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Fruit Categorizer using pH Sensor

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Abstract: The process of grouping or sorting fruits till date is carried out using manual methods & this process is time consuming & can be erroneous. To minimize the sorting time & error, many automation techniques are designed based on image classification & other methods. This paper summarizes all the existing techniques designed to group & sort fruits using image classification and Convolutional Neural Network.

Keywords: Image classification, Convolutional Neural Network, grouping, sorting, minimize error.

I. INTRODUCTION

Fruit Categorizing is a difficult task in a food industry as it requires manual classification based on their colour and shape which is not accurate. There are a few available fruit sorting and grading methods but they are almost expensive for small and medium scale industries. At present, humans do the fruit classification which is time consuming, labour intensive and may lead to misjudgement when humans tend to get bored. Hence, By the usage of Convolutional Neural Network, the identification of the fruit can be done. A pH sensor can measure the pH values of the given various fruit sample input. Using this data, the type of fruit and their ripeness can be identified. All of the above process is done on a conveyor belt. There are certain pH values for healthy fruits and if it drops below or increases beyond that, it can be considered that the fruit is not edible. Based on the pH sensor and CNN, the listed information is displayed on the LCD display:

1) Determining the type of fruit
2) pH level
3) Categorizing the fruit based on ripeness.

Thus, our model can be used in small and medium scale industries and it is accurate compared to other fruit categorizing systems that have been developed.

II. LITERATURE SURVEY

In this paper titled Fruit Recognition and Classification with Deep Learning Support on Embedded System (fruit-net) [1], fruit recognition is performed using image processing techniques. The study created a classification process for Convolutional Neural Networks (ConNN)* deep learning models. The proposed model is developed on the Kera's platform. To implement the study in real life, 20 different fruits are tested on 2 different datasets. The latest model developed is being tested in real time on the Jetson Nano card.

Disadvantage- This paper does not discuss about the categorizing of fruits or quality of fruits.

In this paper [2], they propose a new deep-learning-based Fruit-CNN architecture to identify types of fruit and evaluate real-world image quality under different visual variations, yielding 99.6% test accuracy. Compared to current deep learning models, the proposed architecture demonstrates broad applicability in precision agriculture, as it requires minimal time to train large data sets and test fruit images. It also allows you to train more images belonging to different classes with enhanced parameters, which speeds up model training and reduces processing time.

Disadvantage- This paper fails to discuss about the classification of fruits based on sensor

To overcome drawbacks of above paper in this paper [3] they used computer vision (CV) and deep neural network (DNN) to sort tomatoes by ripeness color. 300 tomatoes are selected and their maturity determined by an expert method. Tomato images are captured, processed, and fed into a DNN classifier to determine tomato cultivars. The proposed DNN classifier achieved a MAP percentage of 95.52%. This demonstrates that computer vision embedded in DNN algorithms can provide an efficient implementation for tomato variety prediction.

Disadvantage- This paper has achieved results for only one particular type of fruit using DNN

This paper [4], proposed a mobile application that uses computer vision techniques to determine the ripeness of banana fruits. Image classification is performed by applying transfer learning to extract edges from a pretrained model.

Convolutional Neural Network (CNN) models are used to train classifiers. Bananas are chosen as an example because of their short shelf life and are widely consumed by Malaysians. This project uses Google Co-lab to run the code because it runs in the cloud and is great for machine learning. TensorFlow Lite with Model Maker library simplifies the process of tuning and transforming TensorFlow neural network models to specific inputs before deploying to Android apps. The result was obtained with an accuracy of 98.25%. The application instantly recognizes the real-time image of bananas, displays the maturity level on the screen based on the best match ratio, and displays the maturity level so that users can easily and quickly check the ripeness of the bananas.

Disadvantage- This paper has achieved results for only bananas using CNN and fails to categorize them.

In this paper [5] they have proposed a Pure Convolutional Neural Network (PCNN) with minimal parameters. PCNN consists of 7 convolutional layers, some straight through. They also used a newly developed Global Average Pooling (GAP) layer to reduce overfitting and averaging of the full feature map, which proved to be very efficient. They demonstrate classification performance using PCNN on the recently introduced fruit-360 dataset. Experimental results on 55244 colored fruit images in 81 categories show that PCNN achieved a classification accuracy of 98.88%.

Disadvantage- This paper failed to determine the quality of fruits inside which could have been achieved through pH sensors.

In this paper [6], they propose a method for classifying fruits in images using ELM (Extreme Learning Machine), MPEG-7 visual descriptors, and PCA (Principal Component Analysis). Optimal ELM and PCA parameters are determined using grid search optimization. When classifying Indonesian fruit images composed of 15 classes, the highest classification efficiency of 97.33% was achieved. The classification accuracy was increased to 98.03% by applying the ELM ensemble. This result shows that the proposed method provides high classification efficiency.

Disadvantage- This paper has achieved the determination of fruits but failed to classify them or check the standard of fruits.

In this research paper [7], they will check the quality of tomatoes in terms of shape, size and maturity. Edge detection algorithms are used to estimate the shape and size of tomatoes, and color detection algorithms are used to determine maturity. All these algorithms are implemented on a Raspberry Pi development board which will be a self-contained and cost-effective system. Our system includes a Raspberry Pi breadboard, conveyor belt, motor, and Pi camera. All pairings of the above devices are complete and constitute an economical embedded system for determining the shape, size and ripeness of tomatoes. The same system can be used for other fruits and vegetables.

Disadvantage- This paper has achieved the determination and classification category but has limited to only one type.

This paper [8] provides a detailed and comparative overview of applications and recent developments in computer vision systems, various algorithms, methods and techniques for classification and classification. Technological advances over the past few decades have resulted in many powerful and scientific algorithms and technical methods. Tools have been identified using different image analysis techniques in the field of maturity classification.

Disadvantage- This paper has summarized the different algorithms and techniques used but has not mentioned any use of sensors.

In this study [9], an automated system for classifying citrus images was developed using a convolutional neural network. Classified two citrus fruits: Orange (Citrus sinensis) and Kino (Citrus Reticulate). First, Orange and Kinnow images they are collected and processed. Second, fruit images and their backgrounds they are segmented using image segmentation and edge detection. they extracted four key features of orange and quinoa fruits based on image segmentation: fruit size, surface color, fruit shape, and fruit surface defects. These features they are explored using convolutional neural networks. For further experimentation, they implemented three separate convolutional neural network models and tested their recognition rates for different parameters. Conventional measures including Precision, Recall, F1 Score, ROC and Accuracy they are used to evaluate performance. A third of the three experimental models exceeded the accuracy of 92.25%.

Disadvantage- This paper has satisfied all the categories needed but has only detected the fruits on the outside but not the ripeness inside and also limited to only oranges.

This paper [11] describes analytical methods to estimate the size and shape of citrus fruits to grade them based on single view fruit images. Stheyet-lime and orange fruits are taken for case study of size and shape determination respectively. The size of the Stheyet-lime fruits was estimated and graded into three categories using simple methods like radius signature method, area method and perimeter method. Also, the existing method based on Light Detection and Ranging

(LIDAR) sensor for citrus fruits size determination was improved through a method employing image processing. The shapes of the orange fruits they estimated using Heuristic Shape separator method and shape numbers they are obtained for varying shaped orange fruits. The results they are found to be reasonably in good agreement with the human assessment.

Disadvantage- This paper has determined the shapes of fruits using analytical methods but limited to only one type.

This article [12] describes the use of various sensors in the food industry. Sensors such as pH sensors, gas sensors, and temperature sensors help determine the condition of food. The system provides an effective presence in restaurants, homes and small businesses. You need such a device that will help you with hygienic nutrition. So, to meet these consumer needs, they created a device that checks whether food is good or bad.

Disadvantage- This paper uses different sensors to determine the condition of food but fails to categorize them and has been used in the food industry rather than fruit industry.

The system is designed [13] as a sorting machine that uses a TCS3200 sensor as a color detector to classify the color of each fruit, and all these processes are controlled using an Arduino with an ATmega328 microcontroller. You need a sorting machine that can quickly and automatically detect and group fruit by color. Therefore, the production of this machine is expected to help improve productivity in the fruit grouping or sorting process.

Disadvantage- This paper classified fruits using color sensors which is used only for fruit detection but failed to categorize.

In this study [14], a method for automatically determining the gradation of orange based on computer vision was proposed. First, orange images they collected and preprocessed. Second, orange and background are segmented via edge detection and image segmentation. Based on image segmentation, four main orange characteristics they identified: fruit surface color, fruit size, fruit surface defects and fruit shape. These features they studied using the BP neural network. Finally, they performed automatic determination of orange degree using a neural network.

Disadvantage- This paper satisfied image classification of fruits and their characteristics but did not check the quality of the fruit or its categorization using sensors.

The applicability and performance of various classification algorithms such as Naive Bayes, Artificial Neural Network, and Decision Tree have been studied. Comparing the results of these algorithms, it was observed that the decision tree classification method for Orange's state is more efficient than the other methods. This article provides tools to quickly distinguish between ripe, unripe, scaled, or rotten oranges. Based on BIC (Border/Inner Pixel Classification), fruit image features including RGB color space and gray values are extracted [15].

Disadvantage- This paper satisfied image classification and categorization of fruits but failed to determine the pH levels.

The objective of the present work is to design a programmable digital electronic platform, equipped with gas sensors and wireless networks for the development of a low-cost and rapid electronic prototype to monitor and record the levels of volatiles and exchange of oxygen and carbon-dioxide of a fruit and estimate a relationship between the gases in order to find an automated way to the determinate the level of ripeness.

Disadvantage- This paper satisfied the use of sensors to classify fruits but failed the determination of fruits or image processing.

III. METHODOLOGY

Fruit will be placed on the conveyor belt on a particular spot through which the IR sensors can detect the fruit's location. The conveyor belts run with the help of motors and IR sensors; we can give delays to the conveyor belts such that it can be made to move in a desired way. Our model makes use of Convolutional Neural Network (CNN) to identify the type of fruit based on its shape and colour. The Arduino Camera Module recognizes the presence of the fruit and image processing is performed using CNN. The CNN is used to compare the data of the fruits that are already being fed to the computer and the data we give as input. The fruit can be determined if its ripened or not based on its colour. After the fruit is recognized, it is sent towards the robotic arm which helps in pricking the fruit. Only the fruits which are ripened are sent to pricking and raw fruits are sent to the waiting room. The ripened fruits are pricked with the pH sensor and then the pH sensor determines whether the fruit is edible or not. If the fruit is edible it is sent to one basket and if it is not edible it is sent to the other basket. There are a certain pH values for a healthy fruit and if the pH values drop below or increase beyond that it can be considered unhealthy or non-consumable. The output will be displayed on a 16x2 LCD display. The model displays – The type of fruit which we are giving as data, the pH value of that fruit and whether that fruit is edible or not.

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IV. CONCLUSION

The unique capabilities of electronic tongue systems, such as the ability to deal with complex and changing background. Different sensing techniques, possible use of unconventional fabrication methods and numerous data treatment procedures indicate that electronic tongue systems can be tailored to various application areas. Moreover, precise and rapid analysis not requiring specially trained personnel make them a promising alternative for time-consuming and expensive analytical methods. Sensing arrays presented in this manuscript are developed to solve real-life problems ranging from humble analysis of foodstuffs' quality, to far-fetched applications. The coming years may disseminate this kind of systems even further, bringing them closer to consumers thanks to specific and advanced technology included in smart tools such as personalized smart watches or disposable low-cost sensor systems.

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