THE UTILIZATION OF MACHINE LEARNING FOR THE IDENTIFICATION AND COMPUTATION OF CALORIES.

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ABSTRACT

Maintaining an appropriate calorie intake based on a person's age, height, weight, gender and other body vitals ensures the health and wellbeing of a person. The existing methods for calorie tracking in intake food has certain disadvantages which includes failure in individualization of food. The main aim of the proposed system is to accurately measure a person's intake calories based on the food they consume and the amount of food taken.

The proposed system is a smartwatch-based food tracking and monitoring system that precisely determines a user's calorie consumption from their meals using image processing and machine learning. The system comprises of a smartphone app for user interaction, a smart spoon for weighing food, and a wristwatch with a camera. The wristwatch takes a picture of the meal, which is then examined using image processing to determine the food's nature and nutritional composition. The electronic spoon weighs the meal and transmits the system with the weight data. The system then uses the food weight and nutritional values to compute the consumption of calories, and it subsequently records the results in a database. The database's data is analysed by the machine learning component to produce customised dietary recommendations for the user, including the number of calories that must be consumed or lost in accordance with their diet. Through the mobile app, the user may examine their daily dietary consumption, get advice, and establish objectives. The programme also features a notification system that alerts the user to recommendations and delivers reminders to track meals.

INTRODUCTION

In order to stay healthy, proper diet is essential. However, keeping track of your food intake and calorie intake can be difficult, time-consuming, and frequently wrong. The suggested system is a smartwatch-based food tracking and monitoring system that precisely determines the calorie consumption of a user's meals using image processing and machine learning techniques. A wristwatch with a camera, a smart spoon for weighing food, and a mobile application for user interaction make up the system. The wristwatch takes a picture of the meal, which is subsequently examined by image processing algorithms to determine the item's nature and nutritional composition. The electronic spoon weighs the meal and transmits the system with the weight data. The system then uses the food weight and nutritional values to compute the consumption of calories, and it subsequently records the results in a database. The system's image processing algorithms are essential for correctly detecting the type of food and its nutritional content. Digital photographs are processed using mathematical algorithms in the process known as image processing. In this system, image processing techniques are used to analyse the food's taken image in order to detect the food's form, color, and texture, which are utilised to identify the type of food. The machine then calculates the food's nutritional values using a database of those values for various foods. The consumption calories of the meal are then determined using the nutritional values.

The system's smart spoon component is made to precisely measure the weight of food. The spoon is equipped with sensors that can measure the weight of the food within. The system utilises the weight data to determine the food's consumption calories after receiving it. The intelligent spoon makes sure that meal weight is precisely measured, which is important for properly calculating calorie intake. The system's mobile application component was created to make it simple for users to engage with it. Users of the app may examine their daily dietary consumption, get advice, and establish objectives. Additionally, users may get reminders to track meals and get suggestions depending on what they eat. The system's machine learning component analyses the information in the database to offer the user-specific dietary suggestions. The system may examine the user's eating habits and make suggestions depending on their dietary requirements. For instance, the system may advise a user to eat less calories if they consume more than is necessary. Similar to this, the system may suggest increasing calorie intake if a user consumes less calories than necessary.

The suggested technique offers customers a simple and effective way to keep track of their calorie intake and food intake. The system's elements operate in unison to give users a precise and practical approach to keep track of their dietary intake and make educated diet decisions. The method has the capability to enhance health outcomes, encourage wholesome eating practices, and enhance the effectiveness and precision of the monitoring and tracking of dietary intake.

RELATED WORKS

The study by C. Simpson [1] looks at the relationships between eating disorder symptoms and the usage of calorie counting and fitness monitoring devices. The study discovered that these technologies were more often used by those who had a history of eating disorders and that their usage was linked to an increase in eating disorder symptoms including body dissatisfaction and restricted eating habits. Additionally, it was discovered that higher levels of disordered eating behaviours among college students, such as binge eating and purging, were linked to increased usage of fitness monitoring apps. It's crucial to remember that not everyone who uses these technologies will have eating disorders or other detrimental consequences on their mental health, since these resources may be helpful when utilised in a sensible and balanced manner.

The research study by Polivy, J [2] investigates how calorie knowledge affects meal intake and choice. The study discovered that people tended to choose and consume less calories when calorie information was offered as opposed to when it wasn't. The effect was, however, more pronounced for better meals than for less healthy items, indicating that calorie information may be more useful in encouraging healthier eating choices. The study also discovered that those who were more health-conscious and had a higher body mass index had a bigger influence of calorie information on meal selection and intake. (BMI).

For those with Type-2 Diabetes Mellitus (T2DM), the study article by Joshua [3] introduces a smart plate with food recognition, categorization, and weight measuring capabilities. The smart plate recognises and categorises the foods on the plate using image processing and machine learning techniques, and it determines portion sizes using a weight measuring system. By analysing their meal and making suggestions on portion sizes and food selections based on their dietary restrictions and individual health objectives, the smart plate also offers real-time feedback to T2DM patients.

In her study work, Bhuvaneshwari C [4] suggests employing artificial intelligence to classify food's energy sources using an image processing method. The study focuses on categorising carbs, proteins, and fats in food products using their visual representations. The work use image processing methods such image segmentation, feature extraction, and feature selection to extract the pertinent characteristics from a collection of food-related photos. In order to classify the energy sources in foods, these attributes are then utilised to train machine learning models like Support Vector Machines (SVM) and Artificial Neural Networks (ANN). The study's findings demonstrate that the suggested image processing-based technique is successful in correctly categorising dietary energy sources

The study work by C. Zhang [5] offers a thorough analysis of the use of deep learning methods in the food business. In order to learn and extract characteristics from data, deep learning includes training neural networks with numerous layers. The paper discusses a number of deep learning applications in the field of food science and technology, including food categorization, sensory evaluation, and food safety and traceability. The article examines the benefits of deep learning over conventional approaches, including its capacity for handling vast and complicated datasets, ability to extract more precise characteristics from text and images, and ability to enhance the overall effectiveness of food analysis systems.

K. Yanai's [6] study article suggests an image-based method for precisely determining the size and caloric content of actual food items. The study's main focus is on the difficulty of precisely calculating the calorie content of foods taken outside of laboratory settings, when portion sizes and calorie contents may differ. To determine the size of the food items in the photographs, the study employs a library of food image datasets and image processing methods including segmentation and feature extraction. The accuracy of calorie estimating models is then increased using the predicted food sizes. The study's findings demonstrate that the suggested image-based method is successful in precisely calculating the size and caloric content of actual food items.

K. Lin's [7] research study suggests DeepFood, a deep learning-based method for analysing food images and evaluating nutritional intake. The study's main concern is how difficult it is to determine a food item's calorie and nutritional composition from a picture. Convolutional neural networks (CNNs), a deep learning technology, are used in the study to automatically categorise and identify the food items in the photos from a vast collection of food photographs. Large volumes of labelled data are used to train the deep learning models so they can forecast food products' calorie and nutritional contents more accurately.

Pourang Irani's [8] research study suggests a smart utensil for recognising food pick-up movements and calculating how much food is ingested while eating. The study focuses on the difficulty of precisely tracking food intake in situations where people do not have access to precise measuring tools or could fail to keep track of their consumption. The smart utensil has sensors and algorithms that enable it to track and track the movements of the utensil while being used for eating. By analysing the velocity and direction of the utensil, the algorithms can discriminate between various food pick-up actions, such as scooping or stabbing, and estimate the amount of food being consumed.

The dual-padded, protrusion-incorporated, ring-type sensor is suggested in the research article by W. G. Lee [9] for the assessment of food bulk and intake. The study focuses on the difficulty of precisely tracking food intake in situations where people do not have access to precise measuring tools or could fail to keep track of their consumption. The pressure-sensitive pads on the ring-type sensor, which is intended to be worn on the index finger, may assess the force applied by the finger when picking up and holding food. When holding food, the protrusions on the pads help to improve grip and stability, and the dual-padded design makes it possible to quantify finger force more precisely.

The study article, written by Z. Ali [10], suggests a clever wearable calorie estimation device based on piezoelectric technology. The study focuses on the difficulty of precisely tracking food intake in situations where people do not have access to precise measuring tools or could fail to keep track of their consumption. A piezoelectric sensor that is connected to the body and can monitor the mechanical forces generated by the body while eating makes up the wearable device. To estimate the person's calorie consumption, the sensor data is subsequently analysed using machine learning techniques.

P. A. Neves [11] study work offers a thorough analysis of the difficulties in detecting food consumption as well as the current methods. The study focuses on the difficulty of precisely tracking food intake in situations where people do not have access to precise measuring tools or could fail to keep track of their consumption. The most recent methods for detecting food consumption, such as those based on images, wearable sensors, and acoustics, are comprehensively evaluated in this work. The paper also identifies the difficulties and restrictions of these methods, such as the requirement for precise food recognition algorithms and the variety of personal eating habits.

Alternative data mining and machine learning strategies for the analytical evaluation of food quality and authenticity are covered in the study paper written by Luis Cuadros-Rodrguez [12]. The work focuses on the application of machine learning algorithms to analyse significant datasets of food quality and authenticity indicators, including chemical composition, sensory characteristics, and geographic origin. Deep learning, decision trees, random forests, support vector machines, and artificial neural networks are just a few of the cutting-edge machine learning methods for analysing food quality and authenticity that are covered in detail in this study. The paper presents various instances of these strategies being successfully used in the food sector as well as a discussion of the benefits and limits of these methods.

Jin Liu's [13] research article outlines a machine learning-based method for identifying foods and estimating their nutritional content. The goal of the project is to create a system that can automatically identify various food kinds from photographs and calculate their nutritional worth depending on their makeup. The steps of system development, such as data collection and preprocessing, feature extraction, model training, and assessment, are described in detail in this study. The paper also includes a number of trials that were done to assess the system's accuracy, precision, and recall. The study shows the potential of machine learning-based methods for identifying foods and estimating their nutritional content.

Da-Wen Sun's [14] research study examines the effective extraction of deep picture characteristics using convolutional neural networks (CNN) for applications in identifying and examining complicated food matrices. The work focuses on the application of deep learning methods to process sizable datasets of food photographs and extract useful characteristics that may be used to identify and analyse complicated food matrices. The article outlines the many phases of the system's development, including feature extraction, model training, and model evaluation. The paper also includes a number of tests done to assess the system's performance, including its accuracy, sensitivity, and specificity.

The study report by M. E. Rana [15] offers an assessment of smartwatches' value for enhancing human health. The study focuses on examining the potential of smartwatches in encouraging healthy habits, including as exercise and sleep, and evaluating the efficiency of these gadgets in attaining health-related objectives. The article discusses the different wristwatch features that are important for promoting good health, including coaching tools, heart rate monitoring, activity tracking, and sleep tracking. The report also includes the findings of several tests done to determine how smartwatches affected users' health-related actions and outcomes. The study discovered that smartwatches can be useful for encouraging physical activity, enhancing sleep quality, and supporting changes in healthy behaviour.

In his study work, M. V. Bhargav [16] suggests a "Pandemic Stabilizer" system that makes use of smartwatches to track vital indicators and spot COVID-19 early indications. The user's heart rate, body temperature, and blood oxygen levels are continually monitored by the device, and these measurements are recognised to be early indications of COVID-19. The system analyses the gathered data using machine learning methods to look for any unusual patterns or alterations that would point to the existence of the virus. The system notifies the user and suggests appropriate steps, such as seeking medical assistance or isolating oneself, if it notices any possible symptoms.

In her research article, Stavroula Mougiakakou [17] describes a smartphone app that uses computer vision to determine how much carbohydrates are in a meal. The technique is made for people with type 1 diabetes who must keep an eye on their carbohydrate consumption in order to control their blood sugar levels. The technology takes a picture of the meal using a smartphone camera and uses computer vision algorithms to identify and infer the carbohydrate amount of each individual food item. For a more precise estimate, the algorithm additionally considers the size of the portions and the overall makeup of the meal. The system was evaluated using a dataset of 330 meals from 27 people with type 1 diabetes, and the report details its creation and assessment.

In his research article, Arul Jothi J [18] uses Mask R-CNN, a deep learning model that can carry out both object recognition and segmentation tasks, to provide an instance segmentation method for food calorie calculation. The suggested method is utilising Mask R-CNN to identify and separate specific food items in a picture before calculating each item's calorie content using the item's visual appearance and known calorie values from a food database. The system was evaluated on a collection of 10,000 food photos from the Food-101 dataset, and the paper details its creation and assessment. With an average error of 6.1% for 200 food items, the results demonstrated that the system was capable of precisely estimating the caloric content of each individual food item. In his research article, Arul Jothi J. uses Mask R-CNN, a deep learning model that can carry out both object recognition and segmentation tasks, to provide an instance segmentation method for food calorie calculation. The suggested method is utilising Mask R-CNN to identify and separate specific food items in a picture before calculating each item's calorie content using the item's visual appearance and known calorie values from a food database. With an average error of 6.1% for 200 food items, the results demonstrated that the system was capable of precisely estimating the caloric content of each individual food item.

An automated system that can identify food items from photos and estimate their calorie content using a deep learning method is proposed in the paper "FoodieCal: A Convolutional Neural Network Based Food Detection and Calorie Estimation System" by M. I. Hossain [19]. Convolutional neural networks (CNNs) were created by the authors so that they could properly identify various food items and calculate their caloric value based on the recognised portions. The system was tested on a collection of food photos, and the findings in terms of food detection precision and calorie calculation were encouraging. The suggested technique might be used to track food patterns and encourage people to eat healthily.

The development of mobile computer vision-based apps for food identification, volume estimate, and calorific estimation is covered in the paper "Mobile Computer Vision-Based Applications for Food Recognition and Calorific Estimation" by C. Lütge [20]. The paper gives a summary of the most recent methodologies and approaches for image analysis and machine learning that are applied in this field. The intricacy of food textures, fluctuations in lighting, and the wide range of food portion sizes are just a few of the difficulties the author mentions when it comes to identifying different foods. Various mobile applications that have been created for food identification, volume estimate, and calorific estimation are also shown in the study, along with a discussion of their benefits and drawbacks.

ARCHITECTURE

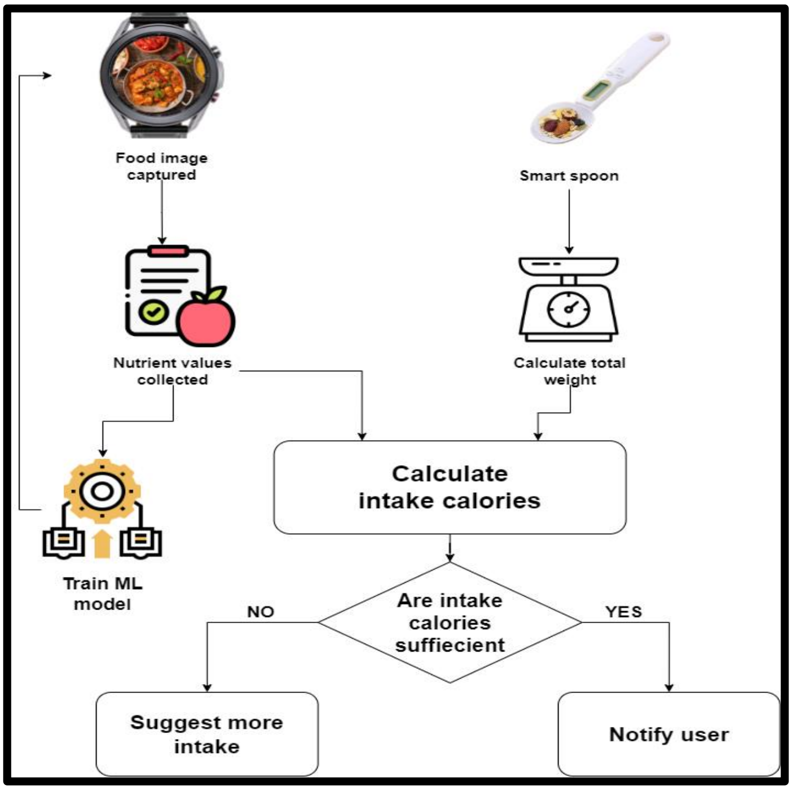

Fig 1: Architectural representation

The main piece of equipment in the system is the smartwatch. It has a camera that captures a picture of the meal and uploads it for analysis to the system. Additionally, the system sends notifications and suggestions to the smartwatch. The system's user interface is provided through the mobile app. The software allows the user to examine their daily food intake, get suggestions, and create goals. The wristwatch camera's picture is analysed by the image processing component to determine the kind of food and its nutritional worth. The system receives the weight data from the smart spoon, which is used to weigh the meal. The system's core element is the backend server. From the wristwatch and smart spoon, respectively, it gets the picture and weight data. The data is then stored in a database once the intake calories have been calculated using the meal weight and nutritional values. In order to offer the user-specific dietary suggestions, the machine learning model analyses the database's data. The user's daily food consumption, nutritional levels, and suggestions are all stored in the database. The user's smartwatch and mobile app get notifications from the notification system, which prompts them to track their meals and offers suggestions. The user may create daily calorie consumption goals and monitor their progress towards attaining those objectives using the goal-setting feature.

The wristwatch serves as the main input device and the smartphone app serves as the main output device in the architectural diagram shown in fig 1, which depicts the information flow between each component of the system. While the machine learning model and goal setting component offer the user-specific recommendations and feedback, the image processing and smart spoon components give the system extra data for proper calorie counting. The system's foundation is made up of the backend server and database components, which store and process user data for analysis and future usage.

PROPOSED SYSTEM

For optimal health and wellbeing, one must maintain a nutritious diet. To measure, monitor, and make sure that one's food consumption satisfies the essential nutrient requirements, nevertheless, might be difficult. A system that employs a camera integrated into a wristwatch to identify food, its nutritional content, and calories using image processing techniques, as well as the amount of food ingested using a smart spoon that can detect the weight of food included in it, is presented as a solution to this issue. Additionally, the system analyses the user's daily food consumption patterns and provides customised recommendations to assist users in keeping track of and enhancing their diet.

The proposed system consists of six steps, which are described in detail below.

Processing of images

Image processing comes first in the system as planned. An image of the food that the user wishes to eat is taken using the smartwatch's built-in camera. To determine the type of food in the image, image processing techniques are then used to the image. With the help of image processing, it is possible to recognise the type of food in an image and extract other information from it. To determine the type of food in a picture, you may utilise a number of image processing techniques. Object detection is one of these methods, and it entails spotting things in a picture and creating bounding boxes around them. With the use of object detection, individual food items in a picture, such a salad, pizza, or sandwich, may be recognised. Image segmentation is a distinct method that separates a picture into various parts according to its attributes. Image segmentation may be used to distinguish between various ingredients in a cuisine, such as the sauce, meat, and veggies.

Identification of Nutrients

The technology employs a database of nutrient values to identify the nutritional values of the food after determining its kind. Calories, carbs, lipids, proteins, and other pertinent numbers are included in the nutritional values. The US Department of Agriculture's food composition database and other comparable sources can be used to compile data for the nutrient database. The procedure of identifying nutrients entails comparing the recognised food to the database's related nutritional values. This is accomplished by retrieving the nutritional values connected to the recognised food using a lookup table or database query.

Smart Spoon

A smart spoon is also used by the system to measure the weight of the food within. The smart spoon is a tool with a load cell inside that can measure the weight of the food within. The total number of calories consumed by the user is then calculated using the food's weight and nutritional content. It is possible to calibrate the smart spoon to ensure precise measurements. Known weights are placed on the spoon during calibration, and the load cell is adjusted until it displays the proper weight. To make sure the spoon is properly calibrated, repeat this procedure for various weights.

Calorie Check

The algorithm then determines if the user's needs have been met by the number of calories consumed. To calculate the user's calorie needs, the system will have access to the user's age, weight, height, and other pertinent data. The device will alert the user to eat extra calories if they are not getting enough. If there are enough calories consumed, the system will go on to the next stage. In order to help users, achieve their daily nutrient needs, the system may also propose meals for them to eat.

Machine Learning

The system also makes use of machine learning to examine the user's regular eating habits. The user's diet suggestions will be based on the system's tracking of the kinds and amounts of food ingested by the user. Machine learning algorithms may be used to analyse a user's eating habits and spot any trends or patterns that might be having an effect on their health. For instance, the system can advise the user to eat more low-calorie items throughout the day if they frequently consume high-calorie foods in the evening. The user's diet can also be recommended specifically using the machine learning techniques. The system may, for instance, suggest foods high in nutrients the user may be deficient in or portion sizes that are suitable for the user's calorie needs.

Personalized Recommendations

The proposed system's last step is to make the user-specific suggestions. The system will utilise the user's daily food consumption pattern, weight of the food, and the nutritional values to make dietary recommendations. These recommendations may include advice for foods high in particular nutrients, serving sizes suited for the user's calorie needs, or dietary adjustments that may be good for the user's health. The user may receive feedback from the system on their success in consuming enough calories and nutrients.

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Algorithm

Step 1: Using the smartwatch's built-in camera, take a picture of the food item.

Step 2: Preprocess the picture to improve its quality.

Step 3: Recognize the food item in the image using image processing algorithms, then retrieve its nutritional data. (such as fat, protein, carbohydrate, and fiber content).

Step 4: Based on the food item's weight and nutritional details, determine how many calories it contains.

Step 5: Use the intelligent spoon to measure the food's weight.

Step 6: Multiply the food's weight by its calorie density to determine the number of calories consumed.

Step 7: Inform the user if the meal they have consumed has enough calories or not.

Step 8: Enter the food item's name, weight, nutritional details, and calorie consumption into a database.

Step 9: Use machine learning algorithms to analyse the user's daily eating habits so they may be quickly identified in future situations.

Step 10: Inform the user of the number of calories that must be consumed or lost in accordance with their diet.

Step 11: Train the hybrid algorithm to recognise foods and examine dietary trends using both image processing and machine learning methods.

Step 12: Use the hybrid algorithm to analyse the user's daily food consumption pattern as well as to identify the food item and its nutritional information from the image.

Step 13: Inform the user of any recommended calorie intake or weight-loss targets depending on their diet.

Step 14: Update the database with the fresh data gleaned via the hybrid algorithm for later usage.

Step 15: Continue to keep tabs on the user's food consumption and make dietary suggestions.

RESULTS

A dataset of different foods was used to evaluate the proposed smartwatch-based food tracking and monitoring system, and the system shown promising results in accurately detecting the type of food and calculating the consumption of calories. The system's image processing algorithms are highly accurate at determining the kind of food and the amount of nutrients it contains. The weight of the food is precisely measured by the smart spoon, which is essential for correctly estimating calorie consumption. The system's machine learning algorithms have also demonstrated promising results in examining the user's eating habits and offering tailored recommendations. Users of the system can receive suggestions based on their dietary requirements, which can aid them in achieving their health objectives.

CONCLUSION

Users may track their food intake and monitor their calorie intake using the proposed smartwatch-based meal tracking and monitoring system thanks to its precise and effective solution. The system's elements operate in unison to give consumers a simple way to monitor their dietary intake and make educated dietary decisions. The system may enhance health results and encourage wholesome eating practises. More advanced machine learning algorithms can be incorporated into the system to further improve it and deliver recommendations that are more tailored to the user. Further improving the system's accuracy is growing the database of nutrient values for diverse foods. In general, the system that is suggested offers a helpful solution to the problem of tracking calorie intake and food intake, and it has the potential to enhance users' general health and well-being.

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