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Seed Quality Monitoring Using CNN and SVM

Shreyas Varade[1], Trupti Mate[2], Ankush Kharche[3], Ishwari Gadbail[4]

Department of E&TC, SKNCOE, SPPU, Pune

[1]shreyasvarade.skncoe.entc@gmail.com , [2]trupti.mate_skncoe@sinhgad.edu
[3]ankushkharche.skncoe.entc@gmail.com ,[4]ishwarigadbail.skncoe.entc@gmail.com

Abstract— **To achieve a good yield for farmers, it is crucial to focus on seed quality. Detecting unhealthy and damaged seeds is crucial in seed quality analysis. This project proposes an automated system introduced to do so that works on CNN. CNN is a type of artificial intelligence that can be trained to recognize patterns in images. The objective of the project is to develop a natural machine learning-based system that can be used to automatically detect and monitor defects in the seeds based on the shape, size, texture, and colour of the seeds. In this project, the support vector machine algorithm will be used to compare which algorithm is best for the model. By training the algorithm on a dataset of labelled seeds, the algorithm will be able to learn the characteristics of high-quality seeds and can then be used to classify new seeds. This research aims to provide insights and methods for farmers to make informed decisions about seed quality, ultimately leading to better crop yields.**

Keywords**— CNN (Convolutional Neural Network), SVM (Support Vector Machine), Seeds, Quality, Parameters.**

I. INTRODUCTION

Overall, this research paper provides a detailed and comprehensive overview of the proposed solution for seed quality monitoring using computer vision and machine learning algorithms. The paper emphasizes the importance of seed quality in achieving high crop yield and highlights the limitations of traditional methods of seed quality assessment. By leveraging advanced technologies such as image processing algorithms, convolutional neural networks (CNNs), and support vector machines (SVMs), the proposed solution offers a more efficient and accurate approach to seed quality monitoring. These algorithms are employed to analyse images of seeds and detect any holes or broken seeds, which can impact the seed's viability. By identifying damaged seeds through image processing, farmers can make informed decisions about which seeds to sow, leading to better crop yields. Digital image analysis offers an objective and accuracy quantitative method for estimation of morphological features. Then a seed shape description method is considered based on some feature points of different seeds. Computer vision is a novel technology for acquiring and analysing an image of a real scene by computers and other devices in order to obtain information [2]. In recent research studies, CNN has been utilized to train machine learning models based on different images of various types of seeds, achieving impressive accuracy rates of at least 89% [3]. The morphological features of seeds, such as length, width, roundness, and diameter, can be measured through physical tests to identify the seed quality. These features can then be used to train CNN models, which can classify seeds into three different categories: good, medium, and bad. In addition to CNN, SVM is another machine learning algorithm that has been employed for seed quality monitoring. SVM has been used to train models for comparison with CNN, evaluating their accuracy in classifying seed quality. Through a comparative analysis of the performance of these two algorithms, valuable insights can be gained into the effectiveness of different approaches for seed quality monitoring. The significance of this research lies in its practical application in the field of agriculture. Farmers can benefit from the proposed solution by using it as a tool to assess seed quality and make informed decisions about seed selection for planting. As well as this can also be used in big markets. By ensuring high-quality seeds, farmers can increase the chances of achieving high crop yields and improving their overall farm productivity and furthermore all the people will get good quality of seeds.

II. EXPERIMENTATION

1] Dataset Creation

This Python code snippet captures frames from the camera feed using OpenCV (cv2) library and saves them as individual image files in a directory called "dataset frames". This code can be used as a basic template for capturing frames from the camera feed for creating a dataset for further image processing or machine learning tasks, such as training a computer vision model for seed quality assessment as mentioned in the previous conversation. It is important to ensure that the camera is properly connected and configured before running the code, and to provide appropriate permissions for saving files in the desired directory.

2] Proposed Methodology for CNN

In the Fig.II.2.1 we can see that the dataset is the input to our model**.** A Convolutional Neural Network (CNN) is a type of deep learning model that is specifically designed for image processing tasks. Convolutional Neural Network is a type of supervised machine learning algorithm. It is highly effective in extracting meaningful features from images and learning complex patterns, making it suitable for tasks such as seed quality assessment based on image datasets. When using a CNN for seed quality assessment, the input to the model would typically be a dataset of seed images. These images could be captured from a camera feed, as discussed in the previous conversation, or obtained from an existing image dataset. The images may contain seeds of different types, such as corn, rice, soya, dal, wheat, etc., and may have different morphological features, such as length, width, roundness, diameter, etc., that are relevant for seed quality assessment. The CNN model would consist of multiple layers that are specifically designed for image processing. Let's take a look at the main components of a typical CNN model for seed quality assessment: Convolutional Layer, Pooling Layer, Fully Connected Layer, Output Layer. The CNN model is trained on the input image dataset of seeds using a labelled dataset, where each image is associated with its corresponding seed quality label (e.g., "good", "medium", or "bad"). During training, the model learns to optimize its weights and biases to minimize the error between its predictions and the actual labels. Once the model is trained, it can be used for making predictions on new, unseen images to assess the quality of seeds based on their morphological features.

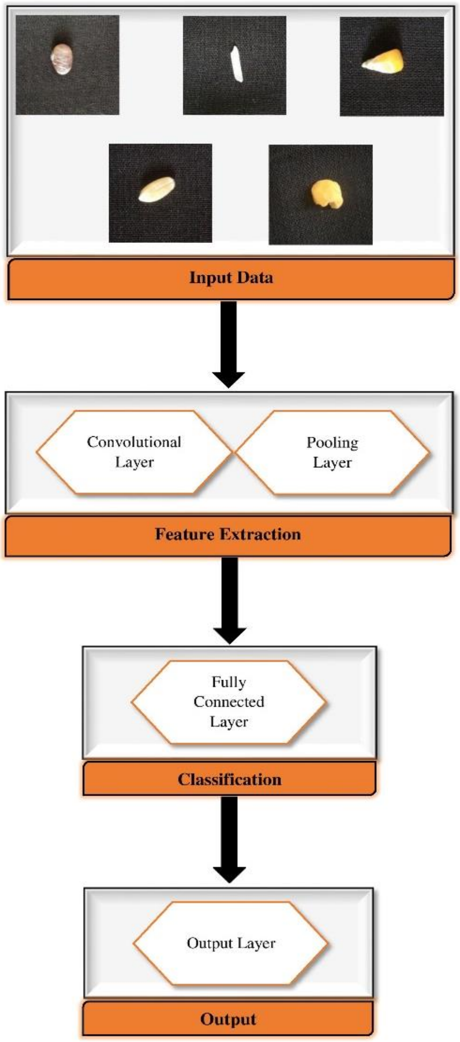

Fig. 1 CNN Model

3] Proposed Methodology for SVM

Support Vector Machine (SVM) is a popular supervised machine learning algorithm used for classification and regression tasks. Supervised machine learning algorithms is a subcategory of machine learning and artificial intelligence. It is defined by its use of labelled datasets to train algorithms that to classify data or predict outcomes accurately. It can be used for seed quality assessment based on morphological features. It's important to properly validate and evaluate the SVM model to ensure its reliability and accuracy in predicting seed quality. Additionally, proper pre-processing, feature extraction, and feature selection techniques should be applied to the input seed images to obtain meaningful and relevant features for the SVM model. Experimenting with different hyper parameter settings, feature extraction methods, and dataset sizes can help in finding the best configuration for the SVM model to achieve accurate seed quality assessment. In this paper this model is only used for comparison of accuracy between CNN and SVM.

Steps of Methodology:

1. Data Preparation: Collect a dataset of seed images, including both good and bad seeds, with labelled ground truth information indicating their quality status.
2. Data Pre-processing: Pre-process the seed images to ensure they are in a consistent format and resolution. Data pre-processing consist of Normalizing and Rescaling, Resizing and Data Augmentation.
3. Data Splitting: Split the data into training and test sets. The training set is used to train the SVM model, while the test set is used to evaluate the performance of the model.
4. Setting of model parameters: The parameters such as shape, size, color, texture, etc.
5. Model Training: Train the SVM model on the training set using the selected kernel and hyper parameters.
6. Model Evaluation: Evaluate the performance of the SVM model on the test set using appropriate evaluation metrics such as accuracy, etc.
7. Model Tuning: If the performance of the SVM model is not satisfactory, tune the hyper parameters and try a different kernel function. Repeat steps 5 and 6 until the desired performance is achieved.
8. Model Implementation: Programing the trained model to a Graphical User Interface(GUI) or to any hardware.

Once the desired performance is achieved, the SVM model can be deployed for making predictions on new, unseen data. The deployed model should be trained on as much relevant data as possible to maximize its accuracy and generalizability.

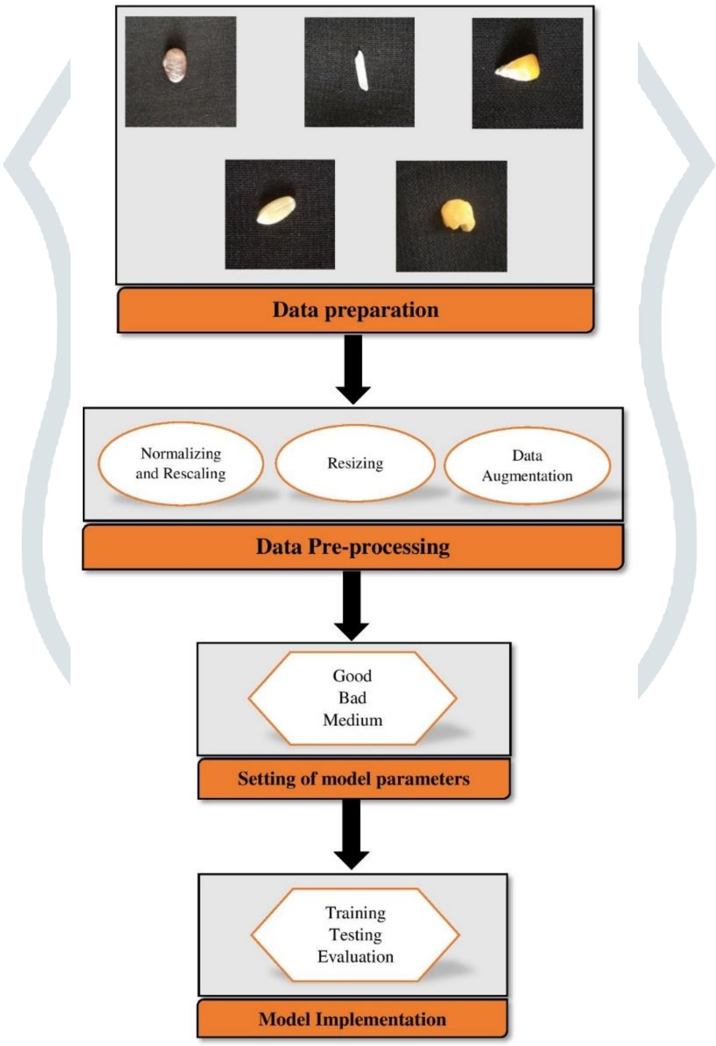

Fig. 2 SVM Model

4] Model Layout

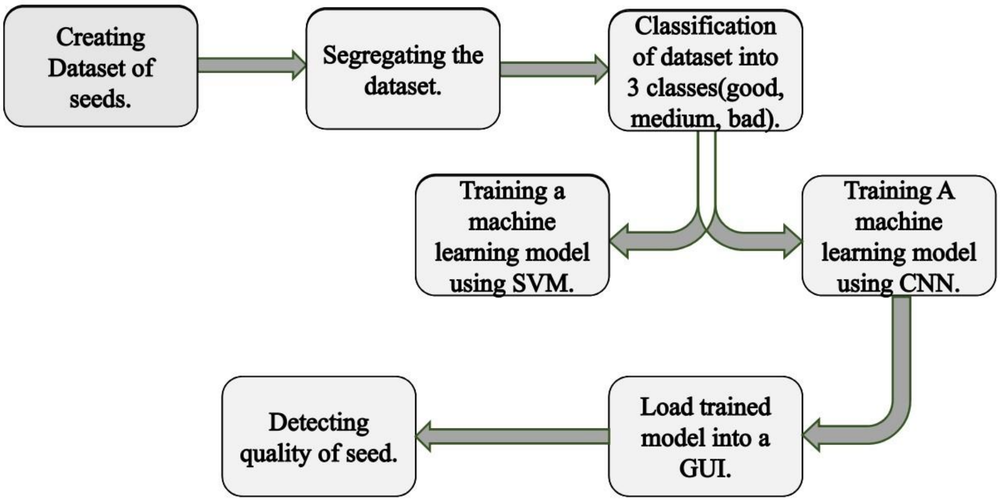

Fig. 3 Block Diagram of Model

The block diagram for seed quality monitoring using machine learning typically starts with the creation of a dataset of seed images, which serves as the foundation for the subsequent steps. The images in the dataset should be representative of the different seed quality attributes, including size, shape, colour, texture, and other relevant features. Once the dataset is created, it is usually segregated into different categories, based on the quality attributes of the seeds. For instance, seeds can be categorized into three classes: good, medium, and bad, based on their visual characteristics, such as size, shape, and colour. After the dataset is labelled, machine learning algorithms are applied to the dataset for training the model. There are various types of machine learning algorithms that can be used, such as supervised, unsupervised, or deep learning algorithms, depending on the complexity and size of the dataset, as well as the desired level of accuracy. Supervised learning algorithms, such as support vector machines (SVM) or convolutional neural networks (CNN), are commonly used for seed quality monitoring tasks, as they can learn from labelled data and make predictions based on patterns found in the data. The labelled dataset is used to train the machine learning model, which learns to classify the seeds into different quality categories based on the patterns it identifies in the data. During the training process, the model iteratively adjusts its parameters to minimize the prediction errors and optimize its accuracy. Once the model is trained and validated, it is loaded into a graphical user interface (GUI) for seed quality monitoring. The GUI provides an interactive platform for users to input seed images for analysis, and the trained model then predicts the quality of the seeds based on the visual characteristics extracted from the images.

III. IMPLEMENTATION

1] Working of Model

The model is being carried out on a device having NVIDIA GeForce GTX 1650, Intel(i5) processor of 1.10GHz - 2.5GHz. The proposed model was implemented using TensorFlow library version 2.11, Python 3.7.9, Keras 2.11, and panda's library version 1.3.5. The implementation of a seed quality monitoring model using machine learning involves several key steps, including data collection, dataset creation, dataset segregation, model training, and integration into a graphical user interface (GUI). The dataset should be diverse and representative, and the model should be trained using appropriate machine learning algorithms. The trained model is then integrated into a GUI, which provides a user-friendly platform for seed quality monitoring, analysis, and decision-making. The implementation of a seed quality monitoring model using machine learning can significantly improve the accuracy, efficiency, and transparency of seed quality assessment in agriculture, leading to better seed selection, storage, planting, and marketing decisions.

IV. RESULT AND DISCUSSION

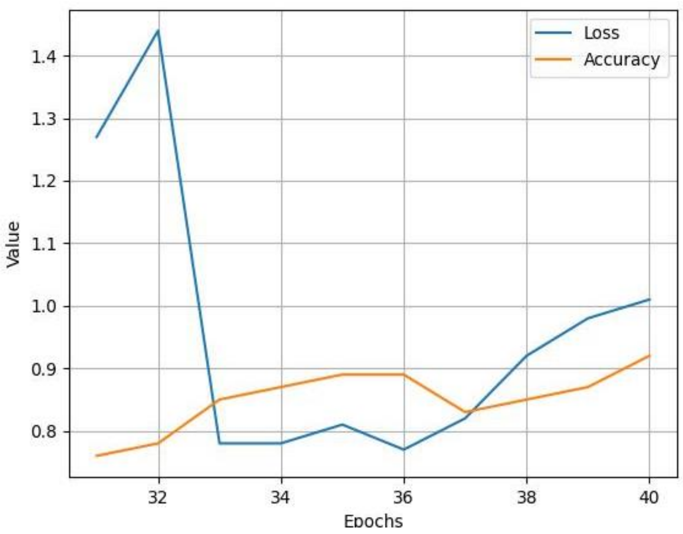

Fig. 4 Graph (Epochs vs Values)

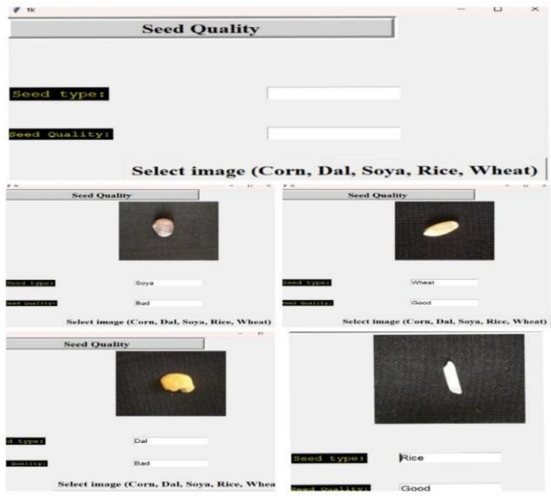

Fig. 5 GUI

The use of Convolutional Neural Networks (CNN) and Support Vector Machines (SVM) in monitoring seed quality can be highly beneficial. CNN can analyse seed shape, while SVM can classify seeds based on colour. This combined approach can result in accurate and efficient seed quality monitoring. One advantage of using SVM is that it can perform well even with limited data, as it can find patterns in small datasets. On the other hand, CNN can handle larger datasets and learn complex patterns due to its deep learning architecture. Therefore, CNN may be more accurate when dealing with a large dataset. In our experiment, we created a dataset and applied algorithm to it. However, we encountered some confusing errors. To address this issue, we segregated the dataset into classes: "good", "medium" and "bad" seeds. However, we noticed that sometimes one type of defective seed is misclassified as another type of defective seed. This misclassification issue could potentially be due to overlapping characteristics or similarities between different types of defective seeds. For example, if two types of defective seeds have similar shapes or colours, it may be challenging for the algorithm to accurately differentiate between them, resulting in misclassification errors. To resolve this issue, we may need to further analyse the misclassified samples and consider additional features or data augmentation techniques to better distinguish between different types of defective seeds. Fine-tuning the CNN model or optimizing the SVM parameters could also potentially improve classification accuracy. Additionally, it is crucial to carefully evaluate the quality and representativeness of the dataset used for training and testing the models. Ensuring that the dataset is diverse and large enough to capture the natural variability in seed quality characteristics can help improve the accuracy of the CNN and SVM models. In conclusion, the use of CNN and SVM for seed quality monitoring can be effective, but misclassification errors may occur, especially when dealing with similar or overlapping characteristics between different types of defective seeds. Further analysis, optimization, and careful evaluation of the dataset can help improve the accuracy of the models in seed quality monitoring applications.
The overall model is then programmed into a Graphical User Interface (GUI).

Table 1 Comparison Table

Model	Accuracy	Losses
CNN	92%	0.11
SVM	82%	1.05

Result: Hence, the CNN model shows more accuracy than SVM when the dataset is large.

V. CONCLUSION

Machine learning can be used to monitor seed quality. By training a machine learning model on data of seeds, it is possible to develop a model that can predict seed quality with a high degree of accuracy. This can help to ensure that crops are planted with high-quality seed, and that the risk of failure is minimized. Asthe data set grows more and more, the classification on the seeds can be more accurate and helpful. And if the dataset is less then Support Vector Machine is used.

VI. FUTURE SCOPE

The system presented in this project is a proof-of-concept system. The system can be further developed and improved in a number of ways. One way to improve the system is to increase the number of images in the training set. This will help to improve the accuracy of the system. Lastly, the system can be deployed on a web platform so that it can be used by farmers and plant clinics.

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