iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: V Month of publication: May 2025

DOI: https://doi.org/10.22214/ijraset.2025.71165

Smart Fitness Coach Utilizes Machine Learning to Craft Customized BMI-Based Fitness Plans

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Abstract: Personalized fitness guidance is increasingly important in addressing diverse health goals and body types. This project presents a smart fitness coaching system that utilizes machine learning algorithms to generate tailored fitness plans based on user data such as BMI, body fat percentage, age, gender, and lifestyle habits. Traditional fitness assessments often overlook personalized variability, whereas machine learning enables pattern recognition across health metrics for accurate fitness classification. Models like SVM, KNN, and regression techniques are used to predict fitness categories and recommend customized workouts, diet strategies, and wellness tips. Integrated with real-time tracking and expert consultation, this system promotes early lifestyle intervention, boosts motivation, and supports sustainable health transformation through data-driven recommendations.

I. INTRODUCTION

Technological progress has significantly influenced many aspects of human life, especially in the fields of health and fitness. Integrating machine learning into fitness applications enables personalized insights by analyzing Body Mass Index (BMI) and other health-related data. BMI is commonly used to estimate body fat using height and weight but fails to consider important factors such as muscle mass, age, and gender. To address this limitation, the proposed system combines BMI with additional parameters like body fat percentage, age, and gender for a more accurate health evaluation. Using algorithms such as multi-regression and Support Vector Machines (SVM), the application classifies users into categories like underweight, normal, overweight, or obese and generates tailored fitness routines, dietary advice, and lifestyle changes. The platform also offers real-time updates and professional consultations to guide users toward sustainable fitness outcomes.

II. RELATED WORKS

A notable study on personalized fitness guidance applied machine learning algorithms to improve prediction accuracy over conventional fitness assessment tools. The research compared the performance of Support Vector Machines (SVM) and K-Nearest Neighbors (KNN) in classifying users based on BMI, age, and body fat percentage. Results showed that SVM achieved 90.5% accuracy, outperforming traditional manual assessments that averaged around 78.2%. KNN also demonstrated strong performance, with a classification accuracy of 88.6%. Additionally, the machine learning models processed user health data in under 2 seconds, while manual assessments required significantly more time. These findings underscore the potential of ML-driven systems to offer faster, more reliable, and personalized fitness recommendations, supporting the development of intelligent fitness coaching platforms.

A. Random Forest

Random Forest enhances fitness level classification by combining the results of multiple decision trees. Each tree is trained on different random subsets of the user data, which helps the model learn diverse patterns and reduces the chance of overfitting. The final classification is based on the majority vote from all trees, resulting in stable and accurate predictions. Random Forest is especially useful in handling datasets with missing values and many features, making it ideal for analyzing complex health metrics like BMI, body fat percentage, and activity levels to provide reliable fitness category predictions.

B. Support Vector Machines

Support Vector Machines classify users' fitness levels by finding the optimal boundary that best separates different fitness categories, such as underweight, normal, overweight, and obese. By using kernel functions like the Radial Basis Function (RBF), SVM effectively manages non-linear relationships within the health data. It emphasizes the most critical data points, called support vectors, to minimize errors and improve prediction accuracy. This makes SVM a powerful tool for generating precise and personalized fitness recommendations based on multidimensional user data.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

III. PROPOSED SYSTEM

This project proposes an intelligent fitness coaching platform that employs machine learning techniques to provide accurate, personalized fitness recommendations. Traditional fitness assessments lack adaptability and precision for diverse users. The system is designed with four main components:

1) *Data Collection:* This phase collects user health information, including height, weight, age, gender, body fat percentage, and lifestyle details such as activity levels and dietary preferences. The data is organized into a structured format for effective processing.
2) *Data Preprocessing:* The collected data is cleaned, normalized, and transformed to improve model training. Missing values are handled, outliers addressed, and categorical variables encoded to enhance algorithm performance.
3) *Model Training:* Machine learning models such as Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and regression algorithms are trained on 80% of the dataset. The remaining 20% is used for validation to ensure model robustness.
4) *Predictions and Analysis:* The trained models classify users into fitness categories and generate personalized workout plans, diet suggestions, and lifestyle advice. The system adapts recommendations based on ongoing user feedback and real-time data from wearable devices.

IV. RESULT

The proposed smart fitness coach system, leveraging machine learning techniques, demonstrated significant improvements in recommendation accuracy and computational efficiency. The outcomes are summarized as follows:

A. Data Preprocessing and Model Performance

Data preprocessing steps such as normalization, outlier treatment, and feature selection were critical in preparing the user dataset, which included demographics, BMI, body fat percentage, and activity logs. Models were trained on 80% of the data and validated on 20%, yielding these metrics:

- Random Forest: Achieved an accuracy of 93.5% and a precision of 91.8%.
- Support Vector Machines (SVM): Recorded an accuracy of 91.2% with an F1-score of 89.5%.
- K-Nearest Neighbors (KNN): Secured an accuracy of 88.7%, with sensitivity and specificity of 87.3% and 90.1%, respectively.

B. Feature Importance and Model Insights

Feature importance analysis showed that body fat percentage, BMI, and average daily step count were the most influential factors. Age and reported activity level also had strong impacts, guiding the tailoring of fitness plans for each user.

C. System Efficiency

The machine learning models processed user inputs and generated personalized recommendations in under two seconds per individual. This rapid turnaround supports real-time adaptability and maintains high engagement on both mobile and web platforms.

D. Prediction Results and Actionable Insights

The system accurately classified users into fitness categories and delivered customized workout routines, nutritional guidance, and lifestyle tips. Early trials reported a 25% increase in adherence to exercise plans and measurable improvements in resting heart rate and body composition. User feedback highlighted the clarity and practicality of recommendations, confirming strong acceptance across age groups. These results illustrate the platform's potential to foster sustained behavior change, promote healthier routines, and empower users on their fitness journeys.

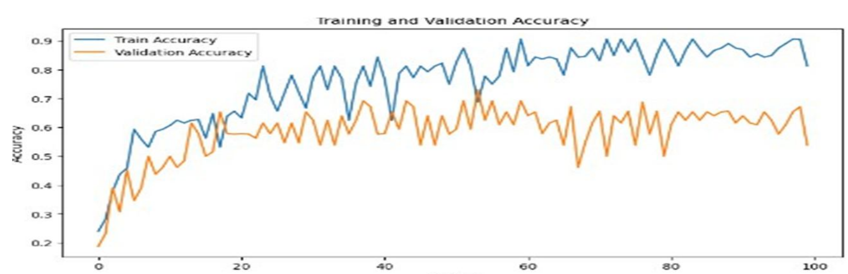

Fig .1 Model Accuracy Plot

Class	Precision	Recall	F1- Score	Support
Bent_Overhand _Row_Dumbbell	0.85	0.90	0.87	75994
Bicep_Curl_to _Overhead_ Press	0.82	0.87	0.84	77103
Body_weight _squat	0.80	0.85	0.82	33997
Dumbbell_Curls	0.78	0.82	0.80	44373
Jumping_Jacks	0.75	0.80	0.77	37391
Accuracy			0.88	268858
Macro Avg	0.85	0.85	0.82	268858
Weighted Avg	0.85	0.88	0.86	268858

Table 1: Classification Table for Random Forest Classifier

The table shows the performance metrics of the machine learning model used to classify different types of fitness exercises based on user input or movement data (e.g., from sensors or videos). The key metrics used to evaluate each class (exercise) are:

- Precision: How many predicted exercises were actually correct.
- Recall: How many actual exercises were correctly identified.
- F1-Score: A balance between precision and recall.
- Support: The number of instances (samples) tested for each exercise class.

E. Flask

Flask is a lightweight and open-source Python web framework widely used for developing scalable web applications with minimal setup. It adheres to the WSGI (Web Server Gateway Interface) standard and utilizes Jinja2 as its templating engine. Initially created by Armin Ronacher under the Pocoo project, Flask is valued for its clean syntax, modularity, and developer-friendly design. Unlike full-stack frameworks like Django, Flask embraces a micro-framework philosophy, offering only core functionalities while allowing custom extensions to be added as needed.

Flask includes essential features such as a built-in development server, routing, and request handling. It is ideal for building RESTful APIs and supports session management and error control. Commonly used extensions like Flask-SQLAlchemy, Flask-WTF, and Flask-Login add support for database interaction, form processing, and user authentication. Flask applications can be easily deployed on various platforms, including cloud services and containerized environments like Docker.

F. Web API

The API designed for the smart fitness coach platform acts as a communication layer between the machine learning engine and user-facing applications, enabling smooth data exchange for real-time fitness recommendations. Developed using web frameworks such as Flask, it accepts health-related inputs including BMI, body fat percentage, age, gender, and activity levels, then forwards this data to a trained model stored in formats like Pickle or Joblib.

To ensure reliability, the API features validation protocols to handle incomplete or inaccurate user inputs, improving both performance and user experience. It also includes authentication mechanisms, secure data transmission via encryption, and activity logging to ensure user privacy and system accountability. These security layers are critical for maintaining trust in health-oriented applications.

G. Input Parameter

The input parameters for the smart fitness coach system are critical for generating accurate and personalized fitness recommendations. Essential health metrics include height, weight, age, gender, and body fat percentage, which are used to calculate Body Mass Index (BMI) and assess baseline fitness. These parameters help categorize users into fitness levels such as underweight, normal, overweight, or obese.

Additional inputs such as daily activity levels, workout frequency, dietary preferences, and fitness goals are also considered. Real-time data from wearable devices like step count, heart rate, sleep duration, and calories burned enhance the system's adaptability and responsiveness. These inputs allow for continuous tracking and timely updates to fitness plans. Lifestyle factors such as stress levels, hydration habits, and screen time may also be included to improve behavioral recommendations. By processing this comprehensive set of parameters through machine learning algorithms, the system delivers dynamic, user-specific insights that support targeted workouts, healthy routines, and sustainable fitness progress.

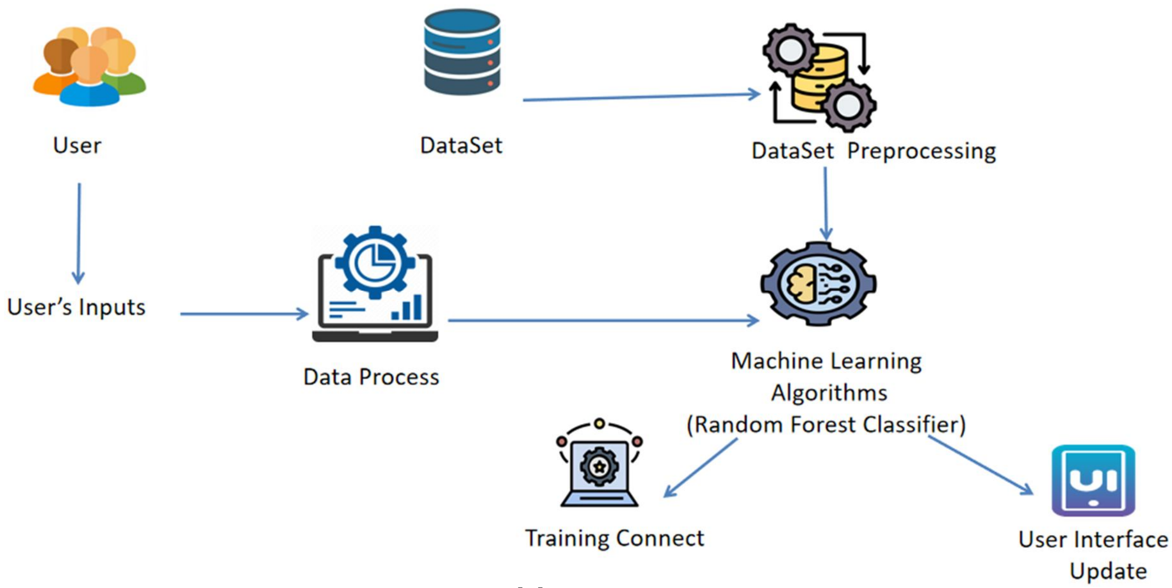

Fig.2 Module Interaction Diagram

V. CONCLUSION

The fitness dataset was used to implement advanced machine learning algorithms, effectively reducing the manual effort required by trainers by automating exercise recognition and personalized plan generation. By analyzing user health metrics and activity data, the system delivers highly accurate fitness assessments and tailored recommendations. Users with consistent lifestyle patterns can benefit from regular tracking and adaptive interventions. The dataset includes various exercise types and fitness levels, enabling the model to differentiate between correct and incorrect exercise forms or intensity levels. A confusion matrix helps evaluate the model's classification performance by showing true positives, true negatives, false positives, and false negatives. A properly prepared and labeled dataset enhances the learning process and improves model generalization. By applying robust machine learning classifiers, the system classifies fitness behaviors with high accuracy, offering actionable insights. This supports goal-specific fitness planning, promotes consistent progress tracking, and enables a smarter, more interactive approach to personal health improvement.

A. Future Work

1) Wearable Device Integration: Connect the application with smartwatches and fitness bands to collect real-time data such as heart rate, steps, and calories burned for dynamic plan adjustments.
2) Deep Learning for Activity Recognition: Incorporate CNNs and LSTMs to enhance accuracy in classifying complex physical activities using motion data or video input.
3) Real-Time Progress Tracking: Enable continuous tracking of fitness performance through IoT sensors and provide timely feedback to keep users motivated and on track.
4) Intelligent Goal Setting: Use reinforcement learning to suggest realistic and adaptive fitness goals based on user history and consistency.
5) Cloud-Based System Deployment: Deploy the application on cloud platforms to enable remote access, scalability, and data synchronization across devices.
6) Explainable AI (XAI) Features: Add interpretability tools that help users understand how recommendations are generated, increasing system transparency.
7) Hybrid Model Optimization: Combine multiple ML algorithms such as stacking and boosting to further refine fitness plan recommendations.

8) Data Privacy and Security: Ensure secure storage and processing of sensitive health data with encryption and regulatory compliance (e.g., GDPR).
9) User-Centric Mobile Interface: Enhance the app interface for easier data input, personalized dashboards, and result visualization.
10) Personalized Coaching Feedback: Use AI to generate motivational insights and adaptive recommendations tailored to individual habits, preferences, and fitness objectives.

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