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Defect Detection of Tomato Fruit Using Image Dataset

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Abstract: ***The tomato crop is more susceptible to disease than any other vegetable, and it can be infected with over 200 diseases caused by different pathogens worldwide. Tomato plant diseases have become a challenge to food security globally. Currently, diagnosing and preventing tomato plant diseases is a challenge due to the lack of essential methods or tools.The traditional techniques of detecting plant disease are arduous and error-prone. Utilizing precise or automatic detection methods in spotting early plant disease can improve the quality of food production and reduce adverse effects. Deep learning has significantly increased the recognition accuracy of image classification and object detection systems in recent years. In this study, a 15-layer convolutional neural network is proposed as the backbone for single shot detector (SSD) to improve the detection of healthy, and three classes of tomato fruit diseases. The proposed model performance is compared with ResNet-50, AlexNet, VGG 16, and VGG19 as the backbone for Single shot detector. The findings of the experiment showed that the proposed CNN-SDD achieved 98.87% higher detection accuracy, which outperformed state-of-the-art models.***

I. INTRODUCTION

Agriculture plays a vital role in constructing and developing of the economy of any nation (Huang et al. 2020). As the world population is expected to reach approximately 10 billion of people by 2050, it is a necessity to increase the agricultural productivity Fess et al. 2011. Among the various fruits, tomato fruit is incredibly useful for health benefits and the livelihood of farmers Dimatira et al. 2016. Tomato is rich in nutrition and it has efficiency in health care Yinli et al. 2011. The biological name of tomato is 'Solanum Lycopersicum'. According to the report of food and agriculture organization of the united nation FAOSTAT 2017, the worldwide production of tomato is approximately 182,301,395 tons and India had produced 20,708,000 tons of tomatoes. India is the second-largest producer of tomato globally after China. Ripe tomato has high-level antioxidant compound, and it can greatly decrease the risk of some severe human diseases like cancer and cardiovascular diseases Ciaccheri et al. 2018. Tomato is a major cash crop. So, reducing diseases in tomato fruit is important for increasing the quality and output of the tomato agriculture Zhao & Qu 2019.

To meet high-scale production with quality of production and to meet the consumer's expectations with the market's standard, it is necessary to perform an accurate and reliable grading method Ireri et al. 2019. According to the regulations EU 2011, tomatoes should be in fresh condition, and the fruits must reach the market without any damage for further processing. Numerous biological and natural parameters are utilized to examine the quality of tomatoes after harvesting by using grading and sorting. Both grading and sorting can be done by measuring the size, shape, defects, colour, and maturity Arjenaki et al. 2013. These parameters are utilized to identify tomatoes without any damage, cracks, and disease to meet the market regulations. Sorting can be used to govern the efficiencies and effectiveness on marketing the products through maintaining the standard packaging and quality Jarimopas & Jaisin 2008.

II. LITERATURE SURVEY

Computer Vision (CV) is a technique of image processing to analyze the different characteristics of any object. CV is widely used in agriculture field for grading and sorting vegetables and fruits (Kamilaris & Boldu 2018). Many researchers have been involved in developing CV-based algorithms form easuring the quality of vegetables and fruits (Bhargava & Bansal 2018). The major features are colour, texture, shape, and size (Al Ohali 2011). Several CV algorithms contain different steps like pre-processing, segmentation, feature extraction ,and classification(Mahendran*etal.*2012).

Mostly, the grading and sorting of fruits are performed during post-harvest storage eand packing process (ElRamady*etal.*2015).So,the CV-based algorithms play a vital role in classifying the tomatoes based on their colour ,shape ,size ,texture ,weight ,and other parameters like disease and appearance. Good quality tomatoes must have better colour and shape, desired texture as well as appropriate aroma.

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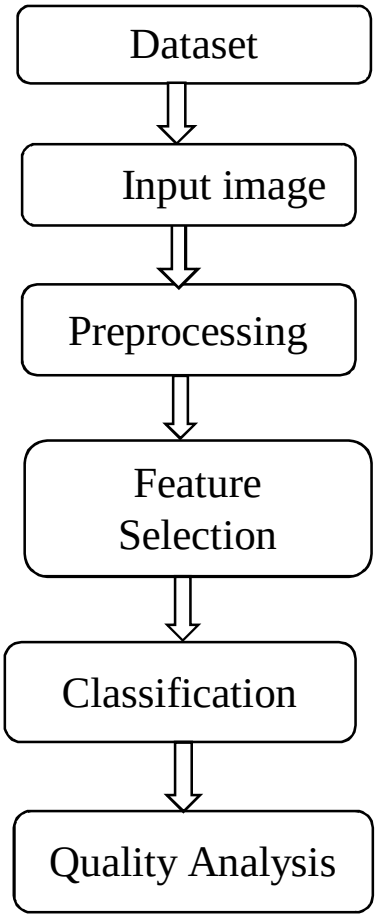
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Firmness is a vital measure in texture of fruit andit heavily affects the shelf life and quality (Pinheiro *et al.* 2013).Conventional scheme for measuring the quality of tomatoes include the quasi-test compression and Magness-Taylor puncture for firmness (Tigist *et al.* 2013).Even though different algorithms are proposed in the literature, still the grading and sorting of tomatoes are a challenging task during post-harvesting (Tripathi &Maktedar2020).

III. OBJECTIVE

The primary aim of tomato sorting using an image dataset could be to develop a machine learning model that accurately classifies tomatoes based on their characteristics such as size, shape, color, and ripeness. This model could then be used in automated sorting systems to enhance efficiency and accuracy in tomato processing plants.

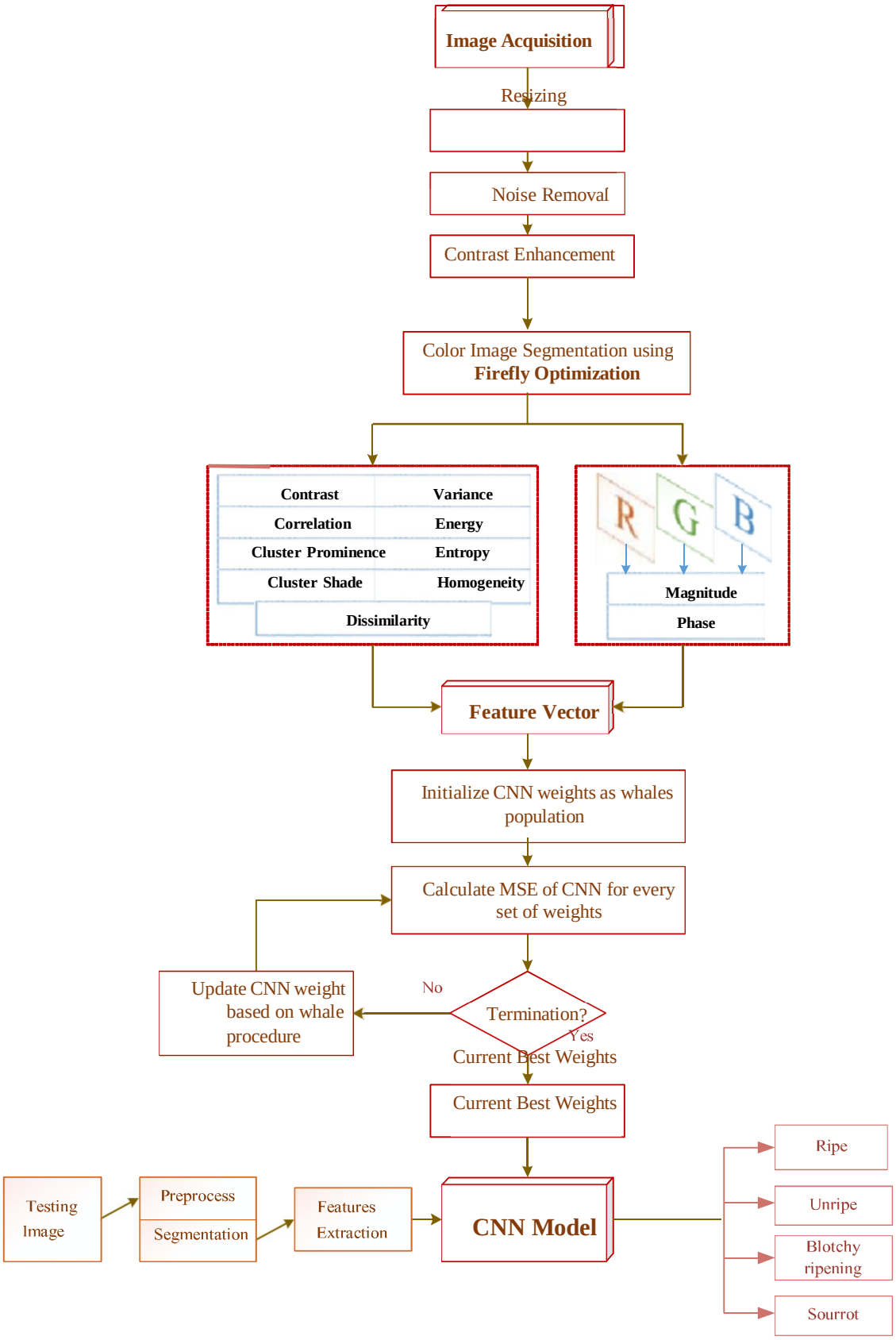
IV. BLOCK DIAGRAM



V. PROPOSED SYSTEM

This research analyses the capability of the WOCNN system in classifying tomato fruits based on their external appearance. Therefore, image processing techniques and classification scheme (WOCNN) are utilized to extract tomato features to classify the tomato in four different classes such as ripe, unripe, blotchy ripening, and sour rot. The dataset includes 40 images per category and a total of 160 images utilized with the resolution of 1600x1200 pixels. This system consists of five major modules such as image acquisition,image pre-processing, image segmentation, feature extraction, and classification. The conceptual diagram of the proposed fruit classification scheme.

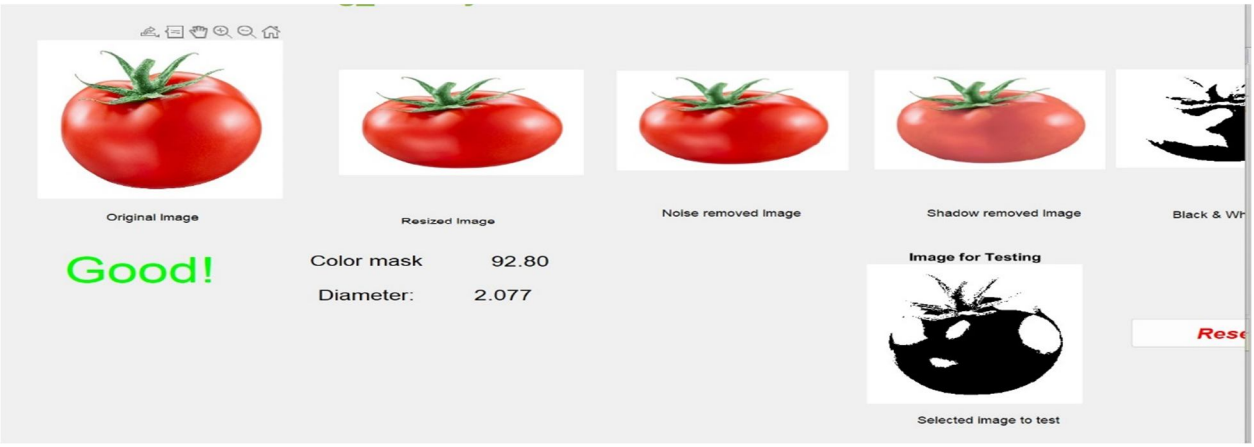
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Flowchart for proposed fruit grading system

A standard pre-processing technique is used to resize the image, remove noise, and enhance contrast. Feature preserve image resize , median filter and histogram equalization are used in the pre-processing stage. This method utilizes the firefly algorithm for image segmentation. FA is a swarm intelligence-based segmentation process which provides an efficient and accurate result . Further, grey level co-occurrence matrix is utilized for feature extraction. As shown in Figure 3.1, the 11 numbers of features are phase, magnitude, homogeneity, entropy, variance, dissimilarity, cluster shade, cluster prominence, correlation, and contrast. The classifier utilizes the features for training and testing purposes. Figure shows the functional flowchart of the proposed CNN-based fruit classifying system.

VI. RESULTS



VII. CONCLUSION

Finally, we briefly telling you that tomato sorting by CNN model using MATLAB R2023b. We are taking a picture of good quality (colour, shape, defect) of tomato, we are training to the software then it ready for grading tomatoes, we have to test the tomatoes. It compares it with good quality tomato and it gives the result as if tomato matches with the good quality tomato, it gives as good or else it gives bad it means it has some defect.

Tomato sorting using image dataset technology offers significant potential for enhancing efficiency and accuracy in agricultural processes. By leveraging machine learning algorithms, such as convolutional neural networks, we can accurately classify tomatoes based on various attributes like size, shape, color, and ripeness. This technology can streamline sorting processes, reduce waste, and optimize resource allocation in the tomato supply chain. Additionally, continuous refinement of these algorithms and the expansion of image datasets will further improve sorting accuracy and performance over time, making tomato sorting more efficient and sustainable for the agricultural industry.

VIII. FUTURE SCOPE

Based on the results of the proposed fruit sorting and grading techniques, the subsequent advancements can be made further. The proposed system, two-dimensional images are used, so if a fault occurs on the other side of the fruit, it cannot be detected. Hence, 3D image capturing, and processing can be stated as future work. Some of the future scope of this research work is summarised below:

1) The proposed fruit classification algorithm can be implemented using different structure deep neural networks to improve the quality of identification of fruit, detection of ripeness and prediction of diseases.
2) The proposed fruit classification systems can be extended to detect the growth of plant and avoid the plant diseases by predicting the diseases.
3) The quality of the classification system can be improved by using other optimized pre-processing modules in removing noise, enhancing the contrast, segmentation, and extracting the features.
4) The proposed automotive fruit classification system can also be used to design agricultural robots. The robots can be used to detect the plant diseases, identify the maturity level of fruits or vegetables, and help in post-harvesting process.

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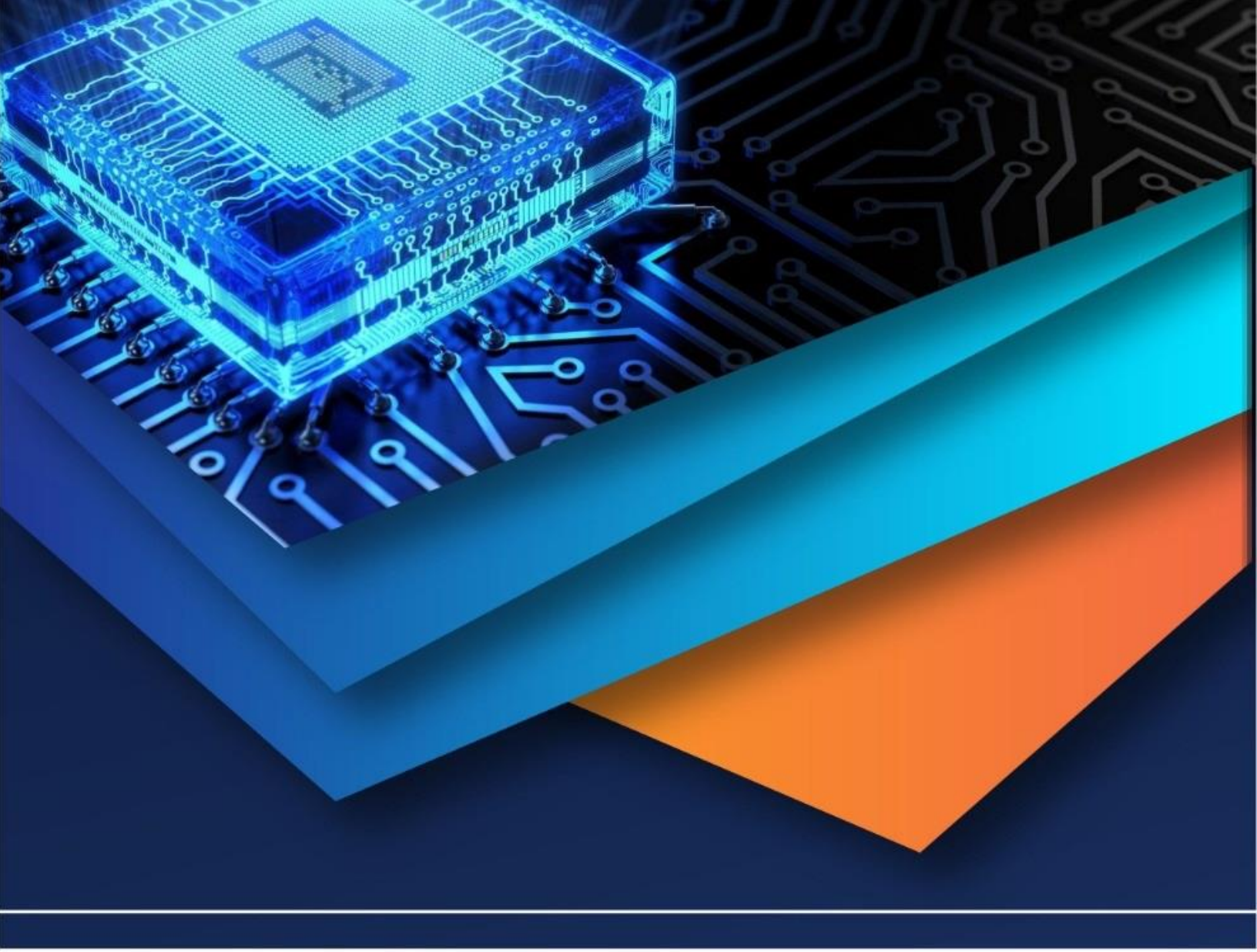
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