iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 Issue: IV Month of publication: April 2026

DOI: https://doi.org/10.22214/ijraset.2026.78741

Virtual Fitness Trainer

Rohan Mhatre[1], Vishwa Naik[2], Diya Kharat[3], Siddhesh Narvekar[4], Medha Kulkarni[5]
Department of Information Technology VPPCOE&VA, University of Mumbai

Abstract: The growing popularity of home-based fitness training has increased the demand for intelligent systems that can guide users during workouts without requiring professional supervision. However, many individuals performing exercises at home struggle to maintain correct posture, which can reduce workout effectiveness and increase the risk of injury. This paper presents a Virtual Fitness Trainer, an intelligent system that utilizes computer vision and pose estimation techniques to monitor exercises and provide real-time feedback. The proposed system captures video using a standard webcam and detects key body landmarks to analyze joint movements during exercises such as bicep curls, push-ups, planks, and yoga poses. By evaluating joint angles and motion patterns, the system automatically recognizes exercises, counts repetitions, and identifies posture deviations. In addition to exercise monitoring, the system integrates a diet recommendation module that provides nutritional suggestions based on user fitness goals such as weight loss, muscle gain, or general health improvement. Unlike traditional fitness monitoring solutions that rely on wearable sensors or specialized hardware, the proposed approach operates efficiently on standard computing devices using camera-based pose estimation. Experimental evaluation demonstrates that the system provides reliable exercise detection and real-time feedback while also supporting personalized dietary guidance. The proposed Virtual Fitness Trainer offers a cost-effective and accessible solution for promoting safe workouts and balanced nutrition in home-based fitness environments.
Keywords: Computer Vision, Pose Estimation, Human Pose Detection, Exercise Recognition, Real-Time Feedback, Fitness Monitoring System, Diet Recommendation System.

I. INTRODUCTION

In recent years, increasing awareness of physical health and wellness has encouraged individuals to adopt regular fitness routines. Many people now prefer home-based workouts due to convenience, accessibility, and the availability of online fitness resources. However, exercising without professional supervision often results in incorrect posture and ineffective training. Improper exercise form can reduce the benefits of physical activity and may increase the risk of muscle strain or injury. Additionally, maintaining a balanced diet alongside regular workouts is essential for achieving optimal fitness outcomes, yet many individuals lack proper nutritional guidance.

Advancements in artificial intelligence and computer vision have created new opportunities for developing intelligent systems capable of analyzing human movements in real time. Pose estimation techniques allow computer systems to detect key body landmarks such as shoulders, elbows, hips, knees, and ankles from images or video streams. By tracking these landmarks, it becomes possible to analyze body posture and identify movement patterns during physical exercises. These technologies enable the development of automated fitness monitoring systems that can assist users during workouts without requiring human trainers.

Traditional fitness monitoring systems commonly rely on wearable sensors such as accelerometers, gyroscopes, or smart fitness devices to track physical activity. While these sensor-based approaches can provide accurate measurements, they require additional hardware and may not be convenient for everyday users. Moreover, the need for specialized devices increases system cost and limits accessibility for individuals who prefer simple home workout solutions.

To overcome these limitations, computer vision–based systems have been proposed that utilize cameras and pose estimation algorithms to detect body movements. These systems analyze video input to recognize exercise patterns and evaluate posture. However, many existing approaches primarily focus on activity recognition and lack integrated features that provide comprehensive workout assistance and nutritional support.

This research proposes a Virtual Fitness Trainer, an intelligent computer vision–based system designed to assist users during home workouts. The system captures real-time video through a webcam and utilizes pose estimation to detect body landmarks and analyze joint movements during exercises such as push-ups, squats, and bicep curls. Based on the detected movement patterns, the system automatically identifies exercises, counts repetitions, and provides posture feedback to guide users in performing exercises correctly.

In addition to exercise monitoring, the proposed system incorporates a diet recommendation module that provides nutritional suggestions aligned with user fitness goals. By combining exercise analysis with dietary guidance, the system offers a more comprehensive fitness assistance platform that supports both physical activity and healthy nutrition.

The main contributions of this research are summarized as follows:

1) Development of a real-time exercise monitoring system using computer vision techniques.
2) Implementation of pose estimation for detecting human body landmarks during workouts.
3) Automatic exercise recognition and repetition counting based on joint movement analysis.
4) Integration of a diet recommendation module that provides nutritional suggestions according to user fitness goals.
5) A lightweight architecture that operates efficiently on standard computing devices without requiring wearable sensors.

By integrating real-time exercise monitoring with nutritional guidance, the proposed Virtual Fitness Trainer aims to provide an accessible and cost-effective solution for improving home-based fitness training and promoting healthier lifestyles.

II. LITERATURE SURVERY

Recent developments in artificial intelligence and computer vision have enabled the creation of intelligent systems capable of monitoring physical activities and assisting users during exercise sessions. Researchers have explored various approaches for fitness monitoring, including wearable sensor-based systems, computer vision–based exercise detection, and intelligent diet recommendation systems.

Early fitness monitoring systems primarily relied on wearable sensors to track body movements. Douzas and Mavroudi [1] proposed a smart gym trainer that used wearable devices to monitor physical activity and analyze exercise performance. Although the system demonstrated accurate motion tracking, the requirement of multiple sensors increased system complexity and reduced convenience for everyday users.

With the advancement of computer vision technologies, several researchers have developed camera-based exercise monitoring systems. Suphanichet et al. [2] introduced a machine learning–based approach for recognizing physical exercises using skeletal tracking. The system analyzed body posture to identify different exercise movements. However, the system mainly focused on activity recognition and did not provide continuous feedback to correct posture during workouts.

Chang et al. [3] developed an artificial intelligence–based fitness trainer designed to assist elderly individuals during physical exercises. The system utilized deep learning algorithms to recognize activities and monitor movement patterns. While the system achieved promising results, the computational complexity limited its deployment on low-cost devices.

In addition to exercise monitoring, several studies have explored intelligent diet recommendation systems that assist users in maintaining balanced nutrition. These systems typically analyze user preferences, health data, or fitness goals to generate personalized meal suggestions. Although diet recommendation systems can help improve nutritional habits, many existing solutions operate independently from exercise monitoring platforms and do not integrate physical activity analysis with dietary guidance.

Despite the progress in intelligent fitness monitoring systems, several limitations remain. Many existing approaches either rely on wearable sensors or require high computational resources for real-time processing. Furthermore, exercise monitoring systems and diet recommendation systems are often developed separately, which limits their ability to provide comprehensive fitness assistance.

To address these limitations, this research proposes a Virtual Fitness Trainer that integrates computer vision-based exercise monitoring with a diet recommendation module. The system utilizes pose estimation to detect body movements during workouts and provides real-time posture feedback while simultaneously offering nutritional suggestions aligned with user fitness goals. By combining exercise analysis and dietary guidance within a single platform, the proposed system aims to provide a more complete and accessible solution for home-based fitness training.

III. PROPOSED METHODOLOGY

The proposed Virtual Fitness Trainer utilizes computer vision and machine learning techniques to monitor exercises and provide dietary guidance for users. The system analyzes body movements using pose estimation and generates personalized diet recommendations based on user fitness goals. The methodology consists of several stages including video acquisition, pose estimation, exercise recognition, repetition counting, and diet recommendation.

A. Video Acquisition

The first stage of the system involves capturing live video using a webcam. The video stream is continuously processed and divided into individual frames for further analysis. Each frame is passed to the pose estimation module where body landmarks are detected.

Using webcam-based input eliminates the need for wearable sensors or specialized hardware, making the system suitable for home-based fitness monitoring.

B. Pose Estimation

Pose estimation is used to detect key body landmarks from the captured video frames. The system identifies major joints of the human body including shoulders, elbows, hips, knees, and ankles. These landmarks are used to construct a skeletal representation of the user. The coordinates of these landmarks are extracted for each frame and used to calculate joint angles. Tracking the variation of these joint angles across frames allows the system to analyze body posture and movement patterns during exercises.

C. Exercise Recognition

Exercise recognition is performed by analyzing the movement patterns of specific joints. Different exercises generate distinct variations in joint angles and body posture.

For example:

- Bicep curls involve repetitive flexion and extension of the elbow joint.
- Push-ups involve coordinated movement of the shoulder and elbow joints.
- Squats involve bending the hip and knee joints.
- Plank exercises involve maintaining a stable body posture for a period of time.

By evaluating these joint movements across consecutive frames, the system identifies the type of exercise being performed.

D. Repetition Counting

The repetition counting mechanism tracks the transition between the starting and ending positions of an exercise movement. When the system detects a complete movement cycle, the repetition counter is incremented.

For example, during a bicep curl exercise, a repetition is counted when the arm moves from an extended position to a contracted position and then returns to the initial state. This automated mechanism allows users to track workout progress without manual input.

E. Diet Recommendation Module

In addition to monitoring exercises, the proposed system also provides dietary recommendations based on user fitness objectives. The diet recommendation module generates meal suggestions according to goals such as weight loss, muscle gain, or maintaining general fitness. The system analyzes user preferences and fitness goals to recommend appropriate food items and balanced nutritional plans. By combining exercise monitoring with diet recommendations, the system supports users in maintaining both physical activity and proper nutrition.

IV. SYSTEM ARCHITECTURE

The proposed Virtual Fitness Trainer is designed as an intelligent computer vision–based system that assists users during workouts and provides personalized dietary guidance. The system integrates real-time exercise monitoring with a diet recommendation module to support users in maintaining a balanced fitness routine. The architecture combines several functional components that work together to detect body movements, recognize exercises, and provide feedback and nutritional suggestions.

The overall architecture of the system is illustrated in **Fig. 1**. The system consists of five primary modules: the video input module, pose detection module, exercise analysis module, diet recommendation module, and user feedback interface.

A. Video Input Module

The video input module captures live video using a standard webcam. The video stream is continuously processed and divided into individual frames. Each frame is forwarded to the pose detection module for further analysis.

Using a camera-based input allows the system to monitor exercises without requiring wearable sensors or specialized hardware. This makes the proposed solution more accessible for individuals performing workouts in home environments.

B. Pose Detection Module

The pose detection module identifies key body landmarks from the captured video frames. These landmarks represent major joints of the human body, including shoulders, elbows, hips, knees, and ankles. By detecting these points, the system generates a skeletal representation of the user's posture.

The extracted landmark coordinates are used to calculate joint angles and track body movements during exercises. This information enables the system to analyze exercise posture and detect movement patterns.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

C. Exercise Analysis Module

The exercise analysis module processes the body landmark data to determine the type of exercise being performed. Different exercises generate distinctive patterns of joint movement, which can be detected by analyzing variations in joint angles across consecutive frames.

The module also identifies the start and end positions of an exercise movement in order to count repetitions automatically. This enables users to track their workout progress in real time.

D. Diet Recommendation Module

In addition to monitoring exercises, the system also provides dietary suggestions to support users in maintaining a healthy lifestyle. The diet recommendation module generates meal suggestions based on user fitness goals such as weight loss, muscle gain, or general fitness.

The system recommends appropriate food items and nutritional guidance that complement the user's workout routine. By combining exercise monitoring with dietary recommendations, the Virtual Fitness Trainer provides a more comprehensive fitness assistance platform.

E. Feedback and User Interface Module

The feedback module provides real-time guidance to the user during workout sessions. The interface displays the detected body pose, exercise name, repetition count, and posture feedback.

If incorrect posture is detected, the system generates visual alerts that help users correct their body alignment. The interface also displays recommended diet suggestions to support users in maintaining balanced nutrition alongside their workout routines.

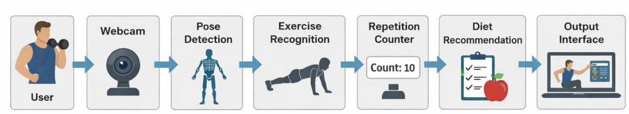


Fig. 1. Architecture of the proposed Virtual Fitness Trainer system.

V. RESULTS AND DISCUSSION

The proposed Virtual Fitness Trainer system was implemented and evaluated to verify its capability to perform real-time exercise detection and provide personalized fitness guidance. The system integrates pose estimation, exercise recognition, repetition counting, and a diet recommendation module to assist users during workouts. The implementation was tested on a standard laptop equipped with a webcam, demonstrating that the system can operate without specialized hardware.

The graphical user interface allows users to select exercises, monitor their movements, and receive real-time feedback on their performance. The interface also provides access to the diet recommendation module, where users can analyze their nutritional intake and calculate BMI-based calorie requirements. The results indicate that the system provides an interactive and accessible platform for home-based fitness training.

The user interface of the system is shown in Fig. 2, where users can select different exercises and initiate the exercise detection process.

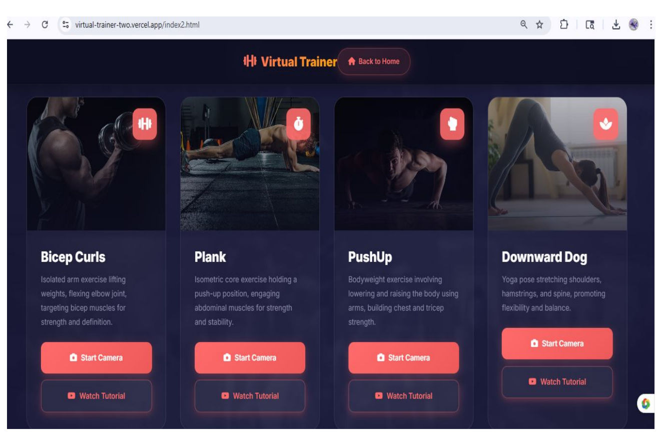


Fig. 2. User interface of the Virtual Fitness Trainer showing exercise selection options.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

The pose detection module plays a crucial role in tracking body movements. Using the MediaPipe pose estimation framework, the system detects key skeletal landmarks from the webcam feed and overlays them on the user's body in real time. These landmarks are used to calculate joint angles and identify body posture during exercise. An example of pose detection and landmark tracking during exercise monitoring is illustrated in Fig. 3.

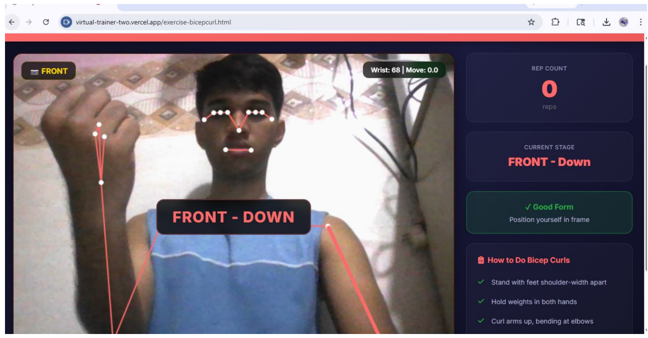


Fig. 3. Human pose detection and landmark identification during exercise monitoring.

The system also tracks exercise progress by counting repetitions based on joint movement thresholds. For instance, during bicep curls or push-ups, the system detects transitions between the start and end positions of the movement and increments the repetition counter accordingly. Real-time feedback is provided through the interface to help users maintain correct posture and exercise form.

In addition to exercise monitoring, the system includes a diet recommendation module that analyzes users' dietary intake and body metrics. Users can enter the food items they consumed, and the system calculates estimated calories and protein intake. The system also integrates a diet recommendation module to assist users in managing their nutritional intake. The meal analysis interface allows users to input food items and obtain estimated calorie and protein values, as illustrated in Fig. 4. In addition, the system includes a BMI and calorie calculator that provides personalized dietary suggestions based on body metrics and fitness goals. The implementation of this module is shown in Fig. 5.

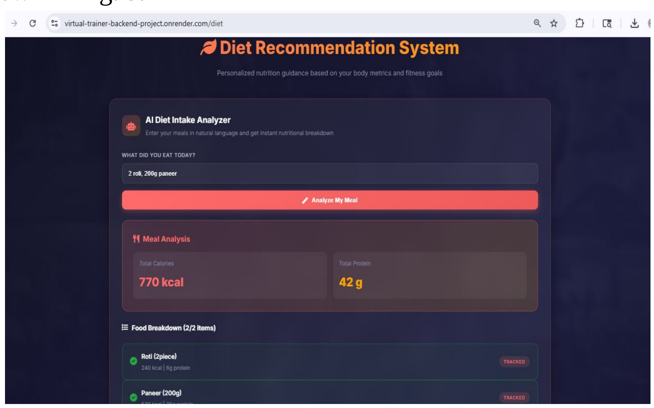


Fig. 4. AI-based meal analysis interface showing calorie and protein estimation from user-input food items.

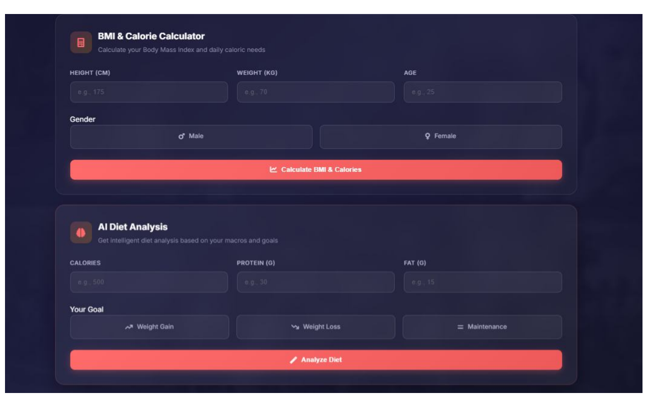


Fig. 5. BMI and diet recommendation module providing personalized nutritional guidance based on user metrics.

Experimental testing demonstrated that the system can perform pose detection and exercise monitoring at approximately 25–30 frames per second on standard hardware, ensuring smooth real-time feedback. The pose estimation model accurately identified major body landmarks under normal lighting conditions and successfully detected common exercises such as push-ups, bicep curls, planks, and yoga poses.

Overall, the results demonstrate that the proposed Virtual Fitness Trainer provides an effective and affordable solution for real-time exercise monitoring and personalized fitness assistance without requiring wearable sensors or expensive equipment.

VI. CONCLUSION

This paper presented a Virtual Fitness Trainer that integrates computer vision–based exercise monitoring with a diet recommendation system to assist users in maintaining a healthy lifestyle. The proposed system utilizes pose estimation techniques to detect human body landmarks and analyze exercise movements in real time using a standard webcam. By tracking joint positions and movement patterns, the system is capable of recognizing exercises such as push-ups, bicep curls, planks, and yoga poses while automatically counting repetitions and providing posture feedback.

In addition to exercise monitoring, the system incorporates a diet recommendation module that analyzes user nutritional intake and calculates BMI-based calorie requirements. This integration enables the platform to support both physical activity monitoring and dietary guidance within a single application.

Experimental implementation demonstrated that the system operates efficiently on standard computing devices without requiring specialized hardware or wearable sensors. The proposed Virtual Fitness Trainer provides an accessible and cost-effective solution for improving home-based fitness training while promoting balanced nutrition and healthier lifestyles.

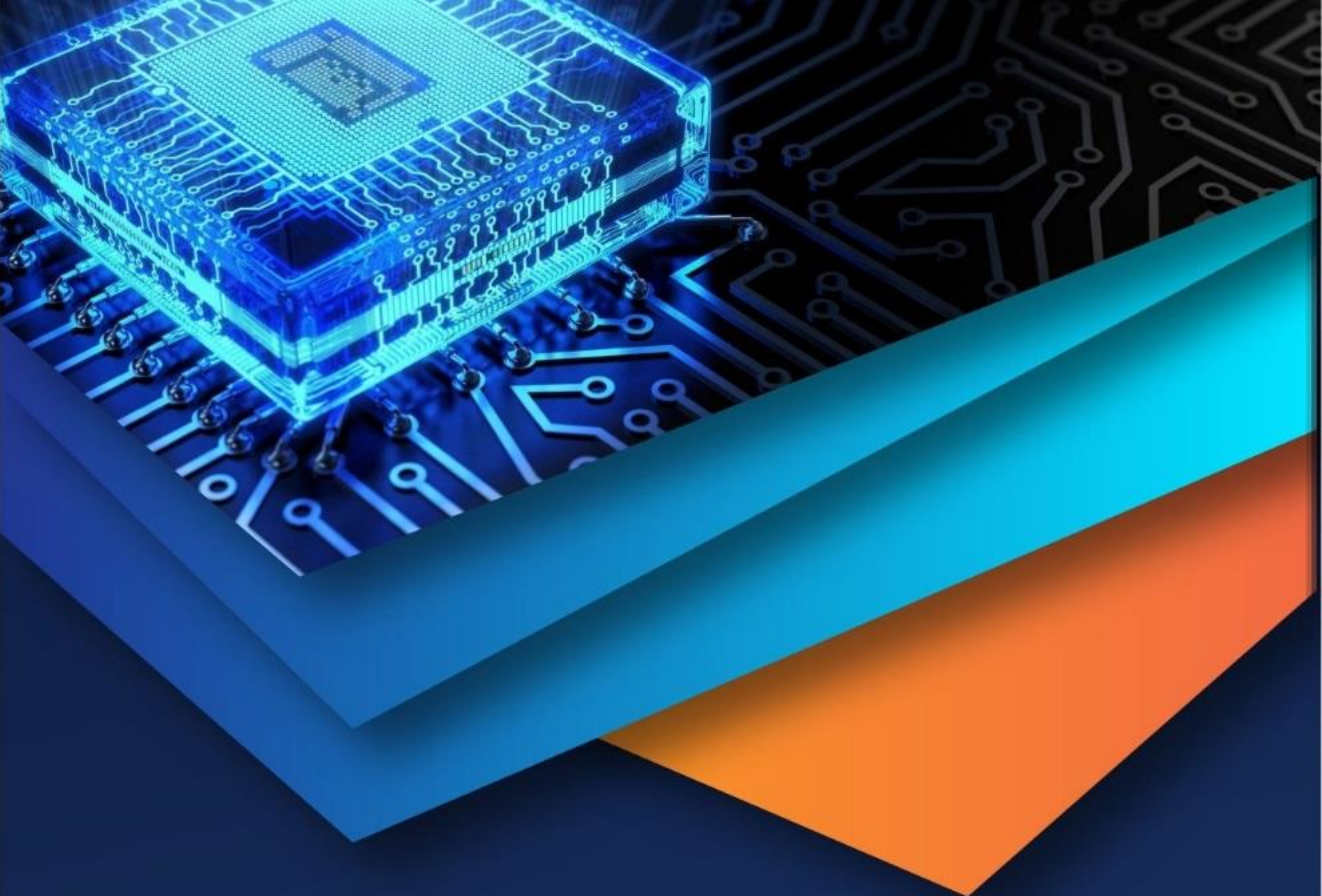
VII. FUTURE WORK

The current system demonstrates the feasibility of integrating real-time exercise monitoring with dietary guidance using computer vision and web-based technologies. However, several enhancements can further improve the effectiveness and scalability of the proposed system. Future work will focus on expanding the range of supported exercises and improving pose estimation accuracy for complex movements. The integration of deep learning–based action recognition models could enhance robustness under varying lighting conditions and camera angles.

Additionally, future versions of the system may incorporate mobile application support to increase accessibility and portability for users. The inclusion of wearable sensor integration and personalized fitness analytics could further improve exercise feedback and performance tracking. Moreover, the diet recommendation module can be enhanced by incorporating machine learning models that generate personalized nutrition plans based on user preferences, health conditions, and fitness goals.

REFERENCES

[1] G. Douzas and A. Mavroudi, "Smart gym: A wearable sensor-based system for real-time fitness monitoring and exercise analysis," IEEE Sensors Journal, vol. 18, no. 12, pp. 4898–4906, Jun. 2018.
[2] S. Suphanichet, T. Wattanachote, and P. Intarasirisawat, "Exercise recognition using skeletal tracking and machine learning techniques," in Proc. IEEE Int. Conf. Computer Science and Software Engineering (CSSE), 2019, pp. 220–225.
[3] C. Y. Chang, Y. C. Lin, and H. T. Wu, "Artificial intelligence-based fitness trainer for elderly exercise monitoring," IEEE Access, vol. 8, pp. 135357–135367, 2020.
[4] Z. Cao, T. Simon, S. Wei, and Y. Sheikh, "Realtime multi-person 2D pose estimation using part affinity fields," in Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR), 2017, pp. 7291–7299.
[5] A. Toshev and C. Szegedy, "DeepPose: Human pose estimation via deep neural networks," in Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR), 2014, pp. 1653–1660.
[6] R. Poppe, "Vision-based human motion analysis: An overview," Computer Vision and Image Understanding, vol. 108, no. 1–2, pp. 4–18, 2007.
[7] H. Zhang, Y. Zhang, and Q. Wang, "Vision-based fitness exercise recognition using human pose estimation," IEEE Access, vol. 8, pp. 189960–189970, 2020.
[8] D. Mukherjee and S. Gupta, "AI-based personalized diet recommendation systems using nutritional analysis," International Journal of Computer Applications, vol. 178, no. 7, pp. 12–18, 2021.
[9] J. Brown and L. Wang, "Computer vision-based fitness monitoring systems: A survey," IEEE Transactions on Multimedia, vol. 21, no. 5, pp. 1120–1132, May 2019.
[10] T. Pfister, J. Charles, and A. Zisserman, "Flowing convnets for human pose estimation in videos," in Proc. IEEE Int. Conf. Computer Vision (ICCV), 2015, pp. 1913–1921.



10.22214/IJRASET

INDEX COPERNICUS 45.98

ISRA JIF IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY