Calories Burned Prediction Using Machine Learning

Dr. Amol Kadam
Bharati Vidyapeeth College of Engineering
Pune, India
akkadam@bvucoep.edu.in

Dr. Anurag Shrivastava
Saveetha School of Engineering, SIMATS
Chennai, India
anuragshri76@gmail.com

Prof. Sonali K. Pawar
Bharati Vidyapeeth College of Engineering
Pune, India
researchguidance64@gmail.com

Vinod H Patil
Bharati Vidyapeeth College of Engg
Pune, India
vhpatil@bvucoep.edu.in

Jacob Michaelson
SSE, Saveetha Institute of Medical and Technical Sciences
Chennai, India
Anuragshri76@gmail.com

Ashish Singh
Lloyd Institute of Management and Technology
Greater Noida, India
research.9871@gmail.com

2023 6th International Conference on Contemporary Computing and Informatics (IC3I) | 979-8-3503-0448-0/23/$31.00 ©2023 IEEE | DOI: 10.1109/IC3I59117.2023.10397623

***Abstract*—In today's world, where people are leading busy lives with changes in their lifestyle and work commitments, it has become difficult to prioritize regular physical activity to maintain good health. The lack of physical activity and unhealthy food habits can lead to various health issues, including obesity. To maintain a healthy lifestyle, it is crucial to balance diet and exercise, and knowing calorie intake and burn is essential. While tracking calorie intake is relatively easy, monitoring calorie burn is challenging due to the limited devices available. This research aims to develop a model using a Random Forest Regressor machine learning algorithm to accurately predict the number of calories burned. The model was trained on more than 15,000 data points and demonstrated a Root Mean Squared Error (RMSE) of 8.3. However, with additional data, the accuracy of the model can improve over time. The primary goal of this research is to develop an accurate and efficient model that can aid people in maintaining a healthy lifestyle by accurately predicting the number of calories burned during physical activity.**

Keywords*— *Machine Learning, Random Forest Regressor, Streamlit, Calories Burned Prediction

I. INTRODUCTION

When people hear the word "calories", they typically associate it with food and weight loss. However, calories are units of heat energy, measured as the amount of energy required to raise 1 gram of water by 1°C. While this measurement can be used to assess energy-releasing systems unrelated to the human body, in the context of the human body, it refers to the amount of energy required to perform a task. Food contains varying amounts of energy, with each item having a distinct calorie count. During exercise, the body's temperature and heart rate increase as carbohydrates are broken down into glucose and converted to energy with the help of oxygen. To predict the amount of energy burned during exercise, various parameters such as duration, average heart rate, temperature, height, weight, and gender can be considered. The prediction can be made using a machine learning Random Forest algorithm fed with data such as exercise time, temperature, height, weight, and age. As per the Indian Council of Medical Research (ICMR) survey conducted in 2018, around 135 million individuals in India are obese, and this number is expected to increase to 175 million by 2025. The study also found that over 20% of the rural population and nearly 30% of the urban population in India are overweight. Additionally, 2019 research published in Lancet Diabetes and Endocrinology revealed that the occurrence of obesity in India has tripled among men and doubled among women in the previous decade. These statistics indicate that a significant number of people in India are concerned about managing their weight. As a result, our project's calories burned prediction feature will fulfil the growing need for tools and resources that can assist individuals in maintaining their weight.

II. MOTIVATION OF RESEARCH WORK

Food has been essential to human life since ancient times and has always held a significant place of interest. Each consumes food with varying nutritional values and calorie counts, which can be high or low. It is therefore essential to encourage people to exercise adequately to maintain a healthy lifestyle. To achieve this, a calorie detection system is necessary that can provide information on the calories burned during exercise and estimate the calories based on parameters such as heart rate, body temperature, age, duration of exercise, and gender of the user. Calorie burnt estimation can give people useful information about their exercise habits and assist them in making health-related decisions. Knowing the approximate number of calories burnt during an exercise session allows people to modify their exercise routine and nutrition to maintain a healthy weight and enhance their general health. Those who want to reduce weight can use this information to their advantage by modifying their caloric intake and exercise regimen accordingly. Additionally, being aware of the calories burned during exercise encourages people to keep up their exercise regimens because they can see the obvious benefits of their efforts. Overall, the ability to anticipate calorie burn properly might give people the information and inspiration they need to keep up healthy routines and live a healthy life.

III. LITERATURE SURVEY

[1] The research article aimed to enhance the accuracy of calorie-burn prediction by incorporating a regression model as one of the machine learning algorithms. The data

979-8-3503-0448-0/22/$31.00 ©2023 IEEE

underwent the requisite preparation, cleaning, and analysis before being used in the regression models. K-fold validation was performed to train and test the models and identify the most suitable one for the study. The performance and predictive accuracy of the regression models were assessed based on the results of model testing after ten iterations. The mean accuracy was computed, indicating that the Random Forest regression model had the best performance in the study, with an accuracy of 95.77%.

[2] The objective of this research study is to construct a system that can guide people to adjust their food choices and offer instructions for maintaining their bodies effectively. If the system provides users with the nutritional information of a food item and categorizes it as healthy or unhealthy, users can calculate the calorie intake of their daily food items. This suggested system assists users in managing their eating habits and provides information on how to burn calories during their daily routines, which promotes their overall health. The Convolutional Neural Network model is implemented to classify food items from the input image, and the proposed system offers the accuracy of the classification.

[3] In this research paper, the Exercise dataset from the UCI Machine Learning repository was used to predict the number of calories burned during a workout. Four methods were employed to predict the rate of burnt calories: pre-processing the dataset with feature scaling and addressing missing values, conducting exploratory feature analysis and visualizing the target variable, fitting the raw dataset to various regressors and analyzing the performance before and after scaling, and applying feature selection principles such as Anova test, Correlated Feature, Variance-Based, and KBest Feature methods and fitting the data to different regressors while analyzing the performance before and after scaling. Python was used to execute the study under the Spyder platform with Anaconda Navigator.

[4] This research paper explores the application of various machine learning techniques for accurately predicting the number of calories burned during different physical activities. The study compares and analyzes the performance of multiple algorithms, such as decision trees, support vector machines, and artificial neural networks, to identify the most effective approach for predicting calorie expenditure. The results of the research provide valuable insights into developing accurate and reliable calorie burn prediction models.

[5] This research paper investigates and compares the performance of different regression models in predicting calorie expenditure during daily activities. The study evaluates the effectiveness of linear regression, polynomial regression, and ridge regression techniques, among others. The research aims to identify the most suitable regression model that can accurately estimate calorie burn based on various factors such as heart rate, activity duration, and body mass index. The findings contribute to improving the accuracy of calorie burn prediction models for personalized fitness tracking.

[6] This research paper focuses on leveraging wearable sensor data and deep learning models to predict calories burned during physical activities. The study explores the use of convolutional neural networks (CNNs) and recurrent neural networks (RNNs) to extract meaningful features from sensor data, such as accelerometers and heart rate measurements. By training and evaluating these models on a large dataset, the research aims to provide an accurate and reliable method for estimating calorie expenditure in real-time, enabling personalized fitness monitoring and guidance.

[7] This research paper presents a novel approach to predict calorie expenditure specifically for indoor cycling activities. The study combines machine learning techniques with sensor fusion, incorporating data from multiple sensors such as heart rate monitors, power meters, and motion sensors. By integrating and analyzing these sensor inputs using machine learning algorithms, the research aims to develop a robust model for accurately estimating calorie burn during indoor cycling sessions. The findings have practical implications for optimizing indoor cycling workouts and enhancing fitness tracking accuracy.

[8] Software programs can improve their forecast accuracy without explicit coding thanks to machine learning, an algorithmic approach. It works on the premise that models are built, and algorithms are used to statistically analyze input data. These models can be tailored to different domains and trained to fit with management's goals by regularly updating outputs with fresh data, enabling precise decision-making to meet organizational goals. [9-11] This research paper's objective is to create a Python-based machine learning project to foretell calorie expenditure. The project uses the Xgboost Regression model to achieve this.

A. Machine Learning

The machine learning lesson explains both fundamental and sophisticated machine learning principles. Our machine-learning tutorial is useful for both students and working professionals.

Currently, it is used for many different things, including recommender systems, email filtering, [12-14] Facebook auto-tagging, image recognition, and speech recognition. You may learn about machine learning and a variety of machine learning approaches, including supervised, unsupervised, and reinforcement learning, in this video. Regression and classification models, clustering techniques, hidden Markov models, and other [15]sequential models are among the topics you will study.

B. Existing System

There are several calorie management applications available, each with its downsides. Here are a few examples of current system applications.

1. ***MyFitnessPal****:* MyFitnessPal is a popular fitness app that allows users to track their calorie intake and exercise routines. [16-17] One of the benefits

of the app is its widespread use and extensive database of exercises and corresponding calorie burn estimates. Users can log their workouts and receive an estimated calorie burn based on factors like exercise duration and intensity. Additionally, the app[18] can connect with fitness tracking devices like Fitbit to automatically monitor exercise and calorie burn. The MyFitnessPal app is widely used, but its calorie burn estimates may not be accurate for every individual and do not consider individual differences in metabolism and other factors.

2. ***Noom****:* The app provides personalized calorie burn estimates based on factors such as age, weight, and fitness level. It allows users to track their exercise and calorie burn through an easy-to-use interface. The app encourages users to set exercise goals and provides motivation and support to help them achieve their goals. The calorie burns estimates provided by the app may not be completely accurate for every individual, as they are based on general formulas and assumptions. [19-21]Some users may find the app's coaching and feedback to be too intensive or overwhelming. The app requires a subscription fee for full access to its features.

3. ***HealthifyMe****:* HealthifyMe has a feature to predict calorie burn during exercise, which is based on factors such as intensity and duration. Additionally, the app offers personalized workout plans for different parts of the body, making it easy to track both calorie intake and workouts. HealthifyMe also offers an Immunity Boosting Plan, which helps users to eat the right food and track daily [22-24] activities to improve their immune system. However, similar to other apps, the calorie burns estimates provided by HealthifyMe may not be accurate for all individuals, as they are based on general formulas and assumptions.

VI. System Design

The following paper introduces an application designed to accurately predict the number of calories burned during exercise. The system considers the user's weight, duration, heart rate, body temperature, gender, age, and height for analysis. It also provides motivational insights into the user's calorie burn with that of similar individuals and offers tips for burning more calories. The system involves a supervised learning algorithm, [25-26]specifically the Random Forest algorithm, for calorie prediction, and the development of the application using Streamlit. With the conclusion to our experiment, we selected the following combinations of methodologies for our model.

A. Streamlit

Streamlit is a widely used open-source framework that is specifically designed for building data science applications. The main advantage of Streamlit is that it simplifies the process of creating and deploying interactive web applications with minimal coding. This makes it easy for data scientists and developers to create custom applications that allow users to explore and interact with data in real-time.

One of the most important features of Streamlit is its user-friendly interface. It is based on Python and provides a clean and intuitive interface that allows developers to create and share applications quickly and easily. Streamlit handles many of the tasks required for building web applications automatically, such as managing state and user input, rendering HTML and CSS, and updating visualizations in real-time.

Streamlit supports a wide range of data science tools and libraries, including NumPy, Pandas, matplotlib, and Plotly. This enables developers to create custom data visualizations and easily integrate them into their applications. Streamlit's real-time updates and data stream capabilities are also noteworthy. Developers can build applications that update in real-time as new data becomes available, making it an ideal platform for building applications that monitor and analyze live data feeds. You can install Streamlit into your system using the pip install Streamlit from your Command Prompt.

B. Scikit-learn

Scikit-learn, also known as sklearn, is a widely used open-source machine-learning library in Python. It offers a comprehensive set of tools for various machine-learning tasks, including classification, [27] regression, clustering, dimensionality reduction, and model selection. In the project for predicting calories burned during exercise, sci-kit-learn plays a crucial role in multiple aspects.

It provides powerful data preprocessing techniques such as the Standard Scaler class for normalization or standardization of numerical features like age, BMI, and heart rate. It also offers the Label Encoder or One Hot Encoder classes for encoding categorical features [28] like gender. These preprocessing techniques ensure that the input data is in the appropriate format for training the Random Forest Regressor model. Scikit-learn encompasses model selection functionalities. The train_test_split function facilitates splitting the dataset into training and testing sets, enabling robust model evaluation. Additionally, the library offers the GridSearchCV and Randomized [29] SearchCV classes for hyperparameter tuning. These tools allow an exhaustive or random search through predefined hyperparameter values, aiding in identifying the best model configuration for optimal calorie burn predictions.

Furthermore, sci-kit-learn includes the Random Forest Regressor class, which implements the Random Forest Regressor algorithm used in the project. This class provides a range of parameters to control the behavior of the random forest model, such as the number of trees and maximum depth. The implementation of Random Forest Regressor in sci-kit-learn is highly efficient, scalable, and well-optimized, making it suitable for accurate predictions of calorie burn based on the given parameters.

Scikit-learn also offers essential evaluation metrics for assessing model performance. Metrics like mean squared error (mean_squared_error) and R-squared score (r2_score) can be computed using sci-kit-learn's functions, enabling the measurement of accuracy and reliability in predicting calorie burn. By evaluating the model's performance, potential improvements or adjustments can be identified.

Lastly, sci-kit-learn seamlessly integrates with the Streamlit web app framework utilized in the project. The trained RandomForestRegressor model can be easily loaded into the web app, allowing the generation of predictions based on user inputs. By leveraging sci-kit-learn's functions [30] and methods within the web app, data preprocessing, predictions, and model evaluation can be performed efficiently, enhancing the user-friendly and interactive experience.

V. PROPOSED METHODOLOGY

The initial project execution utilized a dataset of 15,000 individuals, wherein only the necessary features, including BMI, Age, Gender, Heart Rate, Body Temperature, and Duration, were extracted. The following steps form our proposed methodology for calorie burn prediction:

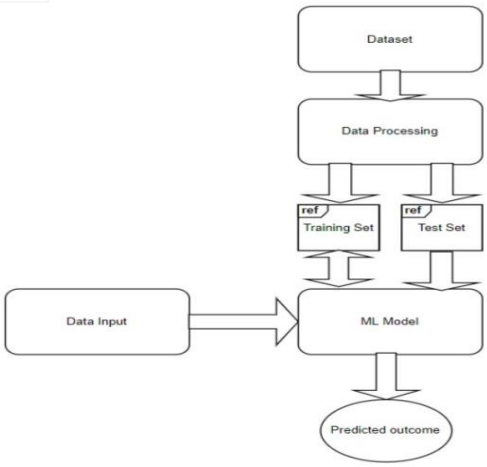

Figure 1. Proposed Methodology

User Input: The user will provide requested information, including height, weight, age, gender, exercise duration, heart rate, and body temperature.

Burned Calories Prediction: The proposed model uses the Random Forest Regressor algorithm, which utilizes the bagging technique and has three hyperparameters - n_estimators, max_features, and max_depth. The model evaluation results show that it has an MAE of 5.33, MSE of 68.92, and RMSE of 8.3. The lower RMSE value of the Random Forest Regressor model in comparison to the Linear Regression model indicates the model's ability to make more precise predictions.

Prediction display: The final output of the project displays the prediction of calories burned during exercise based on user input, along with data about people who have comparable calorie expenditures and general information to encourage individuals to exercise regularly and feel accomplished.

The proposed approach is an efficient, accurate, and scalable method for predicting calories burned during exercise. Random Forest Regressor outperforms other algorithms, such as linear regressor, in producing more precise and accurate results. Additionally, using Streamlit enables the creation of high-quality and dependable web applications.

A. Implementation

1. ***Dataset Collection**:* Initially, the dataset is gathered and inspected for missing or duplicated values, as well as the distribution of the data.

2. ***Data Preprocessing**:* The dataset undergoes column-wise exploratory data analysis and preprocessing for optimal model output. Pearson correlation coefficient is calculated to measure linear relationships between variables. Learning curves are plotted to evaluate performance and identify areas for improvement.

3. ***Model Selection**:* The next step is to select the most suitable algorithm for our model. Random Forest Regressor is a powerful ensemble algorithm that can handle non-linear relationships between variables and can produce highly accurate predictions, making it an excellent choice for our model.

4. ***Model Training**:* The preprocessed dataset is used to train the model, and GridSearchCV, a cross-validation method, is applied to select hyperparameters. The three hyperparameters used are n_estimators, max_features, and max_depth. The GridSearchCV is performed on five splits, and the split with the highest accuracy is chosen.

5. ***Evaluation**:* To evaluate the model's performance, we use evaluation metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), and Root Mean Squared Error (RMSE). Comparing the results of the RandomForestRegressor with those of the Linear Regression, it is observed that the RMSE value for the RandomForestRegressor is lower than that of Linear Regression. This implies that we can make more accurate predictions using the RandomForestRegressor.

6. ***Prediction output**:* The final step is to display the prediction output and related information, such as similar individuals' data and general exercise information, on the Streamlit web application

VI. FUTURE WORK

Finally, areas for future work can be identified as one area to focus on is expanding the range of features that the

model considers improving the accuracy of the predictions. For example, including data on the user's diet, sleep, stress levels, and other lifestyle factors that may affect their calorie burn rate could provide a more comprehensive understanding of the user's fitness profile. Additionally, incorporating user feedback and incorporating additional metrics for evaluation could help to further refine the model's predictions. It could also be beneficial to explore ways to integrate social features, such as user communities and challenges, to encourage engagement and motivation.

VII. RESULTS

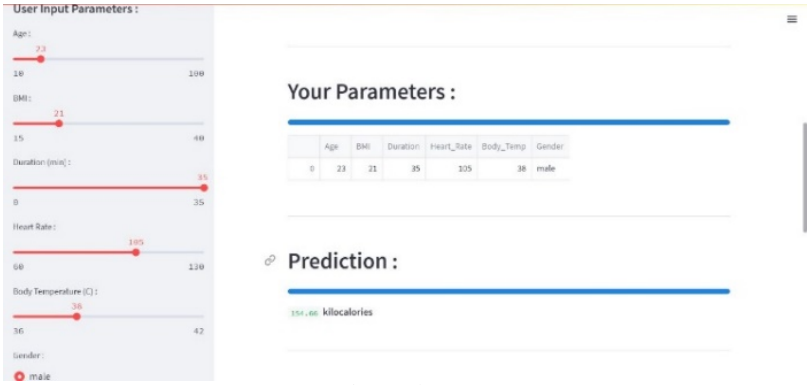

Figure 2. The user input parameters

The user input parameters necessary for the model to anticipate how many calories it will burn are shown in the accompanying image. Additionally, it shows the information entered by the user and the predicted number of calories burned that corresponds

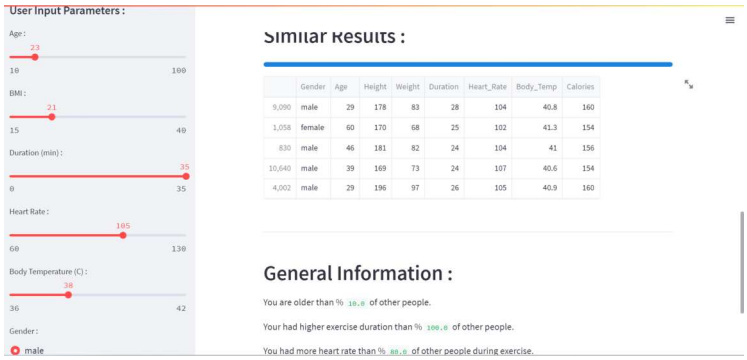

Figure 3. Comparable outcomes and general information

The image presented provides comparable outcomes and general information to encourage individuals and create a sense of achievement.

VIII. CONCLUSION

In conclusion, the project successfully developed a web application leveraging Streamlit and the Random Forest Regressor algorithm for predicting calories burned during exercise. By incorporating parameters such as gender, age, BMI, body temperature, duration of exercise, and heart rate, the system aimed to provide accurate predictions of calorie expenditure.

Throughout the project, various methodologies and techniques were utilized to ensure the effectiveness and reliability of the calorie burn predictions. The scikit-learn library played a crucial role in the implementation of machine learning algorithms, offering a wide range of tools for data preprocessing, model selection, and evaluation. Its ease of use and extensive documentation made it valuable in building predictive models.

The web application design encompassed multiple stages, including data preprocessing, model training, and evaluation. The collected data was carefully prepared, cleaned, and analyzed to ensure its quality and suitability for the regression models. RMSE and MSE validation was performed to assess the performance and predictive accuracy of the models, allowing for the selection of the most suitable algorithm for the task.

The successful implementation of the Random Forest Regressor algorithm demonstrated the capability of machine learning in accurately predicting calorie burn. By considering multiple factors such as gender, age, BMI, body temperature, duration of exercise, and heart rate, the system provided users with personalized estimates of their calorie expenditure, enabling them to make informed decisions about their exercise routines and overall health.

However, it is important to note that individual variations in metabolism and other factors may still contribute to discrepancies between predicted and actual

calorie burn. Further research and refinement of the models could address these individual differences and enhance the accuracy of the predictions.

Overall, the project showcased the potential of machine learning techniques in the domain of calorie burn prediction and provided a foundation for the development of a web application that can assist individuals in optimizing their fitness routines and achieving their health goals. With continuous improvement and feedback, this application could serve as a valuable tool in promoting healthier lifestyles and supporting individuals in their fitness journeys.

REFERENCES

[1] Burned Calories Prediction using Supervised Machine Learning: Regression Algorithm: IEEE DOI: 10.1109/ICPC2T53885.2022.9776710 https://ieeexplore.ieee.org/document/9776710

[2] Prediction of User's Calorie Routine using Convolutional Neural Network. IJEAST, 2020 Vol. 5, Issue 3, ISSN No. 2455-2143

[3] Feature Selection Intent Machine Learning based Conjecturing-Workout Burnt Calories. Turkish Journal of Computer and Mathematics Education Vol.12 No.9 (2021), 1729 – 1742

[4] W. Wu and Yang J. (2009), Fast food recognition from videos, ICME 2009. IEEE International Conference on. IEEE, (pp.1210–1213)

[5] Pouladzadeh P., Shirmohammadi S., Bakirov A., Bulut, and Yassine .Cloud-based SVM for food categorization, 74(14), 5243–5260, DOI 10.1007/s11042-014-2116-x

[6] Ankita Podutwar A., Pragati Pawar D., Abhijeet Shinde V., (2017), A Food Recognition System for Calorie Measurement, International Journal of Advanced Research in Computer and Communication Engineering, Vol. 6, Issue 1, January 2017 DOI 10.17148/IJARCCE.2017.6146

[7] Zhang W., Zhao D., Gong W., Li Z., Lu Q., & Yang S. (2015), Food Image Recognition with CNN. 2015 IEEE (UIC-ATC-ScalCom), DOI 10.1109/UIC-ATC-ScalCom-CBDCom-IoP.2015.139

[8] Muthukrishnan Ramprasath, Vijay M., and Shanmugasundaram Hariharan "Image Classification using Convolutional Neural Networks" in the International Journal of Pure and Applied Mathematics in 2018, Volume 119, No. 17 (pp. 1307-1319).

[9] Deepika Jaswal, Sowmya. V, Soman K.P. (2014), "Image Classification Using Convolutional Neural Networks", International Journal of Advancements in Research and Technology, Volume 3, Issue 6, June-2014, Pages 1661-1668.

[10] Shweta Suryawanshi, Vaishali Jogdande, Ankita Mane (2020), "Animal Classification Using Deep Learning", International Journal of Engineering Applied Sciences and Technology, Vol. 4, Issue 11, ISSN No. 2455-2143, Pages 305-307.

[11] C. Gopalan, B.V. Rama Sastri, and S. C. balasubramaniyam, "Nutritive-Value of Indian Foods" in T. Longvah, R. Ananthan, K. Bhaskarachary, and K. Venkaiah, "Indian Food Composition Tables" and "Dietary Guidelines for Indians" – A Manual, National Institute of Nutrition, Hyderabad, 2010.

[12] National Food Security Mission, "Operational Guidelines", Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, 2007.Balke B, Ware R..US Armed Forces Med J. 1959;10(6):675–88. [PubMed] [Google Scholar]

[13] Blundell JE, King Na. (2000) "Exercise, Appetite Control, & Energy." Nutrition. 16(7–8):519–22. [PubMed] [Google Scholar]

[14] Elbel b, Mijanovich t. Dixon B, et al. Calorie labeling, buying fast food, and going to restaurants. Obesity. 2013;21(11):2172–9. [PMC free article] [PubMed] [Google Scholar]

[15] Hall c, Fernhall, Kanaley ja. "Energy Expenditure of Running/walking" comparison with PE (prediction equation). Med Sci Sports Exerc. 2004;36(12):2128–34. [PubMed] [Google Scholar]

[16] Hill JO, Wyatt HR, Peters JC. Energy balance and obesity. Circulation. 2012;126(1):126–32. [PMC free article] [PubMed] [Google Scholar]

[17] Pontzer H. Burn: How We Burn Calories, Lose Weight, and Maintain Health is Blown Away by New Research, New York: Avery Publishing Group; 2015.Trevon D. Logan NBER,

[18] Ingmar, "Forecasting Workout Burnt Calories Using Machine Learning," in Qatar Computing Research Institute, January 2016

[19] R.N. Dickerson, J. J. Patel, and c. j. McClain, "Protein Needs in Obese Populations. in Nutr Clin Pract. vol. 32, no. 1, 2017. doi 10.1177/0884533617691745.

[20] RajSp, Alen and Fister, and Iztok, "A Systematic Review of the Literature on Intelligent Data Analysis Techniques for Smart Sports Training," in Applied Sciences, vol 10, no. 9, 2020, https://www.mdpi.com/2076-3417/10/9/3013

[21] P. Pouladzadeh, S. Shirmohammadi "Calorie information from image of food," in IEEE, vol. 63, no. 8, pp. 1947-1956, Aug. 2014, doi: 10.1109/TIM.2014.2303533

[22] Dr. Vinod H Patil, Dr. Anurag Shrivastava, Devvret Verma, Dr. A L N Rao, Prateek Chaturvedi, Shaik Vaseem Akram, "Smart Agricultural System Based on Machine Learning and IoT Algorithm", 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), 2022. DOI: DOI: 10.1109/ICTACS56270.2022.9988530

[23] Dr. Vinod H Patil, Dr. Pramod A Jadhav, Dr. C. Vinotha, Dr. Sushil Kumar Gupta, Bijesh Dhyani, Rohit Kumar," Asset Class Market Investment Portfolio Analysis and Tracking", 5th International Conference on Contemporary Computing and Informatics (IC3I), December 2022. DOI: 10.1109/IC3I56241.2022.10072525

[24] Vinod H Patil, Prasad Kadam, Sudhir Bussa, Narendra Singh Bohra, Dr. ALN Rao, Professor, Kamepalli Dharani," Wireless Communication in Smart Grid using LoRa Technology", 5th International Conference on Contemporary Computing and Informatics (IC3I), December 2022, DOI: 10.1109/IC3I56241.2022.10073338

[25] Vinod H. Patil, Dr Shruti Oza, Vishal Sharma, Asritha Siripurapu, Tejaswini Patil, "A Testbed Design of Spectrum Management in Cognitive Radio Network using NI USRP and LabVIEW", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-2S8, August 2019.

[26] Vinod H. Patil, Shruti Oza, "Green Communication for Power Distribution Smart Grid", International Journal of Recent Technology and Engineering™ (IJRTE), ISSN:2277-3878(Online), Reg. No.: C/819981, Volume-8, Issue-1, Page No. 1035-1039, May-19

[27] Lakshmi P., Deepak, A., Muthuvel, S.K., Amarnatha Sarma, C Design and Analysis of Stepped Impedance Feed Elliptical Patch Antenna Smart Innovation, Systems and Technologies, 2023, 334, pp. 63

[28] Gupta, A., Mazumdar, B.D., Mishra, M., ...Srivastava, S., Deepak, A., Role of cloud computing in management and education, *Materials Today: Proceedings*, 2023, 80, pp. 3726–3729

[29] P. William, G. R. Lanke, D. Bordoloi, A. Shrivastava, A. P. Srivastavaa and S. V. Deshmukh, "Assessment of Human Activity Recognition based on Impact of Feature Extraction Prediction Accuracy," 2023 4th International Conference on Intelligent Engineering and Management (ICIEM), London, United Kingdom, 2023, pp. 1-6, doi: 10.1109/ICIEM59379.2023.10166247.

[30] P. William, G. R. Lanke, V. N. R. Inukollu, P. Singh, A. Shrivastava and R. Kumar, "Framework for Design and Implementation of Chat Support System using Natural Language Processing," 2023 4th International Conference on Intelligent Engineering and Management (ICIEM), London, United Kingdom, 2023, pp. 1-7, doi: 10.1109/ICIEM59379.2023.10166939.