledgment of the need of tailored well-being approaches are all driving a significant transformation in the modern health and wellness sector. The change is based on recognizing that general fitness criteria often do not meet the diverse needs and preferences of individuals.

Consequently, personalized fitness assistance has become more prominent. This sector customizes workout routines and food recommendations to meet the specific demands and goals of each person.

Understanding the body types of users is essential in creating effective workout and diet plans when in the physical fitness. Body types, classified as ectomorph, mesomorph, and endomorph, have certain physiological characteristics that come with their own advantages and disadvantages. Ectomorphs usually have a slender physique and find it challenging to increase muscle mass, whereas mesomorphs are known for their strong and athletic build. Endomorphs typically have a greater body fat percentage and may struggle with weight loss.

Utilizing image processing and machine learning techniques to identify users' body types is highly beneficial for gym workouts and workout planning. Fitness programs can customize workout routines for individuals by classifying them into distinct body types according to their physical attributes. Ectomorphs may benefit from high-intensity interval training and calorie-dense meals to increase muscle mass, whereas endomorphs may need a mix of cardiovascular activities and calorie-controlled diets to regulate body fat.

Integrating image processing and machine learning technologies like Convolutional Neural Networks (CNN) algorithm, Flutter, OpenCV, TensorFlow and Python allows the creation of advanced fitness applications that can analyze human body movements and offer immediate feedback during exercise sessions. Researchers can compile photos of different body types and preprocess the data to develop datasets for training machine learning models to properly recognize user’s body types using their waist-to-hip ratio and other physical traits.

Creating a component for analyzing and identifying user body types using image processing and machine learning is a major leap in fitness mobile applications. By offering individualized solutions targeted to user’s specific body types and fitness levels, these applications empower individuals to reach their fitness goals more effectively and safely, ultimately boosting their overall health and well-being. The goal is to empower individuals to make well-informed decisions about their fitness journey by using technology and data-driven insights. This will enhance their quality of life and encourage a culture of self-care and empowerment.

1.1.2 Literature survey

The research on personalized fitness support and the use of machine learning and image processing in fitness applications indicates a notable movement towards customized approaches to health and well-being. This section explores the evolution of tailored fitness solutions, the significance of understanding consumers body types, and the technological improvements driving these progressions.

To comprehend body types and somatotypes, it is crucial to grasp the classification of persons into three basic categories: ectomorph, mesomorph, and endomorph. Somatotypes are distinguished by unique physiological characteristics that impact metabolism, muscle mass, and fat distribution. Ectomorphs usually have a lean physique and may find it challenging to increase muscle mass, whereas mesomorphs are recognized for their athletic build and capacity to quickly acquire muscle. Endomorphs typically have a greater body fat percentage and may struggle with weight loss.

Figure1.2 the primary body types.

It is crucial to determine users body types to create efficient workout routines and food strategies that are personalized to their specific requirements and objectives. Ectomorphs may benefit from high-intensity interval training and calorie-dense meals to promote muscle building, whereas endomorphs may need a mix of cardiovascular exercises and calorie-controlled diets to manage body fat levels. Customizing exercise programs according to somatotypes can help individuals enhance their training routines and attain superior results.

The accurate identification of users body types is crucial for offering individualized workout advice. One method to identify body type is by computing the waist-to-hip ratio (WHR) using photos of users bodies that are posted. The Waist-to-Hip Ratio (WHR) is a dependable measure of how body fat is distributed and can assist in categorizing individuals into various somatotypes. Machine learning algorithms can accurately determine Waist-to-Hip Ratio (WHR) and categorize humans into ectomorphic, mesomorphic, or endomorphic types by assessing anthropometric measures obtained from user photos.

Recent technological breakthroughs in machine learning and image processing have led to the creation of advanced algorithms that can effectively detect people body types from photographs. Convolutional Neural Networks (CNN) have been used to evaluate body photos and extract anthropometric measures for calculating Waist-to-Hip Ratio (WHR) Training algorithms on varied datasets including photographs of persons of different body types can improve the precision and resilience of body type recognition systems.

The amalgamation of machine learning and image processing in fitness apps provides advantages such as customized workout plans, specific dietary suggestions, and immediate feedback during workout sessions. By customizing fitness routines to users individual body types, these applications can improve the efficacy and pertinence of the programs, resulting in superior results. Algorithm bias, data privacy issues, and the necessity for validation procedures are important factors to consider in the creation and implementation of these technologies.

The literature emphasizes the significant potential of combining machine learning and image processing techniques in fitness applications. These programs empower consumers to reach their health and wellness objectives more efficiently and sustainably by detecting users body types and

providing tailored fitness advice. Furthermore, the ongoing progress of technology in this area shows potential for improving the customization and effectiveness of fitness solutions in the future.

1.2 Research Gap

Current fitness coaching and diet planning mobile apps do not offer a complete solution for precisely analyzing users' body types through image processing and machine learning methods, and then recommending tailored body goals. Although research has covered topics like body composition evaluation and disease detection, there is still a significant gap in meeting the unique requirements of individuals looking for personalized fitness advice.

Farina et al. (2016) [1] present a smartphone app for doing individualized body composition assessments through digital photos. This approach provides general information on body composition but lacks specialized analysis and specific recommendations for different body types in the context of fitness coaching. The main focus is on assessing fat mass rather than categorizing body types and recommending appropriate body goals.

Choudhary et al. (2023) [2] introduced a smartphone app in their study to measure the waist-to-hip circumference ratio (WHR), which is associated with health outcomes. This research does not focus on categorizing various body types or provide tailored fitness advice according to individual body analysis for specific fitness objectives.

Research conducted by Tóth et al. in 2014 [3] examines somatotypes in relation to sports to identify appropriate body types for particular athletic endeavors. This research focuses on athletes and does not include the wider range of tailored fitness coaching and food planning for regular users, despite its relevance to body analysis.

Research D (IEEE Xplore, n.d.) [4] focuses on using deep learning techniques to detect Android malware, but it does not pertain to body analysis or fitness coaching. There is a lack of study on creating a smartphone app for personalized body type diagnosis and exercise suggestions using image processing and machine learning techniques.

There is a notable research gap in creating a mobile application that uses advanced image processing and machine learning algorithms to analyze users' body types accurately, recommend appropriate fitness goals, and offer personalized coaching and diet planning suggestions. An application like this would meet the increasing need for personalized fitness solutions and improve user engagement and effectiveness in reaching their fitness goals.

1.3 Research Problem

In our current fast-paced environment, it might be difficult to prioritize health and fitness because of busy schedules and the absence of tailored instruction from conventional exercise approaches in existing fitness related mobile applications. Many generic fitness apps do not cater to the varied needs and preferences of individuals, providing standardized solutions that may not be suitable or safe for all users. Moreover, these programs often fail to take into account the significance of addressing different body types and compositions in the creation of workout and food plans.

The current literature emphasizes the importance of comprehending somatotypes (ectomorph, mesomorph, and endomorph) when designing customized exercise programs. Somatotypes have distinct physiological traits that affect how individuals react to exercise and diet. Accurately identifying users body types and offering personalized recommendations based on their somatotypes can greatly improve the efficacy of fitness programs and enhance overall health results.

The study challenge focuses on creating a novel solution that utilizes image processing and machine learning approaches to precisely assess and categorize users body types. This system utilizes waist-to-hip ratio data from user-uploaded photos to create customized fitness and diet regimens based on individual somatotypes. The study subject focuses on reliably identifying somatotypes, incorporating this information into fitness programs, and assessing the efficacy of individualized recommendations in aiding individuals to reach their fitness objectives.

The research challenge aims to connect traditional fitness approaches with individualized health solutions using technology to address individuals distinct body compositions and exercise requirements.

2.Objectives

2.1 Main Objectives

The main objective of this study is to create a user-friendly system that capable of analyzing the waist to hip body image uploaded by the user and determining their somatotypes using image processing technology. This system will then offer personalized recommendations for body transformation based on the identified somatotypes, aligning with the users individual fitness aspirations and preferences.

2.2. Specific Objectives

There are four specific objectives that must be reached in order to achieve the overall

objective described above.

- **Identify the User's Body type.**
    1. Utilize image processing techniques to analyze uploaded images and extract relevant morphological characteristics.

    2. Apply machine learning algorithms, including Convolution Neural Networks (CNN) to classify individuals into specific somatotypes (ectomorph, mesomorph, and endomorph) using known physiological factors.

- **Determine suitable body transformation recommendations.**

1. Create an algorithm that produce personalized recommendations for body transformation, such as what type of an exercise routines, meal programs and life changes designed specifically for each user's specified body type.

2. Personalize recommendations based on user's individual body compositions and exercise goals to ensure they meet their specific needs and objectives.

- **Integrate the System into the Fitness app.**
    1. Design and implement a user-friendly interface to smoothly integrate the generated system into the fitness program.

    2. Grantee that users with different levels of technical expertise may be easily access and use the personalized recommendation system to encourage it 'is wider acceptance ad utilization,

- **Validate & Optimize the system performance.**
    1. Perform thorough validation test to evaluate the precision and dependability of the created system in identifying somatotypes and offering tailored suggestions.

    2. Enhance the system performance by improving validation result, adjusting algorithms and refining user interface design to improve functionality and user experience.

So, the project intends to enhance personalized fitness solutions by achieving specific targets, helping consumers reach their fitness goals more efficiently and sustainably, and fostering self-care and empowerment in the quest of well-being.

3. METHODOLOGY

The goal of the proposed smart system is to precisely determine users' body types from uploaded photographs through the utilization of image processing and machine learning methods. The approach comprises various essential steps, as listed below:

3.1 Data Collection and Preprocessing

Collecting images of different body types and categorizing them based on their qualities.

Preprocessing includes operations like resizing images, normalizing pixel values, and maybe using data augmentation methods to improve robustness.

3.2 Body Analysis and Body-Type Identification Development

Model Training: Train the chosen models to understand the correlations between body characteristics and body shapes.

Supervised learning.

3.3 Optimizing Feedback and Enhancing User Experience

Enhance the application's performance for real-time processing by reducing latency and optimizing resource use.

Integrate user preferences, fitness objectives, and input into the app's suggestions. Customize exercise routines and dietary recommendations according to individual body compositions, physical fitness levels, and advancements.

3.4 System Diagram

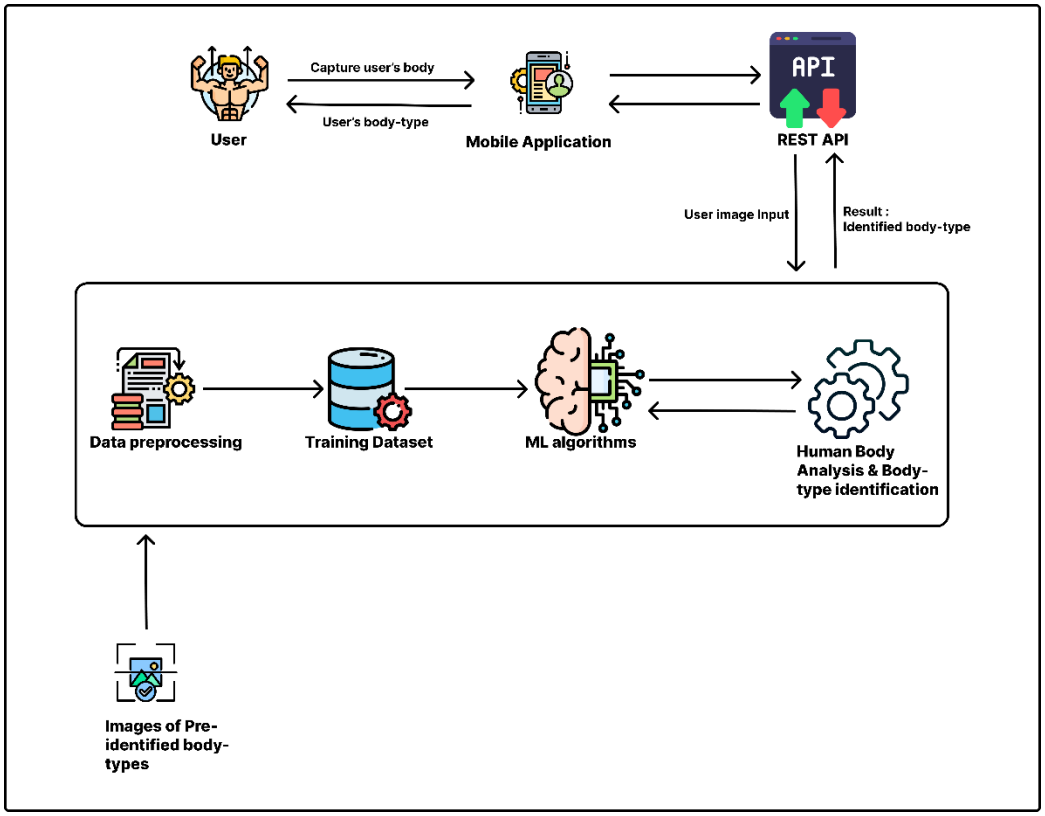


Figure 3.4 system diagram.

- Import Dataset (Images of pre-identified body-types)

According to the system diagram it shows importation of the dataset that created based on the collected images of different body types, including ectomorph, mesomorph and endomorph. These images will serve as the training data for the machine learning algorithms.

- Data Preprocessing

Once the dataset is imported, preprocessing task will perform to standardize and prepare the images for training. This may include resizing, adjusting pixel values and applying data augmentation techniques to enhance the robustness of the model.

- Training Dataset

The preprocessed image set will be separated into train and validate the dataset. The training dataset will be utilized for training the machine learning model, whereas the validation dataset will be use in order to assess the model's performance and optimize hyperparameters.

- ML algorithms

Various machine learning algorithms, such as Convolutional Neural Networks (CNN) will be used to analyze the body and identify body types. The algorithm will analyze the connections between body attributes retrieved from images and the appropriate body types.

- Body Analysis & Body Type Identification:

The trained machine learning model will be deployed to analyze uploaded image by the user and determine the user's body type. Using image input from the user, the system will process the images and generate predictions regarding the user's body types.

- Rest API

A RESTful API will be created to enable communication between the frontend (mobile application) and the backend. The API will process requests from the mobile application, including uploading images for analysis and getting the identified body types.

- Mobile Application (UI)

The system frontend will be developed as a mobile application featuring a user friendly interface. Users can choose to snap pictures of their bodies (waist-to-hip) or submit existing images for examination.

- User Interaction

After uploading an image, it will transmit the image data to the backend usingthe REST API. Next, it start the process of analyzing the image with the developed machine learning models to determine the user's body type.

- Result Display

The recognized body type will be sent back to the frontend for display to the user. Also, based on the identified data the result also stores in the backend to fetch that data to personalize the workout and meal plans.

The suggested system will reliably identify user's body types through image processing and machine learning techniques, offering individualized exercise advice and improving the user experience.

3.5 Software solution

The integration of the described software solution involves multiple steps in the Software Development Life Cycle (SDLC). This systematic methodology ensures the level of accuracy and productivity of the system, as well as its efficacy in recognizing users body types and offering personalized workout suggestions.

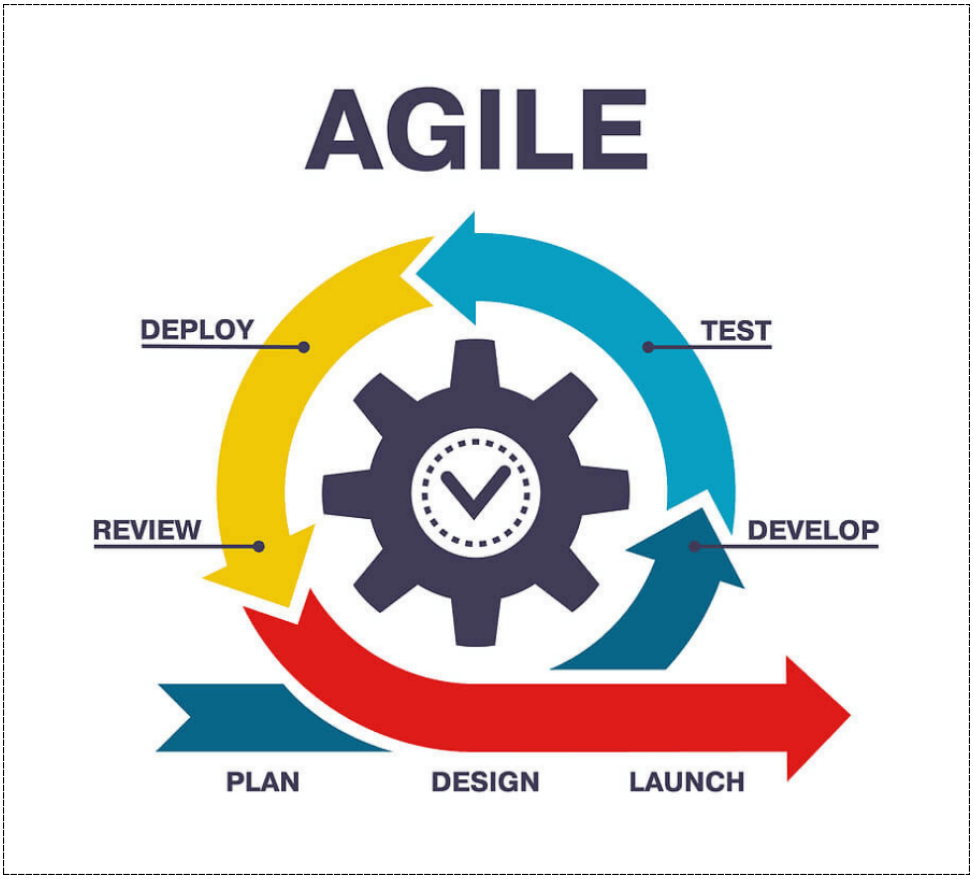


Figure 5.3 agile

- **Requirement gathering**

    - Collecting intel from relevant sources to understand the need for customized fitness tips personalized to different body types.
    - Interview the fitness professionals and potential users to gather insights on fitness goals, preferences and challenges.

- **Feasibility study**
    - Assessing the project's expenses and future profits to verify cost-efficiency.
    - Feasibility Assessment: Evaluating the project schedule to guarantee tasks are completed on time.
    - Technical Feasibility: Evaluating the necessary technical expertise and resources for software development, specifically focusing on image processing and machine learning.

- **Design**
    - Creating the system and software design documents that explain the structure, features, and user interface.
    - Developing the system to provide features for uploading image data, processing, and displaying the result.

- **Implementation**
    - Creating a user-friendly mobile application that works on several platforms utilizing Flutter and React Native to capture and upload photographs.
    - Utilizing OpenCV and TensorFlow Lite to apply image processing techniques for analyzing submitted photos and extracting relevant body attributes.
    - Utilizing machine learning models like Convolutional Neural Networks (CNNs) to classify body types by analyzing extracted data.

- **Testing**
    - Performing various testing techniques such as unit, component, integration, system, and user acceptance testing.
    - Correcting detected flaws, glitches, and inconsistencies to guarantee the dependability and precision of the software.

- **Commercialization**
    - Launching the software solution to fitness enthusiasts, trainers, and health professionals.
    - Providing two editions of the application: a standard version for determining body types and providing tailored suggestions, and a premium version for evaluating the seriousness of fitness obstacles related to body types.
    - Promoting the application to certain users and stakeholders to encourage uptake and utilization.

- **Future Scope**
    - Enhancing the application to cover more fitness-related concerns like correcting posture, preventing injuries, and improving performance.
    - Implementing sophisticated functions like real-time workout feedback and customized diet plans to enhance user experience and improve fitness results**.**

4. PROJECT REQUIREMENTS

4.1 Functional requirements

- The system must accurately identify users' body types from uploaded images.
- It should categorize body types into ectomorph, mesomorph, and endomorph based on image analysis.
- Provide personalized fitness recommendations tailored to each user's identified body type.
- Offer real-time feedback and guidance during user interactions with the application.

4.2 Non-functional requirements

- User-friendliness:
  - Ensure a user-friendly interface accessible via cross-platform mobile apps for Android and iOS.
  - Interface should be attractive, responsive, and easy to navigate.

- Reliability:
  - The system should operate without failures, ensuring users feel confident and secure.
  - Sensitive user data must be protected with robust security measures.

- Performance:
  - Deliver fast and accurate results, handling image processing and machine learning tasks efficiently.

    - Ensure efficient performance during peak usage times to minimize processing delays.

- Availability:
    - Accessible to users worldwide, regardless of location or language preferences.
    - Users should be able to use the app without downtime whenever needed.

4.3 System requirements

- Flutter : Develop cross-platform mobile apps.
- Python with Jupyter Notebook: Implement machine learning algorithms and conduct data analysis.
- OpenCV and TensorFlow Lite: Preprocess images and extract body features for analysis.
- Flask Server: Host machine learning models and handle requests from the mobile app.

4.4 User requirements

- This app will cater to:
    - Individual Users:
        - Upload images of their bodies and receive personalized fitness recommendations.
        - Track fitness progress and receive real-time feedback during workouts.

    - Fitness Professionals:
        - Analyze client's body type and provide customized training and nutrition plans.
        - Monitor client's progress and adjust recommendations accordingly.

4.2 Wireframes

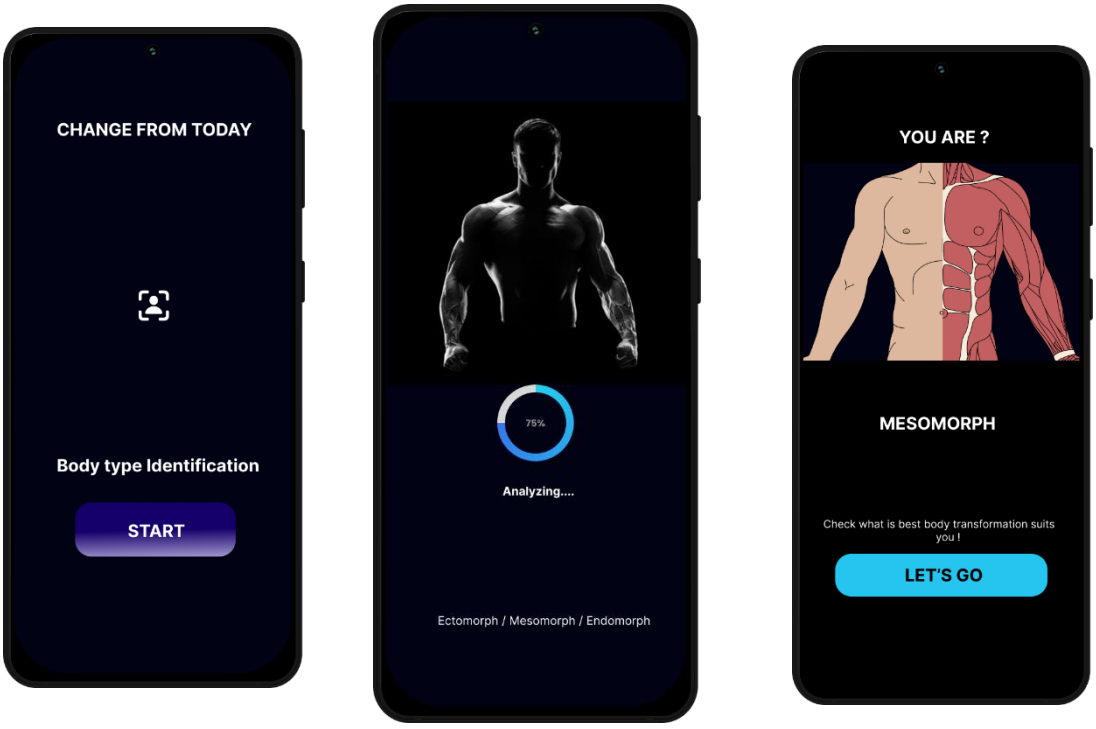
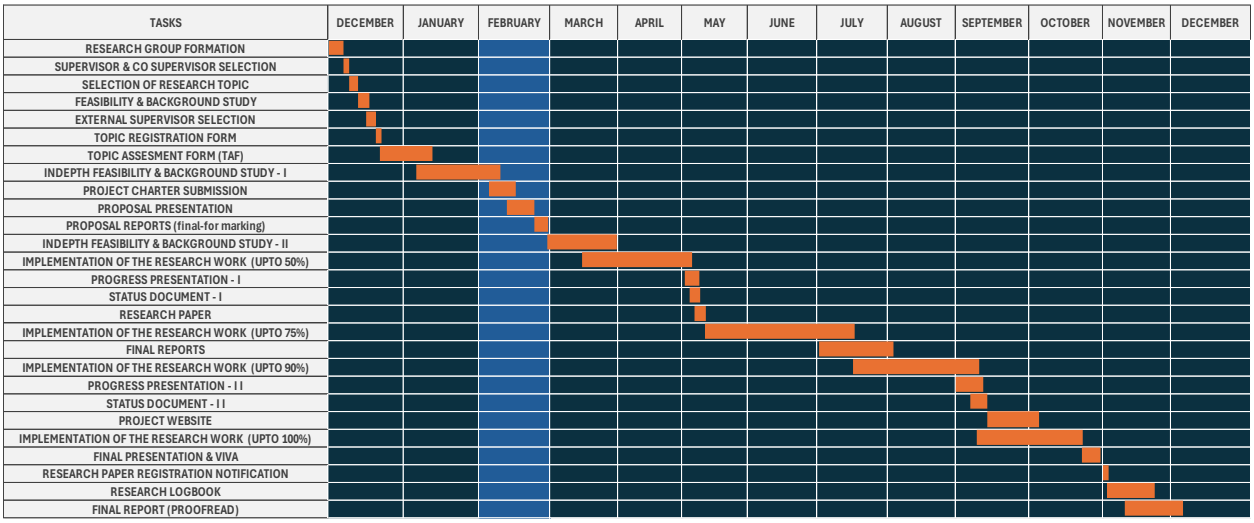
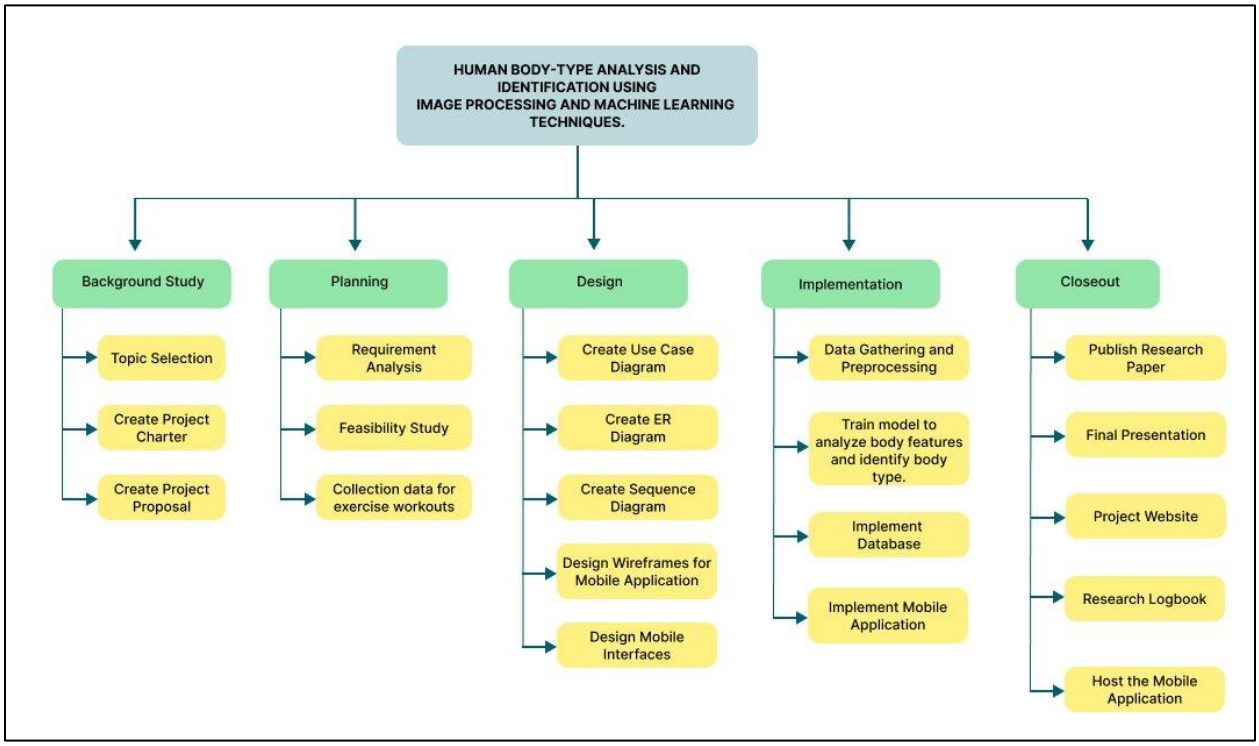


Figure 4.5 wireframe

5. Gantt chart



5.1 Work Breakdown Structure (WBS)



6. BUDGET AND BUGET JUSTIFICATION

Table 6. 1 : Expenses for the proposed system

Expenses	
Requirement	**Cost (Rs.)**
Travelling cost	20000.00
Developers' value of time	100,000.00
Database Price	7000.00
Play store publishing	9000.00
Marketing and Advertisements	14000.00
Total Value of the application	**150,000.00**

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