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Maize Seed Defect Detection Using Deep Learning

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Abstract: In the realm of agriculture, ensuring high-quality seeds is pivotal for maximizing crop yield and productivity. This study delves into the application of deep learning techniques, specifically Google Net, to address the challenge of maize seed defect detection. By utilizing convolutional neural networks (CNNs) and leveraging the power of transfer learning, this research aims to accurately identify and classify various defects in maize seeds. The technique begins with dataset curation and preprocessing, followed by the adaptation of the Google Net architecture. The model is then trained, validated, and tested, with performance metrics.

Keywords: GoogleNet, Convolutional Neural network, Deep learning, Image processing, Segmentation.

INTRODUCTION

Maize holds significant global importance as one of the most crucial crops. Approximately 33% of the global population relies on maize as a staple food, primary source of sustenance. As a result of urbanization, the cultivation the depletion of land resources, especially in China, is a significant concern. The declining quality of seeds has emerged as a pressing issue. The issues affecting us are the observable abnormalities in the characteristics of seeds. The process of identifying seed defects typically depends on manual examination, which is both ineffective and subjective [2]. Consequently, there is a need for an automated and objective method for screening seeds. Machine vision technology has been utilized by researchers. Seed quality testing is a topic of interest among those who possess knowledge in this domain. The assessment of seed quality entails various aspects, including but not limited to colour. Texture, size, and shape can be derived from images [2]. Seeds can be examined for any flaws or imperfections in order to identify potential defects. There are several computer vision-based classifiers available. Automation can be implemented effortlessly, resulting in a considerably enhanced outcome. A more effective approach to sort seeds is by means other than manual inspection.ie. human labour. Deep learning has experienced significant and rapid advancements in recent years. As an illustration, certain search engines and recommendation systems, for instance, image recognition and speech recognition have been embraced or adopted [2]. The utilization of deep learning methodologies has yielded favourable outcomes. As the GPU's performance and parallel computing capabilities advance, real-time processing of graphical data becomes increasingly feasible. Remarkable outcomes have been attained in this regard.

METHODOLOGY

1. Dataset and preprocessing:

The maize seed dataset is taken from Kaggle [8]. It is shuffled and resized to desired image size. The dataset is then loaded and divided into training and testing dataset.

2. Model Selection and Modification:

Inception V3, a pretrained model is chosen as the base model because it is effective in image classification tasks. Custom layers are added on the top of the InceptionV3 base model, including global average pooling layers and dense layers. ReLU activation is used in these layers. The output layer is modified to have appropriate number of units for classifying maize seed defects.

3. Model Training:

The base InceptionV3 layers are frozen to prevent their weights from being updated during training. This model is compiled using Adam optimizer and sparse categorical cross-entropy loss function. The model is trained using the training dataset and validated on a separate validation dataset.

4. Evaluation:

The trained model is then evaluated on a separate test dataset to access its performance on unseen data.

5. Inference:

A predict function is defined that takes an image and the model as input, preprocesses the image, and then returns the predicted class and confidence score. Inference is performed on the sample images from the dataset, and predictions along with confidence scores are displayed.

6. Model Saving:

The trained model is saved both as TensorFlow SavedModel format and as an HDF5 file.

MODELING AND ANALYSIS

Model:

1. InceptionV3: A pre-trained convolutional neural network (CNN) architecture is utilized as the base model. InceptionV3 is chosen for its effectiveness in image classification tasks and its ability to capture intricate patterns in images.
2. Custom Layers: Additional layers are added on top of the InceptionV3 base model to adapt it to the specific task of maize seed defect detection. These layers include global average pooling, dense layers with ReLU activation, and a softmax output layer.
3. Training Strategy: The base InceptionV3 layers are frozen during training to retain the pre-trained weights, while custom layers are trained to adapt the model to the maize seed defect detection task.
4. Evaluation Metrics: The model's performance is evaluated using metrics such as accuracy and loss on a separate test dataset to assess its ability to generalize to unseen data.

Materials:

1. Maize Seed Dataset: A dataset containing images of maize seeds with different types of defects such as broken, discolored, pure, and silkcut. This dataset is used for training, validation, and testing the model.
2. Computational Resources: Access to computational resources such as GPUs or TPUs is required for training the deep learning model efficiently.
3. Software Libraries: The implementation relies on TensorFlow and Keras libraries for deep learning model development, training, and evaluation.
4. Data Augmentation Techniques: Although not explicitly used in the provided code, data augmentation techniques such as random rotation, zoom, flip, and contrast adjustment can be applied to increase the diversity of the training dataset and improve model generalization.
5. Model Saving Mechanism: The trained model is saved for future use in both TensorFlow SavedModel format and HDF5 file format. This ensures that the model can be easily deployed and used for inference on new data.

RESULTS AND DISCUSSION

The results demonstrate the effectiveness of the developed model for maize seed defect detection, achieving satisfactory accuracy and providing reliable predictions on unseen data.

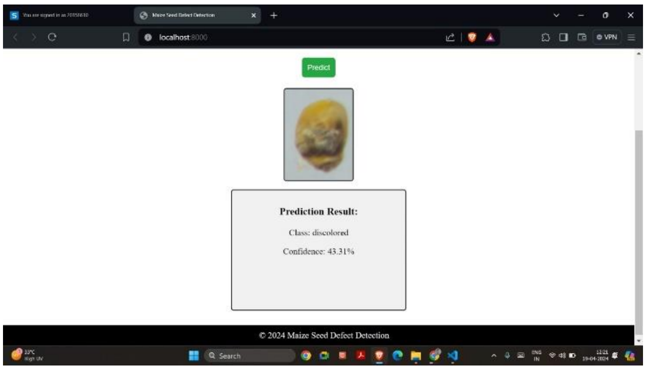

Figure 1: Classified Output

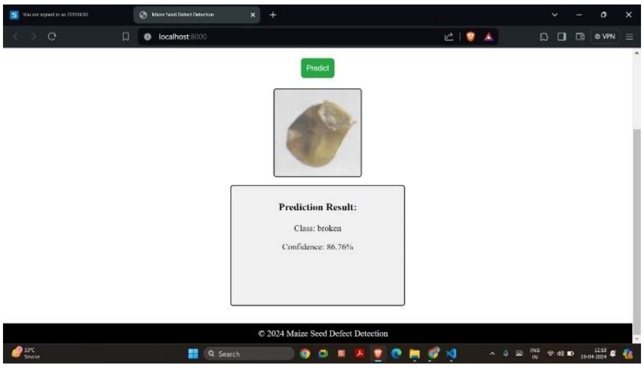

Figure 2: Classified Output

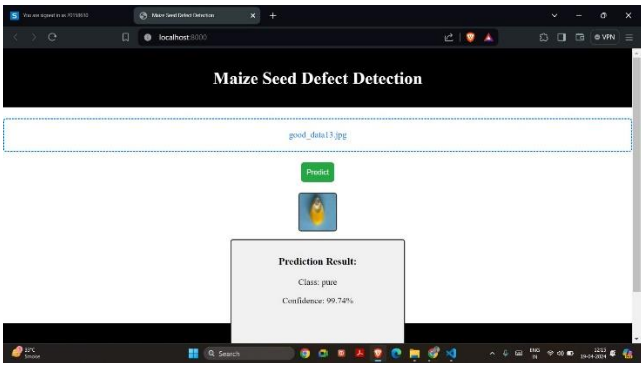

Figure 3: Classified Output

CONCLUSIONS

In conclusion, the development of a maize seed defect detection system utilizing deep learning has yielded promising results, achieving an accuracy of 89%. This accomplishment signifies a significant advancement in the field of agricultural quality control, offering potential benefits such as increased efficiency and accuracy in detecting defects in maize seeds.

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