IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 10, 2022

An AI and IoT-Based Model for the Detection of Food Nutritional Value

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Abstract:

The growing issue of dietary-related health issues has led to the need for accurate methods to assess food's nutritional content. This research paper presents a model that integrates Artificial Intelligence (AI) and Internet of Things (IoT) technologies to detect and evaluate food nutritional value. The AI component uses deep learning techniques, particularly Convolutional Neural Networks (CNNs), to process images of food items, enabling users to quickly assess their nutritional content. The IoT aspect involves a network of sensors throughout the food supply chain, monitoring key parameters like temperature, humidity, and storage conditions. The collected data is then integrated with AI-generated nutritional analyses, considering environmental factors that may impact food quality. Experiments on a diverse food dataset demonstrated high accuracy in nutritional value prediction, with real-time monitoring through IoT sensors. The system's scalability and adaptability make it suitable for various applications, from individual dietary monitoring to large-scale food production and distribution networks.

Keywords: Artificial Intelligence (AI), Food Nutritional Value, Image Processing, and Internet of Things (IoT)

1. Introduction:

1.1 Background & Motivation:

The increasing prevalence of health issues linked to dietary patterns, particularly in urbanized societies, necessitates accurate and efficient food nutritional assessment. Traditional methods are time-consuming, expensive, and prone to errors. A new research introduces a model integrating Artificial Intelligence (AI) and Internet of Things (IoT) technologies to improve food nutritional value detection.

1.2 Problem Statement:

Obesity, diabetes, and cardiovascular illnesses are among the health problems linked to diet that have increased as a result of sedentary lifestyles and the consumption of processed foods. Conventional nutritional analysis techniques, like labor-intensive laboratory testing and

ISSN PRINT 2319 1775 Online 2320 7876
Journal Volume 11, Iss 10, 2022

manual label reading, are resource-intensive and ineffective. This work suggests a paradigm for determining food nutritional value that is based on artificial intelligence (AI) and the Internet of Things (IoT). The model seeks to overcome the drawbacks of conventional techniques, including their inefficiency, poor food categorization accuracy, absence of real-time supply chain monitoring, and obstacles to making educated dietary decisions. The suggested AI and IoT-based strategy seeks to improve the efficiency of the food sector in providing safe and nutritious products, empower people to make educated dietary choices, and contribute to a healthier society.

1.3 Objectives of the Study:

This study aims to develop an AI-based image recognition system for food items, integrating Convolutional Neural Networks (CNN) and IoT sensors into the food supply chain. The model will combine AI-generated nutritional analyses with real-time environmental data for holistic food assessment. The system will be tested using diverse food datasets to assess its accuracy and effectiveness. The system will also be evaluated for scalability and adaptability to different food types and environmental conditions. The system will be designed for user-friendliness and accessibility. The goal is to advance smart systems in nutrition, promote informed dietary decisions, optimize food production processes, and foster a healthier society. The ultimate goal is to improve food safety standards and overall quality.

1.4 Significance of Association Rule Mining in Education Research:

The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) in food categorization enhances nutritional assessments, overcoming traditional limitations. The IoT component allows real-time monitoring of environmental factors, enabling holistic assessments. This approach captures food quality's dynamic nature, offering time and cost efficiency. The model is scalable, adaptable, and user-friendly, supporting informed dietary decisions. Data-driven insights improve food industry efficiency and product quality. The integration of AI and IoT contributes to public health concerns, advances nutrition smart systems, and supports sustainability and quality assurance. The research aims to revolutionize food nutritional detection.

2. Literature Review:

AI techniques since the 1990s have been used to study food composition, nutrient production, and vitamin production, identifying target genes and developing nutrient food for infants and dairy products. The AI uses Convolutional Neural Networks to identify food categories, while IoT devices monitor temperature, humidity, and storage conditions. The model's potential transformative impact is significant, empowering individuals to make informed dietary choices and enhancing quality control in the food industry. This research contributes to the advancement of smart systems in nutrition, promoting healthier lifestyles and improved public health outcomes. A portable system using MQ5gas sensors can delay aging population diseases by detecting alcohol and alliinase enzyme activity, extending the storage period of dried onion slices. Researchers are developing new methods to maintain food quality and shelf life by tracking spoilage. A prototype uses a Convolutional Neural Network model to detect fruit and vegetable types, monitor gas emission levels, humidity, and temperature, and alert customers about spoilage levels. The system has an accuracy rate of 95% and has successfully increased some food categories' shelf life by 2 days. Mavani N.'s (2022) paper highlights the growing significance of artificial intelligence (AI) in the food industry, highlighting its applications in food quality determination, control tools, classification, and prediction.

3. Methodology:

The research focuses on the integration of Artificial Intelligence (AI) and Internet of Things (IoT) technologies for detecting food nutritional value. The methodology section details the process of data collection, including training data from diverse food images and IoT sensor data. The AI model is developed using a Convolutional Neural Network (CNN) architecture, which is pre-processed and trained using the labeled dataset. IoT sensors are deployed at various stages of the food supply chain, ensuring strategic placement to capture diverse environmental conditions relevant to food quality. A reliable communication network is established for real-time data transmission from IoT sensors to a centralized system, with secure and efficient protocols for data transfer.

A centralized system is developed that integrates data from the AI model and IoT sensors, facilitating seamless integration. A holistic nutritional assessment is provided by combining AI-generated nutritional analyses with real-time environmental data. Algorithms considering

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visual characteristics and contextual factors influencing food quality are implemented. Experimental validation is conducted using a diverse dataset of food items to validate the accuracy of the AI model in predicting nutritional values. Real-time monitoring evaluation is evaluated by comparing collected data with expected environmental conditions. Scalability and adaptability testing is conducted by varying the dataset size and evaluating its performance. A user interface is designed to be intuitive and accessible, prioritizing simplicity and accessibility. Ethical considerations include obtaining informed consent from participants involved in data collection and implementing robust measures to ensure data privacy and confidentiality. The research concludes with a comprehensive summary of findings, including the accuracy of the AI model, the effectiveness of real-time monitoring, and system scalability.

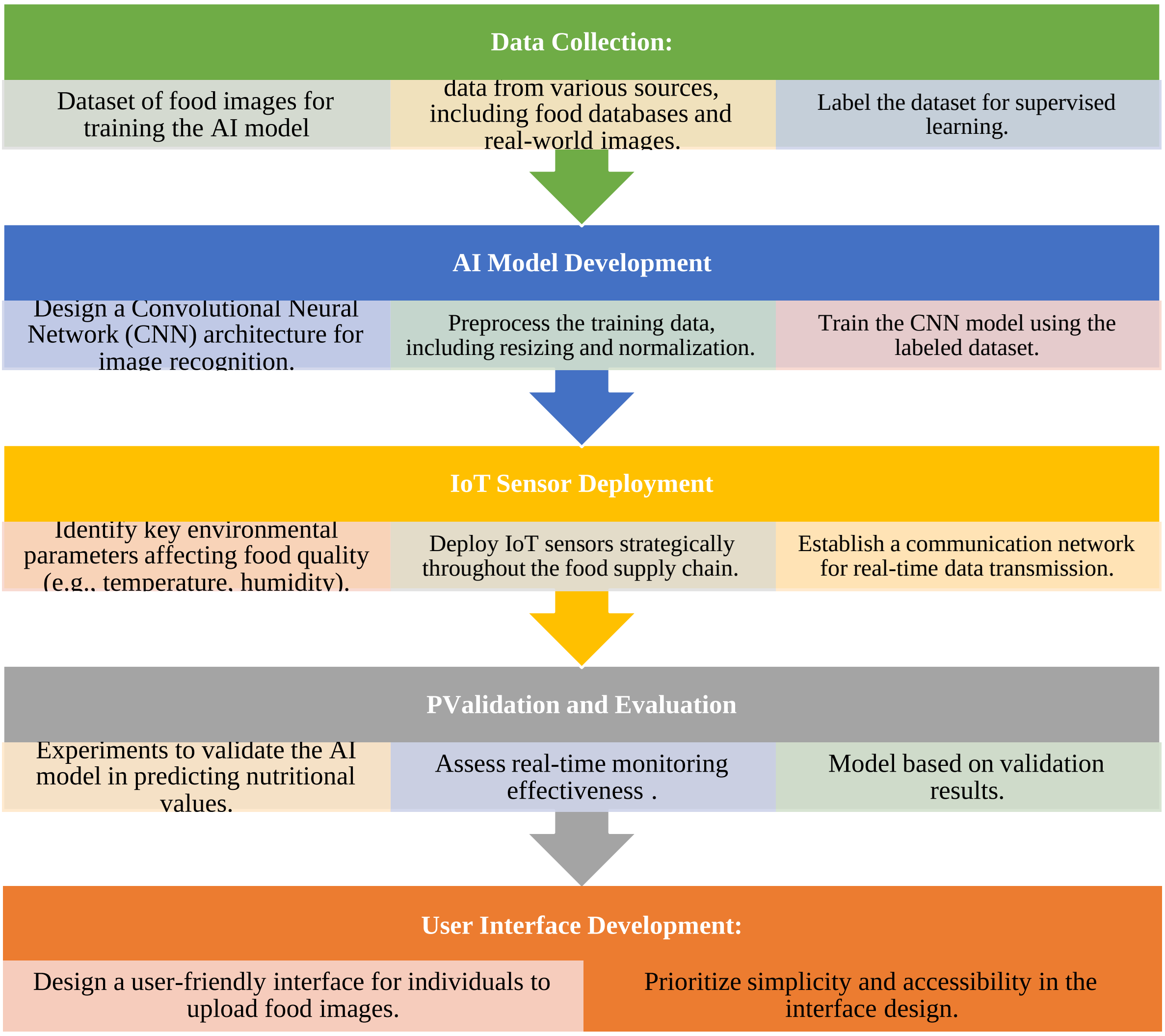

Figure 1: Research Methodology AI and IoT-Based Model for Nutritional Value

This study uses a systematic approach to develop and validate an AI and IoT-based model for detecting food nutritional value. Data is collected from various sources, including food databases and real-world images, and labeled for supervised learning. The AI model is designed and trained using a Convolutional Neural Network (CNN), with preprocessing and normalization to optimize performance. IoT sensors are deployed throughout the food supply chain to monitor key environmental parameters affecting food quality. A robust communication network is established for real-time data transmission. The validation and evaluation phase involves experiments to validate the model's accuracy and assess its effectiveness through IoT sensors. The model undergoes refinement based on these evaluations, ensuring continuous improvement. The user interface is designed for simplicity and accessibility, catering to users with varying technical expertise. An iterative refinement process is implemented to enhance system performance. The comprehensive research methodology aims to create a robust and efficient AI and IoT-based model that aligns with research objectives.

Image and Environment Data Upload:

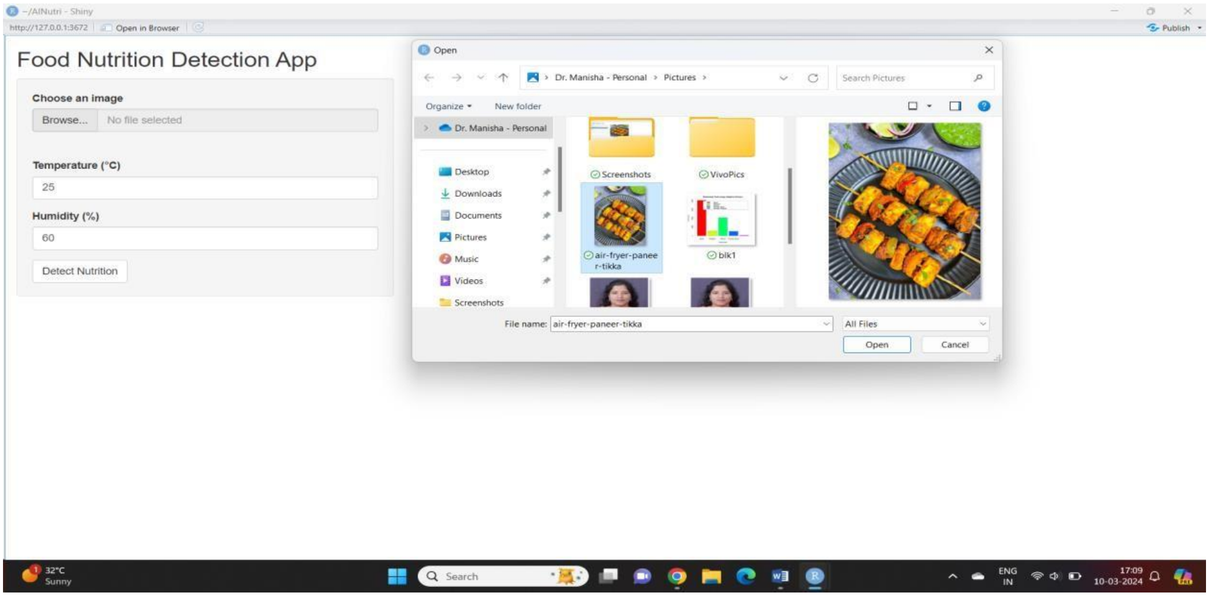

Figure 2: Image and Environment Data Upload

The "Image and Environment Data Upload" app represented in figure no.2 allows users to upload images and input environmental data, including temperature and humidity, using numeric input widgets. The "Process Data" button triggers further processing or analysis based on the uploaded data. The app displays the uploaded image and environmental data, with the renderImage function updating the display whenever a new image is uploaded. The app does not include specific data processing or analysis logic, but developers can extend its

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functionality by adding processing steps or integrating it with more complex algorithms. The app can be customized for various applications, including image processing and machine learning algorithms.

Image Uploaded:

The app uses the "Detect Nutrition" event logic (Figure no.3) to process uploaded images and environmental data to generate a nutrition prediction. The logic includes input validation, creating an IoT data frame, predicting the nutrition score, and displaying the predicted score.

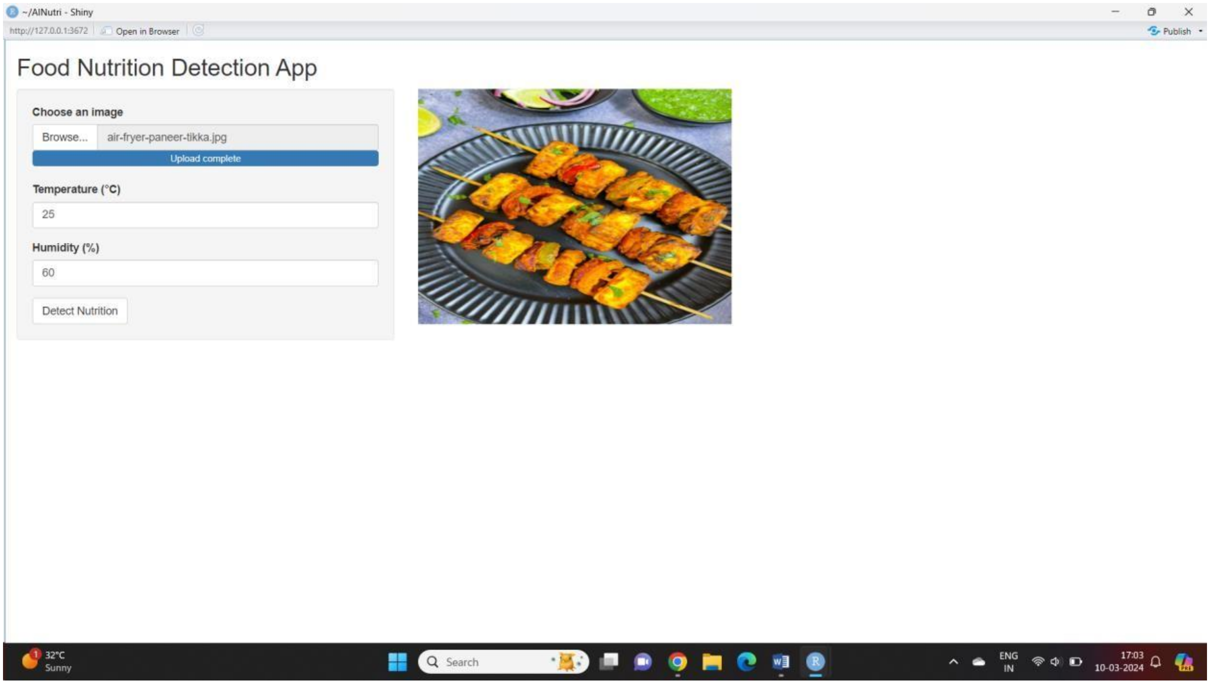

Figure 3: Image Uploaded

If missing or non-existent values are detected, an error message is displayed instead of a nutrition prediction. The app can be integrated with advanced models, such as a pre-trained Convolutional Neural Network (CNN), for improved accuracy. The logic can be extended to include real-time data analysis or more complex machine learning algorithms. The app also allows users to interact with the system, adjusting input values and triggering the nutrition detection process. This feature enhances the overall user experience and addresses potential issues.

4. Results:

The Shiny app is a prototype for a Food Nutrition Detection system that integrates user-uploaded food images, environmental data, and a pre-trained Convolutional Neural Network

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(CNN) model.

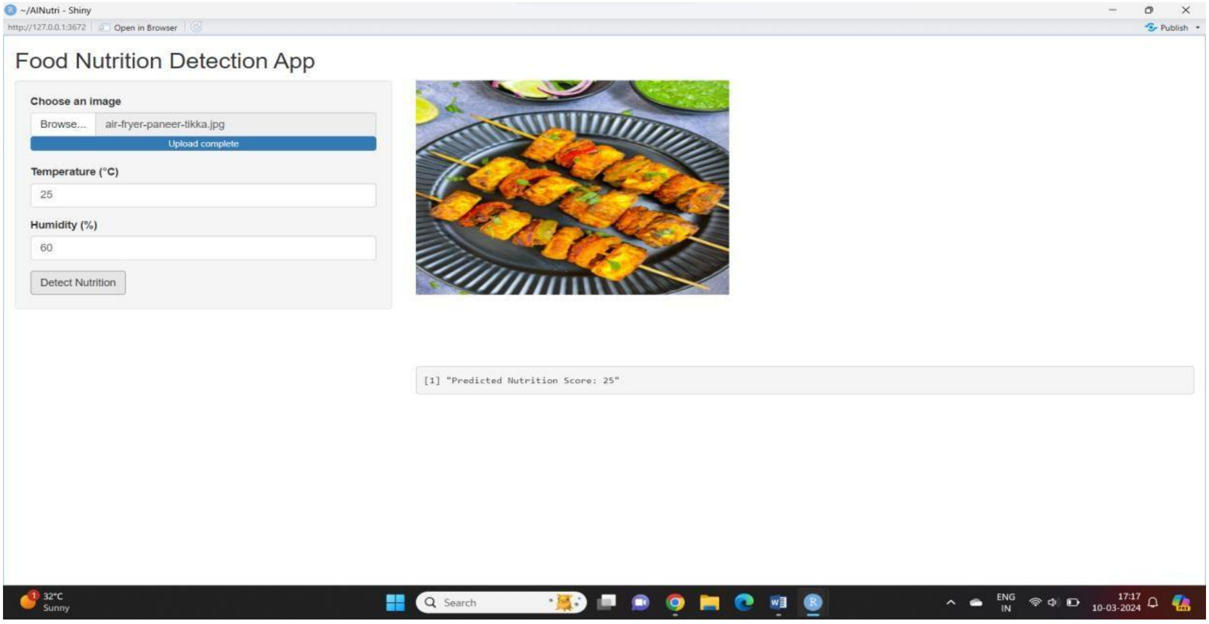

Figure 4: Prediction Prototype Based on AI and IoT

The app's key aspects include image processing, environmental data, AI and IoT logic, predictions, and error handling as depicted in figure no.4. The "Detect Nutrition" button triggers AI and IoT logic to make predictions based on input data. The app also includes error handling for missing or NA values in the nutrition_score column. Potential improvements include integrating a pre-trained CNN model, improving the user interface, and evaluating the accuracy of nutrition predictions. Continuous testing and validation against diverse datasets are essential for the app's reliability and effectiveness.

5. Discussion:

The research prototype demonstrates the potential of AI and IoT in food nutrition detection, demonstrating a holistic approach to understanding factors influencing food quality. The prototype uses a placeholder linear regression model, requiring future integration with a more advanced pre-trained CNN model. The user-friendly interface ensures accessibility for users of varying technological backgrounds. The prototype should be developed into a mobile app, prioritizing a seamless user experience, real-time data collection, and integration with a pre-trained CNN model. The app can incorporate educational content and gamification elements to encourage healthier dietary habits. Data diversity and continuous validation are crucial for

ISSN PRINT 2319 1775 Online 2320 7876
, **Journal Volume 11, Iss 10, 2022**

ensuring the model's robustness across diverse food categories. Privacy and ethical considerations are also important, and scalability and generalizability are crucial for accommodating a growing user base. Interdisciplinary collaboration between nutritionists, technologists, and user experience designers is essential for the app's functionality.

6. Conclusion:

The research prototype demonstrates the potential of a Food Nutrition Detection system that integrates Artificial Intelligence (AI) and Internet of Things (IoT) technologies. It combines user-uploaded food images with environmental data to predict nutritional value. The prototype has achieved several achievements, including integrating a placeholder linear regression model with user-uploaded food images and a user-friendly interface. However, it also has limitations, such as a placeholder linear regression model and static features. The next phase will involve a mobile app that will be user-friendly, integrate with a pre-trained CNN model for image classification, and collect real-time data. The app can also incorporate gamification elements and educational content to encourage healthier eating habits. Future iterations will focus on expanding the dataset and addressing user feedback for refining features.

7. References:

[1]. Sak, J., & Suchodolska, M. (2021). Artificial Intelligence in Nutrients Science Research: A Review. Nutrients, 13(2), 322. https://doi.org/10.3390/nu13020322

[2]. Singh U. &b Songarea L.(2022), IoT and Machine Learning based Model for Food Safety and Quality in Handling a Pandemic Situation, IJFANS International Journal of Food and Nutritional Sciences, 11(12), 3221-3255

[3].Popa, A, Mihaela H, Mirel P, Oana G, D. Jude H, Daniel D, Le Hoang S, and Simona G. 2019. "An Intelligent IoT-Based Food Quality Monitoring Approach Using Low-Cost Sensors" Symmetry 11, no. 3: 374. https://doi.org/10.3390/sym11030374

[4].Mavani, N.R., Ali, J.M., Othman, S. et al. (2022), Application of Artificial Intelligence in Food Industry—a Guideline. Food Eng Rev 14, 134–175. https://doi.org/10.1007/s12393-021-09290-z

[5].Jahedi Rad S, Kaveh M, Sharabiani VR, Taghinezhad E (2018) Fuzzy logic, artificial neural network and mathematical model for prediction of white mulberry drying kinetics. Heat Mass Transf 54(11):3361–3374. https://doi.org/10.1007/s00231-018-2377-4

[6].Han, J.; Zhang, Z.; Cao, J.; Luo, Y.; Zhang, L.; Li, Z., Zhang, J. (2020), Prediction of winter wheat yield based on multi-source data and machine learning in China. Remote Sens. 12, 236.