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VEGTRACK: Vegetable Classification and Freshness Prediction Using Transfer Learning an Updated Review

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ABSTRACT

"VegTrack" represents a comprehensive technological solution at the intersection of agriculture, food quality assessment, and consumer well-being. This innovative system harnesses the power of machine learning, encompassing transfer learning, and nutrient analysis, to revolutionize how we interact with vegetables. The first component of VegTrack focuses on vegetable classification, utilizing transfer learning techniques to accurately identify a wide array of vegetables. This enhances the efficiency of quality control processes, benefiting industries from agriculture to food processing. In the realm of freshness prediction, VegTrack employs Transfer learning to assess the quality of vegetables in real-time, analyzing visual cues such as color and texture. This empowers stakeholders throughout the supply chain to make informed decisions, reducing waste and ensuring consumers receive fresher produce. Additionally, VegTrack offers nutrient analysis, estimating the nutritional content of vegetables from images. By integrating these facets, VegTrack not only improves food quality assessment but also contributes to healthier eating habits and sustainable food practices. This multifaceted system exemplifies the potential of technology to reshape our relationship with food, promoting both quality and well-being.

INDEX TERMS VegTrack, Agriculture technology, Food quality assessment, Consumer well-being, Machine learning, Transfer learning, Vegetable classification.

I. INTRODUCTION

In the modern age, the increasing demand for fresh, high-quality vegetables has placed a premium on the precision of vegetable classification and freshness prediction. The traditional methods of manual vegetable sorting and classification, which are essential for efficient inventory management and supply chain optimization, have long been associated with labor-intensive and error-prone processes. Manual freshness prediction, a key element in ensuring vegetables meet quality standards, has proven to be a tedious and subjective task, often plagued by inconsistencies in assessing vegetable quality. In response to these challenges, our project, "VegTrack," stands at the forefront of innovation by leveraging advanced technologies, particularly transfer learning. VegTrack has been meticulously designed to revolutionize the way we handle vegetables in the agricultural and food processing industries.

It accomplishes this by automating the classification of a diverse range of vegetables, making it more efficient and accurate. One of VegTrack's most groundbreaking contributions is its pioneering approach to predicting freshness levels with remarkable precision. By analyzing visual cues like color and texture in real-time, the system reduces food waste and, concurrently, elevates consumer satisfaction. With the ability to provide consistently accurate assessments of vegetable quality, VegTrack ensures that consumers receive the fresh and high-quality vegetables they demand while also benefiting the entire supply chain from production to distribution.

This paper highlights the critical role of VegTrack in addressing the pressing challenges of vegetable sorting, classification, and freshness prediction, showcasing the potential of advanced technology to optimize vegetable handling and contribute to sustainable food practices.

II. LITERATURE REVIEW

The classification and detection of fresh and rotten fruits and vegetables have gained significant attention in recent years, owing to their essential role in human nutrition and the need to prevent the contamination of healthy produce. Several studies have contributed to this field by leveraging deep learning techniques and convolutional neural networks (CNNs) for accurate and efficient classification.

Tasmima Akter[2022] works on"Local Vegetable Freshness Classification Using Transfer Learning Approaches"[1]. proposes a novel approach to assess the freshness of vegetables through automated computer vision systems. By employing the DenseNet201 Transfer Learning model, the research achieved impressive results, attaining a test accuracy of 98.56% in categorizing vegetables into fresh, aged, and rotten classes. This work highlights the potential of transfer learning in automating the detection of vegetable freshness, reducing human reliance, and enhancing the quality control process in the food industry.

J N V D Tanuja Nerella [2023] introduced “Performance Comparison of Deep Learning Techniques for Classification of Fruits as Fresh and Rotten”[2]. This study is focused on the classification of fruits as fresh and rotten, crucial for the agricultural industry. It evaluates various deep learning models, such as ResNet50, MobileNetV2, VGG 16, and InceptionV3, with InceptionV3 outperforming the others with an accuracy of 97.1%.

Chai C. Foong [2021] introduces "Convolutional Neural Network based Rotten Fruit Detection using ResNet50"[3] explores the detection of rotten fruits and focuses on the classification of bananas, apples, and oranges. By implementing the ResNet50 model, the research achieved a high validation accuracy of 98.89%. The study emphasizes the significance of deep learning and CNNs in addressing the challenges of fruit quality control. The fast processing time, approximately 0.2 seconds per fruit image, is a notable advantage for practical applications in the food industry.

Ricardo Muñoz Bocanegra [2023] introduced "Fruit and Vegetable Information System Using Embedded Convolutional Neural Networks” [4]. The development of a mobile application using Convolutional Neural Networks (CNNs) for fruit and vegetable recognition is the main focus here. It also provides nutritional information about recognized items.

Prof.Sarika Bobde [2021] introduced a “ Fruit Quality Recognition using Deep Learning Algorithm”[5]. Freshness is the most critical indicator of fruit quality, and directly impacts consumers’physical health and their desire to buy. Also, it is an essential factor in the price in the market. Therefore, it is urgent to study the evaluation method of fruit freshness. Taking banana as an example, in this study, we analyzed the freshness-changing process using transfer learning and established the relationship between freshness and storage dates. Features of banana images were automatically extracted using the GoogLeNet model and then classified by the classifier module. The results show that the model can detect the freshness of bananas and the accuracy is 98.92%, which is higher than the human detecting level. To study the robustness of the model, we also used this model to detect the changing process of strawberries and found that it is still useful. According to the above results, transfer learning is an accurate, non-destructive, and automated fruit freshness monitoring technique. It may be further applied to the field of vegetable detection.

Prabha Shanker Arya [2021] introduces "A Proposed Architecture: Detecting Freshness of Vegetables using Internet of Things (IoT) and Deep Learning Prediction Algorithm”[6]. This paper explores a unique approach that combines the Internet of Things (IoT) and deep learning to detect the freshness of vegetables. It includes sensors, voltage, temperature, color, and a deep learning-based prediction algorithm, achieving an accuracy of 97.5%.

Md Abrar Hamim [2023] worked on "Bangladeshi Fresh-Rotten Fruit and Vegetable Detection Using Deep Learning Deployment “[7] The focus here is on the detection of fresh and rotten fruits and vegetables in the context of the agricultural industry. Various fruits and vegetables are classified using image processing methods and Convolutional Neural Networks (CNNs), achieving a 95% accuracy rate with the CNN model.

Shobana G,[2022] works on "Fruit Freshness Detecting System Using Deep Learning and Raspberry PI”[8]. This research addresses food quality checking and fruit freshness detection using deep learning and machine vision. It integrates various deep learning and machine learning algorithms with a Raspberry Pi, aiming to provide a recommendation system for blind individuals.

Jiangong ni[2021] introduced a "Monitoring the Change Process of Banana Freshness by GoogLeNet”[9]. Recent research has focused extensively on the ripening and classification of bananas, recognizing their global importance and demand. Various techniques have been explored, including clustering, classification, and computer vision-based sorting systems. Studies have utilized machine learning tools, such as artificial neural networks, random forest classifiers, and fuzzy classification methods, to predict the maturity, shelf life, and quality attributes of bananas. While some approaches have successfully distinguished between immature and ripe bananas, challenges remain in accurately discerning overripe fruits. Optical properties and biogeographic optimization methods have been proposed to enhance classification accuracy. Additionally, colorimetric indices and laser-induced backscatter imaging have been investigated for their potential in predicting banana ripening stages. These endeavors underscore the importance of advanced technology in ensuring the quality and marketability of bananas for global consumers.

Subash. S. I. [2023] introduced "A Novel and Efficient CBIR using CNN for Flowers”[10]. This paper discusses the application of Convolutional Neural Networks (CNNs) in flower image classification and retrieval, addressing challenges in content-based image retrieval (CBIR). It aims to improve the accuracy and specifications of image retrieval using CNNs.

Inferences from the literature survey suggest a recurring reliance on custom datasets for training the models in various studies. The choice of models, whether Convolutional Neural Networks (CNNs) such as ResNet50, MobileNetV2, VGG 16, and InceptionV3, or other deep learning approaches, is consistently associated with the necessity for these models to adapt to the unique characteristics of the vegetables or fruits under consideration. The emphasis on custom datasets, comprising images of specific vegetables or fruits like cucumber, capsicum, chili, lemon, coriander, and others, underscores the importance of tailoring the training data to the intricacies of the target produce. This approach enhances the models' ability to generalize and accurately classify vegetables or fruits such as fresh, aged, or rotten, thereby optimizing their performance in real-world scenarios specific to the agricultural context

Table 2.1 Comparison Table

Sl No.	Reference Paper	Specification of Existing System	Proposed System
1	Tasmima Akter et al. - "Local Vegetable Freshness Classification Using Transfer Learning Approaches"	Automated system using transfer learning for vegetable freshness. CNNs used for image categorization. Custom dataset of cucumber, capsicum, chili, lemon, and coriander. Classifies vegetables into fresh, aged, and rotten.	Uses a model of CNN for Image Classification.
2	Tanuja Narella et al. - "Performance Comparison of Deep Learning Techniques for Classification of Fruits as Fresh and Rotten"	Automatic grading system using deep learning models (ResNet50, MobileNetV2, VGG 16, InceptionV3) for fruit classification. More efficient and accurate than manual grading.	Usage of Deep Learning Models for Freshness Prediction.
3	Chai C. Foong et al. - "Convolutional Neural Network Based Rotten Fruit Detection Using ResNet50"	Focus on intelligent rotten fruit detection using ResNet50 on a Kaggle dataset. Aims to optimize training parameters for accurate detection.	Contribution to advancing agricultural quality assessment through the exploration and implementation of advanced technologies. Utilizing a dataset sourced from Kaggle.
4	Ricardo Muñoz Bocanegra et al. - "Fruit and Vegetable Information System Using Embedded Convolutional Neural Network"	Integration of CNNs in agriculture for automated fruit and vegetable identification. Emphasis on enhanced efficiency, reduced waste, and sustainability.	Uses a model of CNN for Image Classification.
5	Prof. Sarika Bobde et al. - "Fruit Quality Recognition Using Deep Learning Algorithm"	Utilization of Keras framework for fruit quality recognition. Achieved 95% accuracy in categorizing fruits as good, raw, or damaged.	Demonstration of the transformative potential of deep learning for fruit classification, overcoming inefficiencies in traditional sorting methods.Usage of Keras Framework.
6	Prabha Shankar et al. - "A Proposed Architecture: Detecting Freshness of Vegetables using IoT & Deep Learning Prediction Algorithm"	Integration of sensor technology, IoT, and deep learning for accurate assessment of fruit freshness. Achieved 97.5% accuracy.	Novel approach using advanced technology for fruit freshness assessment. Emphasis on replacing conventional methods with innovative solutions.
7	Md Abrar Hamim et al. - "Bangladeshi Fresh-Rotten Fruit & Vegetable Detection Using Deep Learning Deployment in Effective Application"	Application of deep learning for image classification in detecting fresh and deteriorating produce. Focus on CNNs, particularly in the context of Bangladesh.	Integration of deep learning in agriculture for defect identification, contributing to improved product quality.
8	Shobana G et al. - "Fruit Freshness Detecting System Using Deep Learning and Raspberry PI"	Recognition of the critical role of AI and ML in revolutionizing fruit quality assessment. Proposed solution integrates Deep Learning algorithms and a Raspberry Pi-based recommendation system.	Emphasis on using AI and ML for fruit quality assessment, with a focus on accessibility for visually impaired individuals.
9	Subash. S. I et al. - "Monitoring the Change Process of Banana Freshness by Googlenet"	Employed googlenet model for fruit freshness assessment, achieving 98.92% accuracy. Extended applicability to strawberries.	Introduction of transfer learning as a precise and non-destructive technique for fruit freshness evaluation.
10	Tiangong Ni et al. - "Novel and Efficient CBIR using CNN for Flowers"	Integration of CNNs in CBIR for flowers, focusing on enhancing accuracy and specificity. Experimental validation using the Oxford-102 flower dataset.	Optimization of feature extraction through CNNs to develop a CBIR system capable of retrieving similar images without explicit feature extraction and classification.

III.CONCLUSION

In conclusion, the reviewed literature unequivocally highlights the indispensable role of deep learning and Convolutional Neural Networks (CNNs) in revolutionizing the automated classification and detection of fresh and rotten fruits and vegetables. The studies examined underscore the growing importance of computer vision systems in bolstering food quality control and ensuring consumer safety. Through the integration of transfer learning and the Internet of Things (IoT), these innovative approaches not only provide high accuracy and efficiency but also significantly reduce reliance on human intervention.

It is crucial to recognize that the effectiveness of these models is intricately linked to the quality of the custom datasets employed. The emphasis on dataset quality emphasizes the need for rigorous curation to ensure robust and reliable performance across various applications. Beyond their immediate application in freshness detection, these transformative technologies hold the promise of reshaping the future of the food industry. Their impact extends to influencing pricing dynamics, catering to evolving consumer preferences, and facilitating accessibility solutions, ultimately contributing to the overarching goal of improving produce quality and safety on a global scale. As these advancements continue to unfold, they pave the way for a more resilient and technologically empowered food supply chain, fostering a positive paradigm shift in the industry's landscape

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