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Empowering Farmers: Deep Learning Technology for Coconut Classification and Glucose Level Prediction

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ABSTRACT: Deep learning, a subset of artificial intelligence, mimics human brain functions to process data and make decisions. It has evolved alongside the digital era, fueled by the explosion of Big Data from various sources like social media and e-commerce platforms. Deep learning, particularly through deep convolutional neural networks (CNNs), excels in tasks such as image classification and segmentation, owing to its hierarchical structure and ability to learn abstract features from data. Its success stems from its capability to automatically discover relevant features without explicit engineering. As a result, deep learning is highly adaptable across domains and applications, offering solutions to complex problems in computer vision, natural language processing, and autonomous systems.

I.INTRODUCTION

Tender coconut water is a natural beverage renowned for its isotonic properties, comprising electrolytes, vitamins, and minerals essential for replenishing lost fluids. It stands out for its low-calorie profile and high potassium content, making it an optimal choice for hydration.

Abundant in vital nutrients such as vitamins C and B6, potassium, magnesium, and calcium, tender coconut water plays a pivotal role in supporting immune function, mitigating inflammation, and fortifying bone health.

Furthermore, it harbors bioactive enzymes that facilitate digestion and foster the growth of beneficial gut bacteria, thereby easing gastrointestinal discomfort and averting constipation.

Of notable significance are the cytokines present in tender coconut water, plant hormones acknowledged for their anti-aging attributes, which retard the aging process and stimulate cellular rejuvenation.

Figure 1: Coconut harvester

In essence, tender coconut water emerges as a holistic and rejuvenating elixir, offering not only hydration but also a plethora of health benefits.

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According to research studies, the glucose level in tender coconut water can range from 2.5 to 5.0 mmol/L (millimoles per litre) while the fructose level can range from 2.5 to 4.0 mmol/L. This means that the total sugar content of tender coconut water can be between 5 to 9 mmol/L.

For example, the International Commission on Food Standards specifies that a tender coconut of a certain size should have a minimum glucose level of 1.8 g per 100 ml.

However, people with diabetes or other medical conditions that require monitoring of blood sugar levels should consume tender coconut water in moderation and as part of a balanced diet.

II.LITERATURE REVIEW

Shrihari Kallapur G proposed a Identification of aromatic coconuts using image processing and machine learning techniques [1]. The technique of Forensic investigation of VM using snapshots as an evidence that can be shown as a proof in front of court of law. In that mechanism, software stored and maintained snapshots of running VM selected by the user which acted as a good evidence. VM can be created by the user as per his choice from the physical machines that are available. Any cloud software similar to that of Eucalyptus instead of request of a user, takes the snapshots of the machines stores till terminated. Snapshots can be stored only till it reaches the maximum but when once maximum is reached the snapshots which were taken long before gets deleted. So the huge storage management of snapshots of VM becomes difficult as it affects the performance of the system.

Problem Identified as Coconuts are grown widely throughout the world and have their unique significance. They are used in various products such as coconut skimmed milk, coconut milk powder, and coconut oil. Since they have low calories and are high in fibre they have their health benefits as well.

Objective of this proposed in this research, it is possible to identify the aromacy through non-invasive mechanisms with the help of image-processing techniques. The brightness of the image has to be adjusted accordingly for actual implementation. The underlying principle is that the colour of the region of interest at the bottom part of the coconut shell is correlated to its age.

Image Processing is a method to perform operations on an image in order to obtain useful information from it. Digital Image Processing specifically refers to performing these operations on digital images. The input has to be an image and output may be an image or characteristics/features associated with that image. There are various techniques such as Segmentation, Feature Extraction, and Morphological Processing etc. Once the camera is opened, an image capturing object is defined which captures images frame-by-frame. The frames are displayed continuously. K-means clustering is one of the simplest and popular unsupervised machine learning algorithms.

The coconut images captured are from Thailand in that paper while the coconuts are of Indian origin in this paper. Overall, this research provides more accurate information regarding the coconuts to the consumers. K-means is compared with Density Based Clustering of Applications with Noise (DBSCAN). Clusters formed in K-Means are of the same size and of spherical shape. The number of clusters has to be fixed. The quality of the segmented images increases with the number of clusters. This property gives the privilege of determining the quality of the segmented image depending on the requirement.

Relevance to current Research

In this paper, the author proposed incorrect supply coconuts to oil processing units leads to overproduction or sometimes unfulfilled demand. One of the ways that industry uses is to manually count the total number of coconuts at each farm before selecting a tree(s) for sourcing.

Soumyadip Majumder **[2]** Smart Sourcing Using AI (Coconut Detection and Count with Artificial Neural Network), 2021

Authors presented To address the challenges, we started looking for various possibilities at process level, at software level and also hardware that may be useful for solving the problem. Our first approach was to go through a few of the images of the coconut trees collected by the client. Based on the quality of the images, we came up with a few techniques for image collection. Initially they evaluated implementing Computer Vision technique using Opencv to detect and identify any object. This technology brings an ability of automating the counting process to some extent, but it was not sufficiently addressing all challenges. Finally, we decided to go with Deep Learning for multiple object detection. We implemented Convolutional Neural Network with the technique of Transfer Learning. The model generates an output file with the total count of all the coconuts detected across all the images. So, business users will never have to manually count the number of coconuts. Just to check the reliability, business users will have access to images with identifiers for the classified coconut. This will help them to compare the output file generated with the

detected coconut images. With all the images that will be used for auditing, will be used later more retraining the model for higher accuracy.

Figure 2 : Disease Coconut

Relevance to current Research

The proposed method for performing Manual harvesting of coconuts is a highly risky and skill-demanding operation, and the population of people involved in coconut tree climbing has been steadily decreasing. Hence, with the evolution of tree-climbing robots and robotic end-effectors, the development of autonomous coconut harvesters with the help of machine vision technologies is of great interest to farmers.

Peng-Yeng Yin; Rajendra Machavaram proposed [3] Detection of Coconut Clusters Based on Occlusion Condition Using Attention-Guided Faster R-CNN for Robotic Harvesting, 2020 In this paper has discussed This study proposes a deep learning-based object detection Faster Regional-Convolutional Neural Network (Faster R-CNN) model to detect coconut clusters as non-occluded and leaf occluded bunches. To improve identification accuracy, an attention mechanism was introduced into the Faster R-CNN model. The image dataset was acquired from a commercial coconut plantation during daylight under natural lighting conditions using a handheld digital single-lens reflex camera.

To improve identification accuracy, an attention mechanism was introduced into the Faster RCNN model. The image dataset was acquired from a commercial coconut plantation during daylight under natural lighting conditions using a handheld digital single-lens reflex camera. The proposed model was trained, validated, and tested on 900 manually acquired and augmented images of tree crowns under different illumination conditions, backgrounds, and coconut varieties. On the test dataset, the overall mean average precision (mAP) and weighted mean intersection over union (wmIoU) attained by the model were 0.886 and 0.827, respectively, with average precision for detecting non-occluded and leaf-occluded coconut clusters as 0.912 and 0.883, respectively. The encouraging results provide the base to develop a complete vision system to determine the harvesting strategy and locate the cutting position on the coconut cluster. In this study, a deep learning model based on state-of-the-art Faster R-CNN with VGG-16 was proposed for

detecting coconuts based on their occlusion condition. The analysis showed that the model achieved high precision and speed for identifying non-occluded and leaf-occluded coconuts, which can evade potential damage to the tree and robot end-effector during robotic harvesting. The attention mechanism was introduced into the Faster R-CNN model to improve the ability of the network to identify occluded coconuts.

Figure 3 : Normal Coconut Tested

Relevance to current Research

Coconut is one of the commercial and versatile crops and is a part of day to day food in India. Classification of coconut is a process of separating the nuts based on its maturity.

Siddesha S, S K Niranjan [4] Colour and Texture in Classification of Coconut, 2020 In this paper, we proposed a model for classifying the nuts by colour and texture features. SVM is used as a classifier for classifying nuts into three separate classes, tender coconut (TC), mature coconut (MC) and Copra (CP). All these classes are used for different purposes and occasions. Colour histogram and colour moments are used as colour features with wavelet, LBP, GLCM and Gabor features as texture features. Experimentation is conducted on a data set of 900 images with combination of colour and texture features using SVM as classifier. In the classification part, we used two SVM approaches One-Against-One and One-Against-All with four different kernel functions namely, linear, quadratic, polynomial and radial based. An accuracy of 99.07% is attained with the combination of colour moments and Gabor using One-Against-All SVM for linear kernel function.The classification is carried out using SVM with two different approaches One-Against-One and One-Against-All. To analyse the impact on classification accuracy we used four different kernel functions. The combination of colour moments and Gabor texture with One-Against-All SVM approach having linear kernel function shows a good accuracy of 99.02% with 40% training. The other kernel functions for the same combination also gave comparatively good results and the difference in classification accuracy is insignificant.

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Relevance to current Research

In the above mentioned research paper, author have Revolutionising the post-harvest process using lowcost non-destructive approaches such as acoustics is a promising frontier to uplift the conventional farming practices as well as adapt machine learning tools to further increase the accuracy of the system.

Nemilyn A. Fadchar proposed Design and Development of a Neural Network – Based Coconut Maturity Detector Using Sound Signatures, 2020

The author in their research work, This study attempts to develop a prototype that uses the sound signatures to classify the maturity level of the young coconut by using a neural network. Specifically, it aims to: extract the acoustic features from the sound signal; train the data set and develop the classification model using neural network; develop a program for the prototype; design and fabricate the hardware for the prototype; and test and evaluate the prototype.To develop a prototype that is capable of predicting the coconut maturity levels based on acoustic technique. The accuracy of prediction is further enhanced through the aid of supervised machine learning tools such as the neural network. The main component that runs the prototype is the Raspberry Pi 3 model b+ that is capable of performing the classification based on the neural network model.Based on the results, the developed prototype for coconut maturity detection using sound signatures coupled with a neural network was able to successfully classify the maturity levels of the coconut fruit. The overall classification accuracy of 91.3% and an R-value of 0.9429 indicates a high prediction accuracy rate. It also shows that the prototype has a higher accuracy rating as compared to the manual practice. Hence, further evaluation on the efficiency and functionality is encouraged for future research in order to improve the device and meet industry standards [5].

Relevance to current Research

The work presented in this paper takes due care of the To develop a prototype that is capable of predicting the coconut maturity levels based on acoustic technique.

No.	Paper Title	Author Name	Key Points	Remark
1	Tender coconut water quality analysis using computer vision and machine learning techniques	A. Srinivasan, R. Prakash, and P. N. Pankajakshan	Novel approach for quality analysis of tender coconut water. Utilizes computer vision and machine learning techniques. Potential applications in food and beverage industry. [1]	Innovative integration of computer vision and machine learning. Potential for further refinement and application in food quality assessment.
2	A machine vision-based approach for the identification of tender coconut varieties	R. Arulmurugan, S. S. Kumar, and S. Ramalingam,	Novel machine vision-based method for identifying tender coconut varieties. Utilizes visual characteristics for accurate classification. Practical application in food industry for sorting tender coconuts. Published in the Journal of Food Science and Technology. [2].	Address the issues concerned with Innovative application of technology in agriculture and food processing. Potential for further optimization and commercial implementation.
3	Region-based convolutional networks for accurate object detection and segmentation. IEEE Trans. Pattern	Girshick, R., et al	Introduces Region-Based Convolutional Networks (R-CNN) for object detection and segmentation. Achieves high accuracy, surpassing previous methods. [3]	Signifies a major advancement in computer vision. Offers a robust framework for complex visual tasks. Potential for further enhancements and applications.
4	COCONUT TREES DETECTION ON THE TENARUNGA USING HIGH-RESOLUTION SATELLITE IMAGES AND DEEP LEARNING	J. Zheng, W. Wu, L. Yu and H. Fu	This methodology showcases the potential of advanced remote sensing and deep learning in addressing challenges related to sustainable development and resource management in remote island regions. [4].	Further research could explore the scalability and transferability of this approach to other geographic areas and tree species detection tasks.

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In summary, the work presented in this paper is built on previous research to explore how security of research could explore the scalability and transferability of this approach to other geographic areas and tree species detection tasks.

III.METHODOLOGY OF PROPOSED SURVEY

Aromatic Coconuts Using Image Processing and Machine Learning:

Image Processing is a method to perform operations on an image in order to obtain useful information from it. Digital Image Processing specifically refers to performing these operations on digital images. The input has to be an image and output may be an image or characteristics/features associated with that image. There are various techniques such as Segmentation, Feature Extraction, and Morphological Processing etc. Once the camera is opened, an image capturing object is defined which captures images frame-by-frame. The frames are displayed continuously. K-means clustering is one of the simplest and popular unsupervised machine learning algorithms..

Smart Sourcing Using AI:

Initially they evaluated implementing Computer Vision technique using Opencv to detect and identify any object. This technology brings an ability of automating the counting process to some extent, but it was not sufficiently addressing all challenges. Finally, we decided to go with Deep Learning for multiple object detection. We implemented Convolutional Neural Network with the technique of Transfer Learning.The model generates an output file with the total count of all the coconuts detected across all the images. So, business users will never have to manually count the number of coconuts. Just to check the reliability, business users will have access to images with identifiers for the classified coconut. This will help them to compare the output file generated with the detected coconut images. With all the images that will be used for auditing, will be used later more retraining the model for higher accuracy.

Coconut Clusters Based on Faster R-CNN for Robotic Harvesting

The proposed model was trained, validated, and tested on 900 manually acquired and augmented images of tree crowns under different illumination conditions, backgrounds, and coconut varieties. On the test dataset, the overall mean average precision (mAP) and weighted mean intersection over union (wmIoU) attained by the model were 0.886 and 0.827, respectively, with average precision for detecting non-occluded and leaf-occluded coconut clusters as 0.912 and 0.883, respectively. The encouraging results provide the base to develop a complete vision system to determine the harvesting strategy and locate the cutting position on the coconut cluster. In this study, a deep learning model based on state-of-the-art Faster R-CNN with VGG-16 was proposed for detecting coconuts based on their occlusion condition. The analysis showed that the model achieved high precision and speed for identifying non-occluded and leaf-occluded coconuts, which can evade potential damage to the tree and robot end-effector during robotic harvesting. The attention mechanism was introduced into the Faster R-CNN model to improve the ability of the network to identify occluded coconuts.

Colour and Texture in Classification of Coconut:

we proposed a model for classifying the nuts by colour and texture features. SVM is used as a classifier for classifying nuts into three separate classes, tender coconut (TC), mature coconut (MC) and Copra (CP). All these classes are used for different purposes and occasions. Colour histogram and colour moments are used as colour features with wavelet, LBP, GLCM and Gabor features as texture features. Experimentation is conducted on a data set of 900 images with combination of colour and texture features using SVM as classifier. In the classification part, we used two SVM approaches One-Against-One and One-Against-All with four different kernel functions namely, linear, quadratic, polynomial and radial based. An accuracy of 99.07% is attained with the combination of colour moments and Gabor using One-Against-All SVM for linear kernel function.The classification is carried out using SVM with two different approaches One-Against-One and One-Against-All. To analyse the impact on classification accuracy we used four different kernel functions. The combination of colour moments and Gabor texture with One-Against-All SVM approach having linear kernel function shows a good accuracy of 99.02% with 40% training. The other kernel functions for the same combination also gave comparatively good results and the difference in classification accuracy is insignificant.

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Neural Network – Based Coconut Maturity Detector Using Sound Signatures:

This study attempts to develop a prototype that uses the sound signatures to classify the maturity level of the young coconut by using a neural network. Specifically, it aims to: extract the acoustic features from the sound signal; train the data set and develop the classification model using neural network; develop a program for the prototype; design and fabricate the hardware for the prototype; and test and evaluate the prototype.This paper attempts to develop a prototype that is capable of predicting the coconut maturity levels based on acoustic technique. The accuracy of prediction is further enhanced through the aid of supervised machine learning tools such as the neural network. The main component that runs the prototype is the Raspberry Pi 3 model b+ that is capable of performing the classification based on the neural network model.Based on the results, the developed prototype for coconut maturity detection using sound signatures coupled with a neural network was able to successfully classify the maturity levels of the coconut fruit. The overall classification accuracy of 91.3% and an R-value of 0.9429 indicates a high prediction accuracy rate. It also shows that the prototype has a higher accuracy rating as compared to the manual practice. Hence, further evaluation on the efficiency and functionality is encouraged for future research in order to improve the device and meet industry standards.

IV.CONCLUSION AND FUTURE WORK

In this paper, we have proposed an automated solution for detecting and classifying different types of tender coconuts and estimating their glucose level using Laplacian of Gaussian (LOG) Edge Detection and Tender Coconut Neural Network (TCNN). By leveraging TCNN and LOG edge detection algorithm, the system aims to enhance accuracy and efficiency. This advancement holds promise for improving quality control, reducing costs, and ensuring product safety in the tender coconut industry.

In terms of future scope, the paper suggests the development of a mobile application to provide easy access to the system on smartphones and tablets, facilitating usage for producers and consumers alike. Additionally, the system could be enhanced by offering real-time recommendations based on estimated glucose levels and environmental parameters like temperature, humidity, and rainfall. Such recommendations would enable producers to make timely decisions, ensuring that tender coconuts meet desired quality standards.

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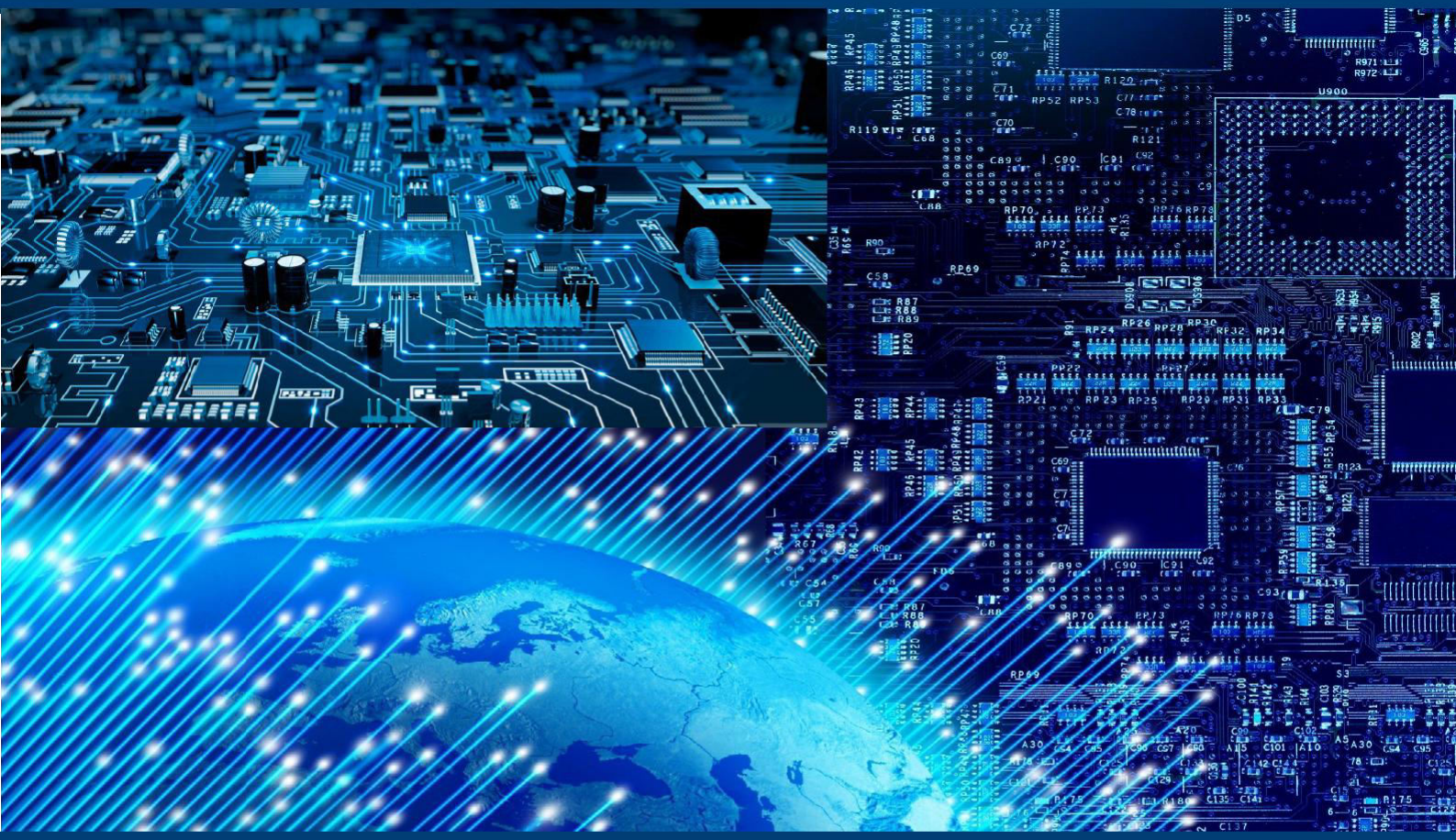

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