# NutriFit-AI: Nutrition System of Vision Based Calorie Estimation and Fitness Welfare

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***Abstract*** **--- Due to the rising rates of obesity, physical inactivity, and improper dieting, the demand to have available and intelligent wellness solutions has increased in direct proportion. Although there are numerous fitness and nutrition apps nowadays, most of them are single-use or need manual data entry or professional supervision and adherence and long-term are minimized. In addition, people are often lacking instant feedback of exercise performance and tracking of calories intake usually seems tedious and inaccurate. In this paper, we introduce NutriFit AI which is a multimodal intelligent fitness and nutrition system that combines computer vision-based exercise analysis with vision-based calorie estimation on a single web platform. The vision models associated with the proposed system are deep-learning-based, which means that food images are processed to give approximate values of calories and macronutrients, rendering the process of dietary tracking easy and allowing the removal of manual food recording. Simultaneously, human pose estimation is implemented to the workout videos to assess the motions of body joints and make it possible to count the repetitions of an exercise automatically, without relying upon wearable sensors. The system is provided through the use of a Flask-based server, OpenCV, and MediaPipe as pose estimators, a lightweight SQLite database to store history and progress trends of users. It has been experimentally demonstrated that the system is highly reliable in repetition counting of popular bodyweight activities, and provides useful nutritional estimations of regular meals. Although the system is not claimed to be clinical in the precision, it is useful in helping to perform self-monitoring on a daily basis and long-term fitness awareness. NutriFit-AI will prove the viability of a low-cost, user-friendly, and well-integrated AI-based virtual fitness assistant that could be used in the context of real-life personal wellness management.**

**Sub Key Words: Artificial intelligence (AI), Computer vision, Pose detection, Nutrition detection, Fitness tracker, Vision-based calorie counting, MediaPipe..**

## I. Introduction

Sedentary habits, unbalanced physical activity, and lack of awareness of the food people consume have led to the increased incidences of lifestyle disorders like obesity, diabetes, high blood pressure, and heart diseases. Despite the fact that people have become more interested in healthy lifestyle, not all of them can afford regular exercises and proper nutrition control. Trainer or dietician-led professional advice is useful since it is usually costly and inaccessible to students and the working population. The digital fitness apps are trying to help but most of them rely on manually recording, on pre-recorded workouts, or generic guidance. Logging meals is both time intensive and prone to error, whereas at home exercises generally have no visualization on posture or quality of repetition. Such restrictions lower motivation and undermine the long-term engagement.

New methods are made available by recent advances in artificial intelligence and computer vision. Human motion could be analyzed using a normal camera with pose estimation models and food items estimated using deep learning systems and calculating the calorie and macronutrient contents. With this kind of technologies, it is becoming feasible to conduct automated and cheap monitoring. Most of the available solutions however address diet and exercise individually and thus generate partial insights. Good fitness management involves the awareness of the effect on the intake and activity on each other. As the solution to this requirement, the current paper will introduce NutriFit-AI, a multimodal assistance tool, by combining nutrition estimations, workout management, and BMI-based measurement in one web application. It is a system that integrates image-operated approximations of calories with position-based repetition counting, and a centralized database that is used to keep past records and aid in visualizing trends.

The main value of this paper is that it has shown that the commonly used vision technologies can be coordinated into a low-cost, easy to use system that provides unceasing and interpretable feedback. NutriFit-AI facilitates sustainable practice of healthier lifestyles by focusing on automation and combined tracking.

## I. Literature Survey

In the recent past, computer vision and deep learning have made tremendous contributions to systems of personal health monitoring. Two main research streams on this topic have taken shape: (i) dietary analysis: Dietary analysis visionary methods have been created in order to identify and estimate the amount of calories in food, but not to exercise it; (ii) vision based exercise monitoring: Pose estimation has been used to count repetitions and profile posture, but not to exercise it.and (ii) vision-based exercise monitoring: Pose estimation has been applied to count repetitions and evaluate posture, but not to exercise. Even though the two research streams have had good outcomes on their own, a combination of dietary and exercise intelligence into a single platform has not been a large-scale activity. The NutriFit-AI project will fill this gap by integrating the analysis of the food images and the workouts in one web-based system.

**A. Identification of Food and Calorie Estimation:** Automated image-based methods are seen as the solution to the time-consuming and inaccurate manual calorie logging. Ruede et al. suggested a multi-task learning method at calculating calorie content, based on a massive recipe database with nutritional data incorporated [13]. Their analysis revealed that the collective prediction of the calories and other related features like ingredients and nutrients enhances the performance of a model. Their methodology however relies heavily on well annotated datasets. DeepFood is a deep learning framework presented by Jiang et al. that directly predicts nutritional values of food images [6]. The model was quite effective when using structured data sets but when attempting to work with visually complex or mixed dishes, the model was limited. On the same note, Poply and Arul Jothi used advanced image segmentation methods to estimate the calories in multi-dish food images [12], which is the significance of food regions isolated in the image prior to the calculation of calories. Still other recent works have been concerned with detection-based strategies.

Kumar et al. estimated calories in food and beverages with deep learning models [8], whereas Ibrahim et al. adopted a framework based on the YOLO in food recognition to enhance the accuracy of the model [9]. Jayanthi experimented with Faster-R-CNN and Mask-R-CNN in order to localize food objects much more accurately in the image [10]. Yarde et al. also suggested a deep learning-based system of food recognition and estimating the calories in a real-world application [11]. Also, Naritomi et al. created CalorieCaptorGlass that incorporates wearable gadgets to determine the number of calories consumed through the image capture [7]. Though innovative it is costly and not as accessible as it depends on extra hardware. In general, the literature proves that AI-based systems can assist in the provision of meaningful calorie estimates. Nevertheless, it has its obstacles because of concealed ingredients, variations to cooking, and uncertainty of the portion sizes.

**B. Pose Estimation Exercise Monitoring:** Similar studies have been done on computer vision to analyze a workout. It was demonstrated that the local body features in combination with holistic posture information introduce a better accuracy in human landmark detection [2]. Zhu et al. improved the accuracy of pose estimation in dynamic settings with the combination of detection and mapping methods [3]. Application-oriented systems were close to come. Dsouza et al. have created a smart gym trainer that can provide guidance to the user during workouts through pose-estimation [5]. Taware et al. introduced a real-time exercise performance product based on AI, which is an exercise assistant [4]. Recently, Kaushik et al. applied the MediaPipe and OpenCV to achieve real-time posture correction and repetition counting [1] and proved to have a stable performance in controlled conditions. Though the systems are effective in tracking exercises, they concentrate mainly on physical movements and never include nutritional awareness and long-term health measurements.

**C. Deficits Noted in Current Literature:**

Based on the literature review, there are a number of recurrent gaps: Exercise and nutrition systems are normally created in isolation. There are not many solutions that relate the number of calories with exercising activity. There are certain systems that need wearable items or controlled space. Customers end up using several applications, which creates disjointed health records. Though the individual components show high levels of technical performance, the majority of existing platforms do not have integrated reasoning going between dietary behavior and physical activity.

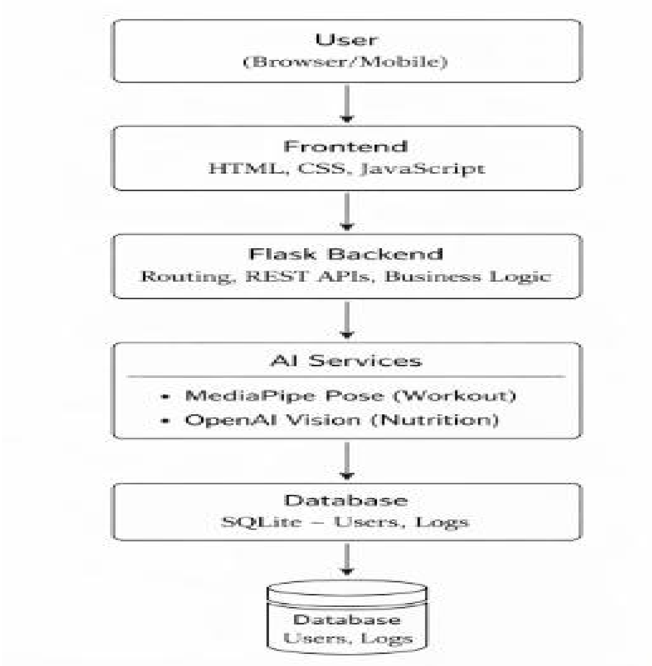
**D. Research gap & Contribution of NutriFit-AI:**

Although there are developed algorithms to perform food recognition and pose tracking, it is still unable to be practically applied to one, low-cost ecosystem. An integrated system that will analyze meals, track exercises, and save the historical trends will be able to give more detailed and individualized feedback. NutriFit-AI is based on the multi-task nutritional modeling [13] and pose-based exercise tracking [1], including those in a web-based architecture. The system enables users to: • Determine food images, calorie and macro nutrition. • Count exercise repetitions automatically. Calculate health indicators based on the BMI. • Monitor historical information using a web-based dashboard. With all these capabilities, NutriFit-AI will become more than a single-effort monitoring device and will advance to a complete AI-based wellness assistant.

## II. Methodology

**A. System Design Overview**

The proposed NutriFit-AI framework is based on a modular and service-oriented design combining understanding of nutrition, exercise and health, integrating them in a unified platform. The architecture of the building is split into four levels of cooperation that include the user interface, application logic, artificial intelligence, and long-term memory. Due to this separation, it allows for an independent development, an easier maintenance and also future scalability.




Users interact with the system via a web interface which is developed using standard frontend technologies. Requests from the interface will be accepted by a backend of the application written in Python with the Flask framework, which will coordinate the communication between AI modules and the database. The design will deliver automated health intelligence on the basis of the only consumer grade camera and no wearables or special hardware are necessary.

**B. Health Assessment Methodology**

The health assessment methodology is utilized in health evaluations to evaluate clients' health and assign care plans. Health assessment module gives a rapid analysis of physical condition based on Body Mass index (BMI). The height and weight values are entered by the users and are verified and converted to metric units. BMI is calculated by the conventional mathematical formula:

$$\text{BMI} = \frac{\text{weight}}{\text{height}^2}$$

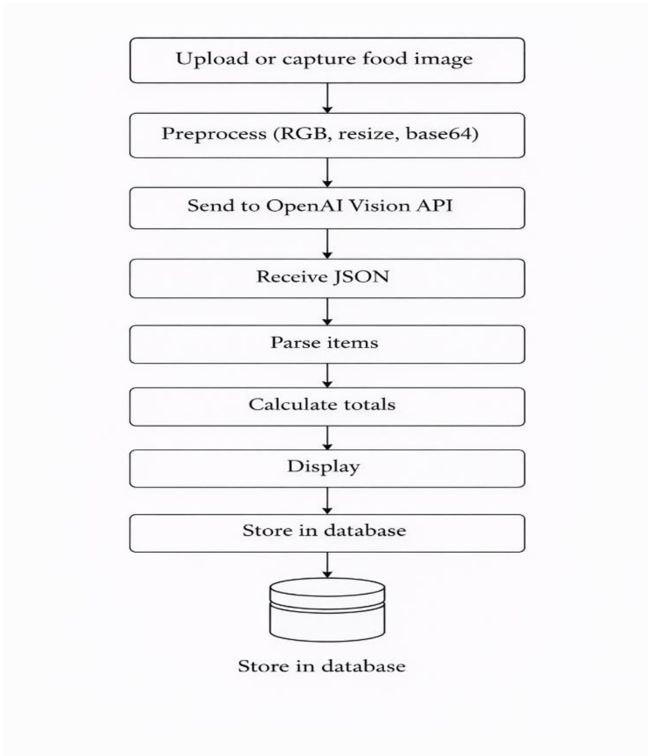
According to international accepted standards, the outcome is classified as being underweight, normal, obese, or overweight. The system then comes up with light lifestyle recommendations in relation to the identified category. The records are time-stamped and stored in the database, which makes it possible to monitor the longitudinal changes and visualize the trends. Despite its simplicity, this module can form a fundamental marker of bridging the outcomes of nutritious intake and physical movement.

**C. The Method of Nutrition Analysis**

The nutrition pipeline is a process by which the picture of a food is converted into a form of organized diet.

1. **Image Acquisition** : The user can post a photograph of a meal on the web interface.
2. **Pre-processing :**The picture is coded into a format that is to be transferred to API communication.
3. **AI Inference :** A vision language model runs through the visual information to provide the identified food items and information based on that data on estimated calories, protein, carbohydrates, and fats.
4. **Post-processing and Storage :** The textual response forms are converted to numerical values and aggregated and presented to the user and recorded in the database.

**Fig : Nutrition Analysis Flowchart**




The methodology was designed to be similar in its approximation to being clinically accurate, which is adequate in the example of everyday awareness and behavior monitoring. This method is easier to use, does not need a complex portion reconstruction or depth estimation.

**D. Workout Analysis Methodology**

The workout module has the functionality of counting the repetitions automatically by watching videos uploaded and doing the exercise.

1) Pose Detection MediaPipe Pose is used to obtain body landmarks of humans in each frame. These landmarks provide spatial coordinates of the great joints.

2) Angle Computation Angular biomechanical is computed with respect to joint triplets.

For example:

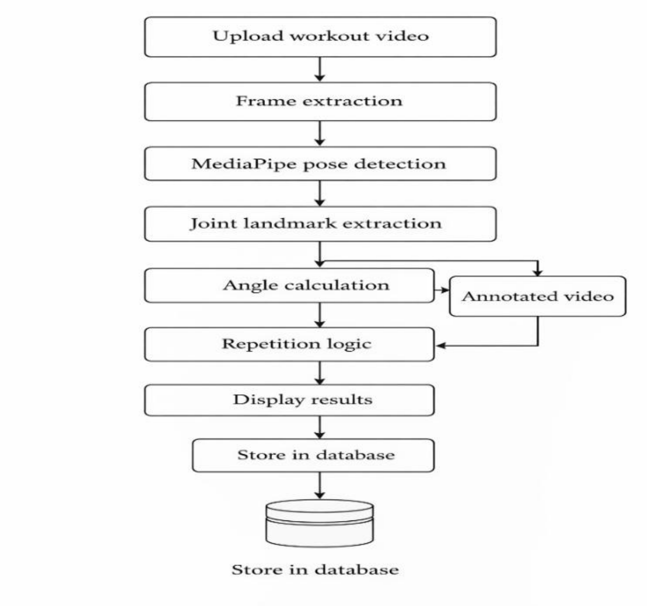
• Elbow angle → push-ups

• Knee angle → squats

3) State-Based Repetition Logic. A state machine perceives the steps of movement (e.g. up/down).A repetition is given when the movement is in sequence through. predefined boundaries. The presented plan offers resiliency. to accelerate variations and minor detecting noise. 4) Visual Landmark and counter Superimposition of landmarks and counters on the output frames is made to increase the transparency and trust by users. The last count of repetitions

and exercising information are saved in terms of analysis of progress.

**Fig : Workout Analysis Flowchart**




### E. Data Management and Integration:

A central SQLite database is communicated with all the modules. Profiles users, recording of BMI, nutrition and work out logs are stored in separate tables. This hierarchy allows accessing past data in a short time and facilitates the creation of composite progress reports. Session based authentication makes records to be linked with the right user and is still able to maintain its privacy and access control.

### F. Deployment Considerations :

The system can be executed on common hardware (i.e. laptops and smartphones). Problems which are computationally expensive in AI are done using optimized libraries and third party services of inference, with practical response times without expensive infrastructure.

### G. Methodology Contributes :

The methodology presents the combination of heterogeneous artificial intelligence capabilities vision based dietary estimation and use the pose driven movement analysis into a unified workflow. Focusing upon modularity, automation and consumer accessibility, the strategy offers good solution on the way to scalable digital fitness support.

## IV. SYSTEM ARCHITECTURE

**A. Architectural Overview:** NutriFit-AI is a user interaction, layered architecture that is built of: intelligent processing and insurmountable data management as single ecosystem. The system can be automated regarding health. energy consumption, nutrition and physical activity analysis. and not wearing any wearable sensors. The building is made up of There are four significant layers in high-level User Interface, Application. Rationality, Data storage and Artificial intelligence. The isolation of duties that it is made more sustaining and, in any case, more easy, at such degrees. scalable and makes it possible to make intelligence modules. synonymously augmented and not replaced.

**B. User Interface Layer :** It is the point where the user and the intelligent services and this is called the User Interface (UI) layer. It is made using the web technologies and displayed in a dynamically compiled server side templates. This layer provides access to the following things when they are needed: Authentication (sign up, log in, log out),

- BMI-based health assessment,
- submission of food images to be analyzed in terms of nutritional values,
- workout video upload, and
- The project is visualized on the historical development. The UI is intentionally light in order to be accessible to laptops and smart phones, but offload the computationally-heavy parts to backend services.

### C. Application Logic Layer

A server based on Flask application is used as the backbone of the application. This layer will be used as an orchestrator that will handle request routing, request validation, session management, and communication between AI modules and the database. It has the duties of:

- Input processing, calls pipelines of the inference of the ai.
- Parsing and formatting model and output of models, Enforcement of business reasoning (e.g. BMI classification), and Answers to visualization preparation.

The architecture, separator of orchestration and intelligence modules, will permit fluidity in the accommodation of. Analytics providers in the future or other AI.

### D. AI Processing Layer

The AI layer provides the intelligence of the system and it is broken down into two specialized engines.

1)Nutrition Intelligence The food images are sent to a vision language inference service which recognize visible objects and provides an organized estimate of calories and Macronutrients. It is a system in which there is regular allowing for clinical precision a approximation everyday practical monitoring.

2) Workout Intelligence Pose estimation Used to frame by frame to analyse exercise videos. Body landmarks are obtained, biomechanical angles can be calculated and a state transition mechanism of repetition count is threshold driven.

Visual overlays are made to increase readability and confidence of the user. The modular structure allows for extra exercises or high-tech analytics (e.g. posture grading) in order to be added using the lowest amount of interference.

### E. Data Storage Layer

Continuing data is all stored in the form of a relational SQLite database. All the assessments are related to the storage plan, nutrition activities, and exercises to the verified user. This design supports:

- Generation of historical trends,
- Cross-module correlation,
- Dashboard summaries, and
- Prolonged behavioral examination.

The outcomes of AI are in structure format, meaning that they are offered in predictive or the addition of recommendation engines may be added later. processing raw media.

### F. Data Flow and Integration

The working pipeline is regular of the following kind:

1. The user gives the interface inputs.
2. Flask server authenticates the request and redirect request.
3. Inference is done by using the right AI module.
4. Findings are analyzed and normalized.
5. Outputs are presented and hence allowed to be stored.
6. Progress analytics is fed on stored records.

This is a closed loop that allows continuous learning of user habits and engagement through improvement that is measured.

### G. Architectural Contribution

Offered in the architecture, heterogeneous AI capabilities vision-based calorie estimation and pose driven motion analysis can co-exist in a single deployable web-based framework. In contrast to single applications, NutriFit-AI combines an environment in which the behavior of the diet, the performance of exercise, and the background health parameters inform each other.

Design is focused on affordability, extensibility and real-world usability and makes it appropriate to be widely adopted by non-technical people.

## V. EXPERIMENTATION

### A. Objective of Evaluation

The experimental study was aimed at investigating the functional behavior of NutriFit-AI when it is used under realistic conditions. This assessment aimed at determining the ability of the system to perform BMI calculation in a consistent manner, give rough estimations of nutritional value of food pictures and the number of repetitions of exercises based on pose estimation. Instead of aiming at medical grade accuracy, it was aimed to test usability, stability, and everyday usability awareness.

### B. Experimental Setup

The experiments were implemented using some of the available consumer devices like laptops and mobile cameras. The deployment was in the form of a web system implemented in Flask and SQLite as the persistent store. Videos of the workouts and food pictures were taken in informal settings, and the light was not controlled, and neither were the backgrounds. MediaPipe was used in the estimation of the pose, landmark detection, OpenCV was used in frame processing and visualization. A vision-language model that was able to interpret visible foods was used to make nutritional inferences. This arrangement guaranteed the project scope of offering a cost effective and easy to install solution.

### C. Input Conditions

1) Health Assessment : Height and weight was entered manually by the users. These values were manipulated to calculate the BMI and give recommendation in category form.

2) Nutrition Analysis

The images of meals were of a different angle, distance, and presentation. Some of the plates had several items whereas other plates had foods in them with internal properties not seen inside.

3) Workout Analysis

The participants filmed brief videos of supported exercises:

| Exercise | Joint Analyzed | Angle Thresholds |
|---|---|---|
| Push-up | Elbow | Up: ¿160°, Down: ¡90° |
| Squat | Knee | Up: ¿160°, Down: ¡100° |
| Pull-up | Elbow | Down: ¿150°, Up: ¡80° |
| Jumping Jack | Feet & Hands | Feet apart + Hands up |

The films varied in terms of camera placement, speed of movement and the complexity of the background.

D. Evaluation Strategy

1) BMI Module One compared the calculated values with manual calculations with the help of the same formula so that mathematical correctness and classification might be applied.

| BMI Range | Status | Health Score |
|---|---|---|
| Less than 18.5 | Underweight | 60/100 |
| 18.5 to 24.9 | Fit | 85/100 |
| 25.0 to 29.9 | Overweight | 70/100 |
| 30.0 and above | Obese | 50/100 |
| Invalid inputs | Unknown | 0/100 |

2) Nutrition Module

Since the visual analysis would not allow determining the presence of other concealed ingredients or the precise amount thereof, the analysis focused on consistency but not on accuracy. Various tests with repeated captures of similar meals were made to ensure that the system gave reasonable and stable ranges.

3) Workout Module

The numbers of repetitions were automated and compared with manual observations. A performance analysis was done in terms of: Ability to detect phase transitions,

• Moderate tolerance to variation in speed,

• Behavior when the joints were partially blocked.

4) Data Logging

The progress dashboard was used to check all the outputs to ensure that they were stored, retrieved and linked to user sessions.

## VI. RESULTS AND DISCUSSION

The NutriFit-AI was tested in real-life scenarios to confirm that it could help to automate BMI measurements, nutrition awareness, and exercise tracking through normal cameras and web infrastructure. BMI module was able to give consistent outputs that were similar to manual calculation and the history of the stored data allowed the user to see gradual changes over time.

The nutrition component transformed meal images into systematized calorie and macronutrient excesses that eradicated the search by hand. Although there were differences based on the difficulty of the visual, the estimates of similar foods were similar and this was enough to identify the pattern of consumption. To monitor exercise, the pose pipeline was useful in identifying the landmarks and counting repetitions using the transitions that were performed based on angles. The performance was predictable under the condition of keeping the body in view, and visual overlays enhanced readability and accuracy of the user. The module was an effective resource to people who have to train on their own. One of the outcomes of the project was the successful centralization of all the information in one dashboard where users were able to see the diet, activity, and assessment history.

### B. Discussion

The assessment proves that it is possible to provide meaningful support of personal wellness even without any specialized hardware. The mechanization of what used to be manual processes helped to decrease the effort and also made a routine tracking to be more friendly. The inputs though rough, gain more value in the eyes of the user as time passes, enabling people to develop consciousness of patterns and improvement. NutriFit-AI is a holistic tool as opposed to. those which concentrate on such issues separately by the fact. that the nutrition, exercise, and baseline evaluation are interacting within the same ecosystem. The strategy emphasizes the method through which modular AI technologies may be incorporated into. an integrated and self-explanatory workflow.

### C. Limitations

The system operates under the realistic boundaries. BMI is merely an general health scale and fails to consider the body. physiological differences of one person. Nutritional estimations are based on visual picture representers, and therefore they are unable to be correct in intricate meals. Depending on placement of the camera, light or partial darkness, repetition. counting may be affected. The website is also committed to. monitoring and visualization in contrast to automated medical.

## VII. FUTURE WORK

Computer vision, AI services, are evidenced by NutriFit-AI. and web technologies may be married together to support an. available and convenient wellness tracking. Even though the current system automatizes the evaluation of the BMI, the There is yet estimation of nutrition, and tracking of exercise. some instructions to add to the intelligibility and customization. The future can bring the development of future. health profiling to yet another level and beyond involve other. user characteristics such as age, activity or wearable. device indicators. More would be the reason to justify such inputs. prescribing them personally and remain straightforward.

The visual ambiguity can be reduced by enhancing the nutrition module to make it less subjective. Addition could be made to the meal consistency with either portion guidance, user verification, or repetitive learning of meal patterns. Similarly, an individual diet history would be kept and this would help the system to adapt to the users habits. The training program can alter the repetition numbers to higher coaching capabilities. The potential extensions include the examination of the posture, the evaluation of the quality of movement, and the expanded range of the exercises. It would also be value added to give real-time feedback as opposed to post-processing that would improve the outreach and remedial worth.

At the system level, scalable cloud storage can provide the opportunity to implement cross-platform access and sophisticated analytics such as trend detection and goal development which can be modified. The increased cross-module reasoning would also help the user gain a better picture of the interaction of nutrition and activity. Lastly, the system could be made easier to use by adding such features as reminders, gamification, and customized milestones that would increase long-term compliance and make the platform easier to use as a beginner. To conclude, further developments of work will be directed at relocating the simple monitoring process to smarter and more personalized assistance without sacrificing cost-effectiveness and deployment simplicity.

## VIII. CONCLUSION

The paper presented NutriFit-AI, a multimodal system enhancing the access to personal fitness and nutrition monitoring with the artificial intelligence and computer vision applied. The motivation behind the work is the challenge people experience when it comes to exercising on a regular basis and keeping track of their diets without the help of a professional. Most of the available tools use manual data or do not consider dietary and activity individually, which makes them less useful in the long term.

The suggested site integrates the evaluation of the BMI, the use of food photos to determine the nutritional value, and the analysis of poses during exercise into one web application. An AI interface is arranged through a Flask server that organizes the AI services of the calorie knowledge and body recognitions, and a database which records the previous data. This integration allows its users to see the history of trends and get a more meaningful picture of how the habits change in time. Intended use was found to be reliable in an experimental application. Computation of BMI was held constant, nutritional products provided feasible estimations and counting of repetition performed successfully when the subject was in full view. The integrated dashboard was particularly useful in displaying diet and activity data side-by-side, which motivates a person to reflect on themselves.

All in all, the case of NutriFit-AI demonstrates that valuable digital wellness care is achievable by using low-cost infrastructure and widely accessible cameras. The system offers a realistic basis of achieving long-term intentions of engaging in healthy lifestyle behaviours, which is achieved by reducing the manual effort and focusing on the interpretable feedback.

REFERENCES

[1] M. Kaushik et al., Posture Correction, Real-Time Exercise Tracking and Feedback M. Kaushik et al. in Proc. 4th Int. Conf. Comput. Graph. Reality (CGR), Virtual, 2024, pp. 1–6.

[2] X. Fan et al., “Combining local appearance and holistic view: Dual-source deep neural networks in human pose estimation, in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), Boston, MA, USA, 2015, pp. 1347–1355.

[3] J. Zhu et al., “A Pose Estimation Approach in Dynamic Scene using YOLOv5, Mask R-CNN and ORB-SLAM2, in Proc. 7th IEEE Int. Conf. Signal Process. (ICSIP), Suzhou, China, 2022, pp. 456–461.

[4] G. Taware et al., “AI-based Workout Assistant and Fitness guide, in Proc. 6th Int. Conf. Comput. Commun. Ubiquitous Eng. Appl. (ICCUBEA), Pune, India, 2022, pp. 15.

[5] G. Dsouza et al, Smart gym trainer based on Human pose estimation, in Proc. IEEE Int. Conf. Innov. Technol. (INOCON), Bangalore, India, 2020, pp. 1–4.

[6] L. Jiang et al., “DeepFood: Food Image Analysis and Dietary Assessment with Deep Model, IEEE Access, vol. 8, pp. 4747747489, Mar. 2020.

[7] S. Naritomi et al., CalorieCaptorGlass: Food Calorie Estimation by Real Size using a See-Through Glass and a Kinect in Proc. IEEE Virtual Reality Workshops (VRW), Atlanta, GA, USA, 2020, p. 741- 742.

[8] P. Kumar, S. Senapati, etc. Calorie Estimation of Food and Beverages with Deep Learning, in Proc. 7th IEEE Int. Conf. Comput. Methodol. Commun. (ICCMC), Erode, India, 2023, pp. 324–329.

[9] S. Ibrahim et al., Deep Learning Framework to Detect and Track Calories in Food in 2023, in IEEE Int. Conf. Comput. (ICOCO), Langkawi, Malaysia,2023,pp.397–401.

[10] S. Jayanthi, V., 2023, 9 th Int. Conf. Smart Comput., Using Faster R-CNN and Mask R-CNN, Food Image Analysis and Calorie Prediction. Commun. (ICSCC), Kochi,India2023,pp.83–89.

[11] P. Yarde, D. Bordoloi, R. M. Chavan, V. Vekariya, H. Patil and L. Natrayan, “A Deep Learning Neural Network-based System for Food Recognition and Calorie Estimation,” Proc. 3rd Int. Conf. Innov. Ind. Appl. (ICIMIA), Bengaluru, India, 2023, pp. 1551–1558.

[12] P. Poply and J. A. Arul Jothi, “Refined image segmentation for calorie estimation of multiple-dish food items,” in Proc. 2021 Int. Conf. Comput., Commun. and Intelligent Systems (ICCCIS), Greater Noida, India, Feb. 19–20 2021, pp. 682–687.

[13] R. Ruede, V. Heusser, L. Frank, A. Roitberg, M. Haurilet and R. Stiefelhagen, “Multi-Task Learning for Calorie Prediction on a Novel Large-Scale Recipe Dataset Enriched with Nutritional Information,” in Proc. 2020 25th Int. Conf. Pattern Recognit. (ICPR), Milan, Italy, 2021,pp.1555–1562.