Identification and Classification of Rice Varieties from Seed Coat Images using Deep Learning-based Approach

A project submitted for the requirements for the award of the degree
of
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in
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By

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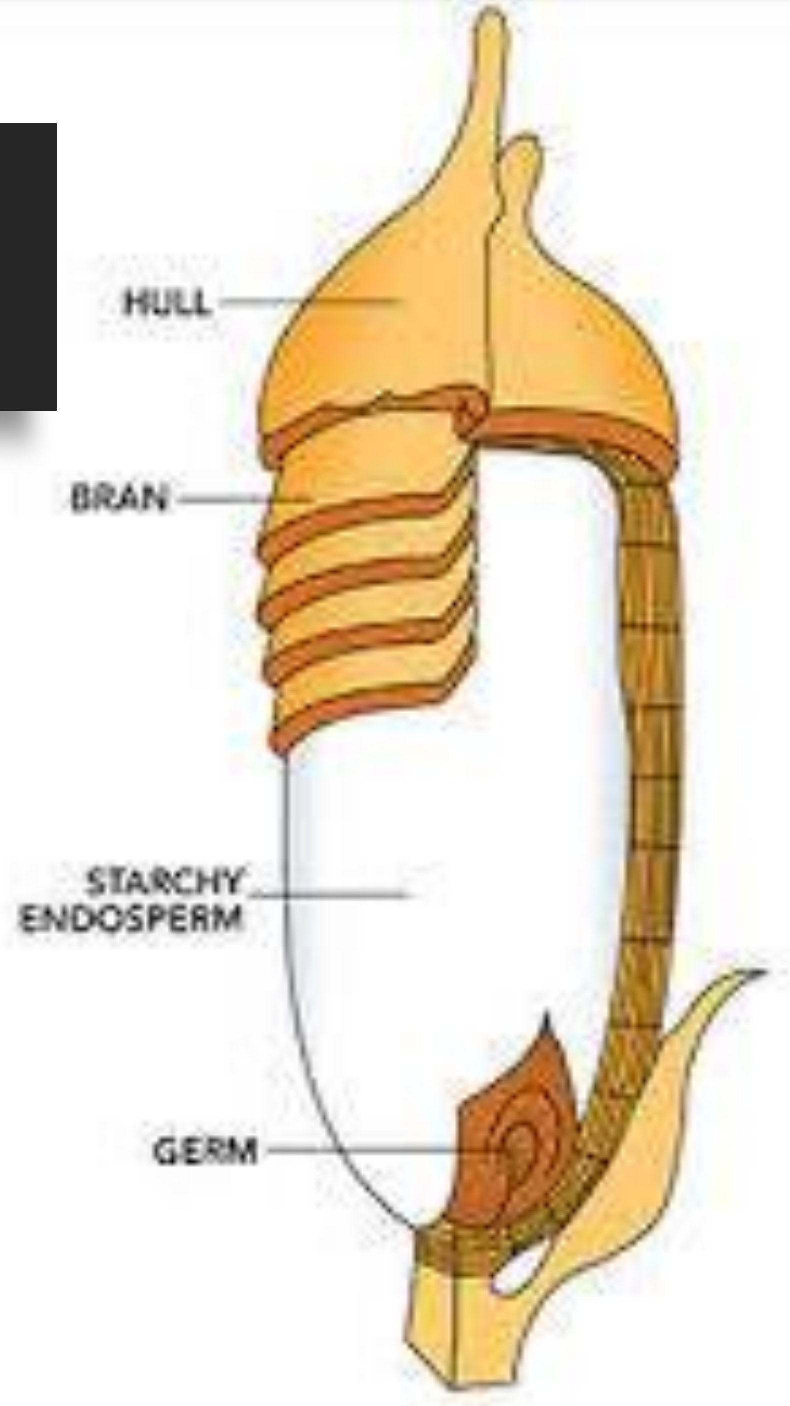
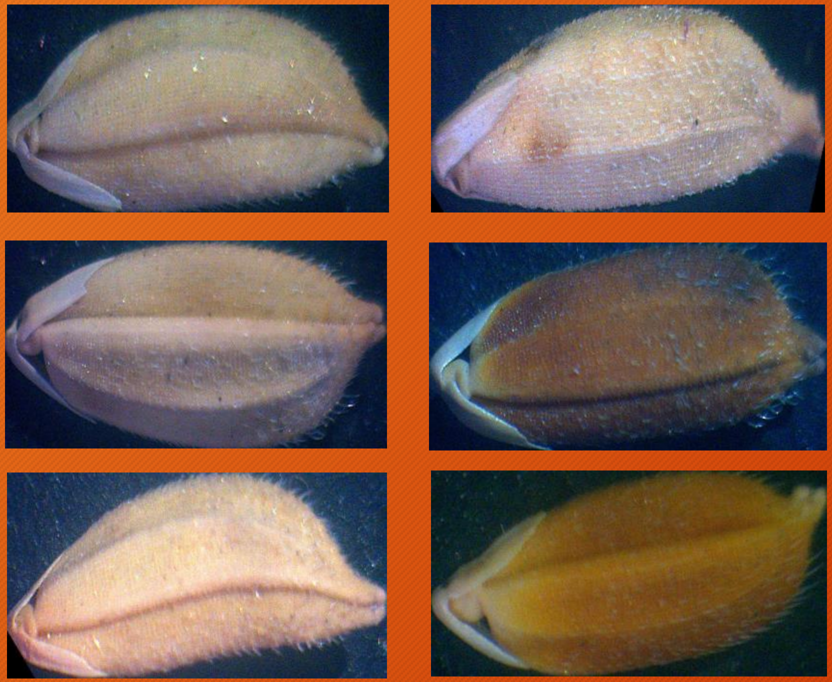
Introduction

In the agricultural field, the identification of different rice varieties is an important but difficult task, especially when performed by eye, based on manual observations and methods. Our project deals with a deep learning-based approach for the identification and classification of 20 rice varieties. In this work we used a state-of-the-art model based on traditional convolutional recurrent neural network architecture with long short-term memory as the recurrent operation. This model was tested on 20,668 samples of the 20 varieties and achieved a lower cross-entropy loss of 0.0205 and an accuracy of 99.76%. This proposed model of ours is able to capture features which cannot be done by a traditional convolutional neural network. This model captures the surface structures and treats them as a sequential data. Eventually, this model gives us a very succinct and accurate manner.



Dataset and its Pre-processing



A sample of 6 different classes is shown.

Total Images: 20668
Number of Classes:20

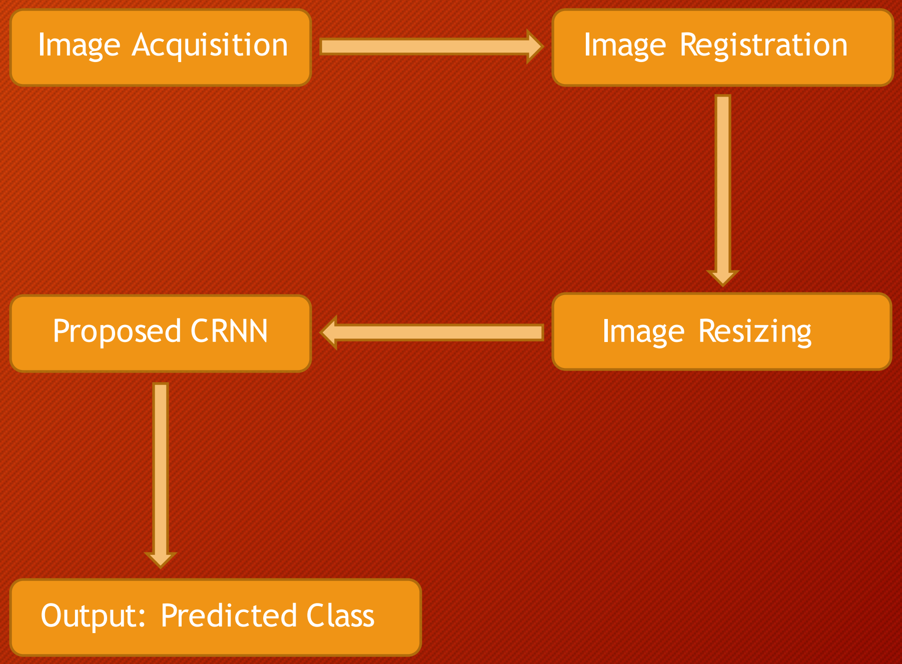
The images were resized to 256x256 pixels following acquisition, maintaining their original aspect ratio. This was done by resizing the images to either a height or width of 256 pixels and cropping the other direction to maintain the aspect ratio. The resized image was then overlaid on a null matrix of 256x256 pixels. The resizing provided the ideal input for the proposed network, which further optimized the performance of the model.

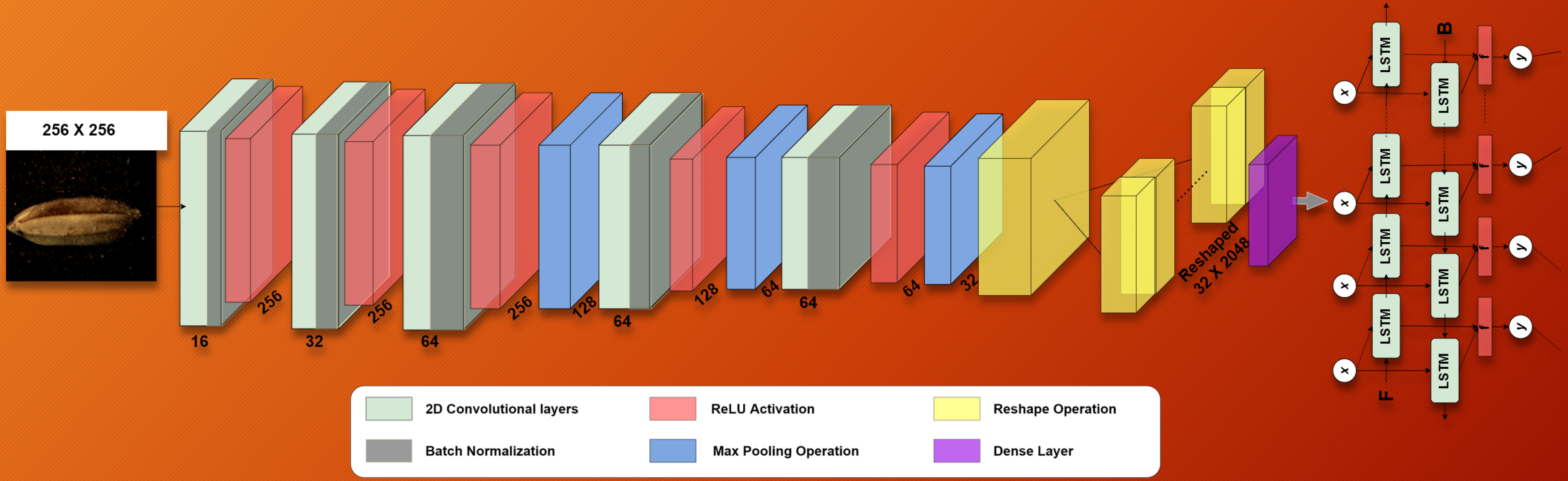
Fold	Training Split	Testing Split	Validation Split
1	63%	30%	7%
2	72%	20%	8%
3	63%	25%	12%
4	48%	40%	12%
5	68%	20%	12%

Flow Chart of Our Proposed Work

Varieties of Rice we perform Classification are:

1. Aghani Bora
2. Bhasa Kalmi
3. Bygon Mongia
4. Chamar Mani
5. Danaguri
6. Dehradun Gandeswari
7. Geli Giti
8. Gobindo Bhog
9. Jhuli
10. Jhulur
11. Joldubi
12. Kala Bhat
13. Kamolsankari
14. Kasuabinni
15. Kokila Pateni
16. Mugojai
17. Radhuni pagal
18. Sada Ponny
19. Sundari
20. Yellow Patari





Proposed Model

Model Development

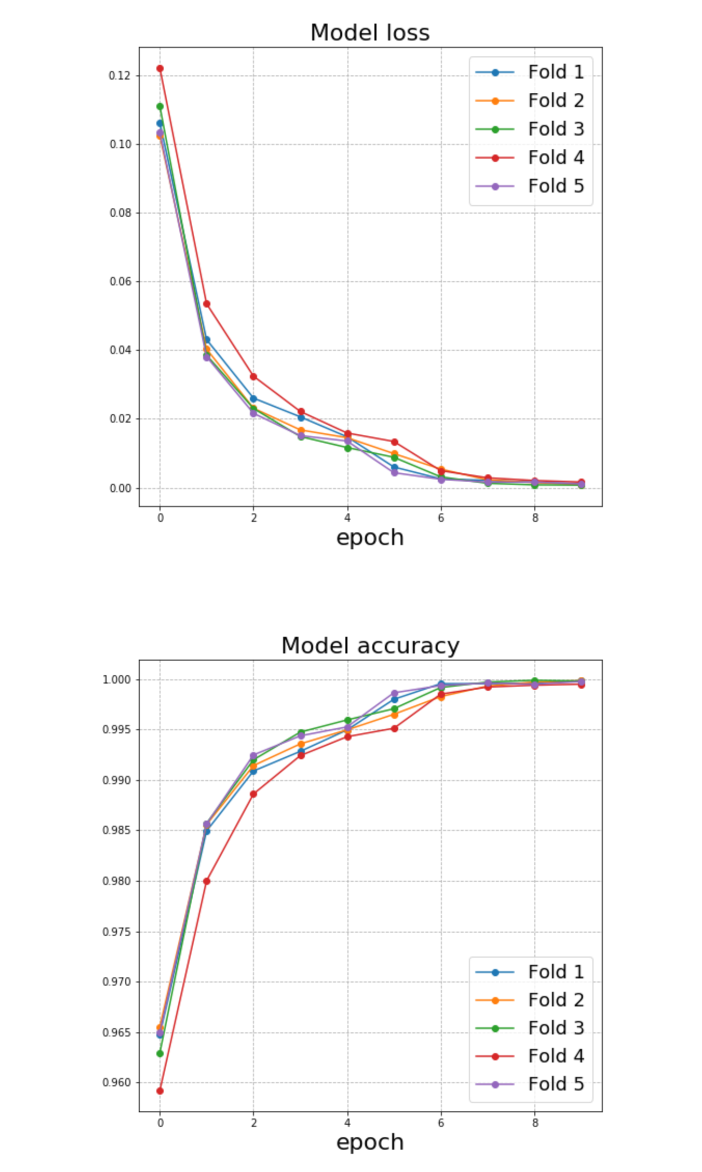
In this work, a deep learning-based model has been developed using convolutional recurrent neural network(CRNN) architecture. The CRNN network is used to assist the learning process of the model with hidden sequential and gradient-based features within the image instead of the traditional convolution neural network (CNN). The proposed model thus enhances the effciency and overall performance of classification tasks. The rice grain images used in the proposed methodology provide a different class of features, such as textural and colour features, which can easily be recognized using the CNN. However, the morphological features, such as length, width and serial tusk structure, are best analysed when treated as sequential data. Thus, we used recurrent neural network (RNN) architecture with the CNN, combined into CRNN architecture. The CRNN is known for extensive analysis of sequences in images and hyper spectral image classification.

The proposed CRNN architecture was found to perform well in the proposed methodology , overcoming the performance of traditional CNN architecture. The proposed CRNN architecture consists of the traditional convolutional layers, given the image dimensions as input and followed by the recurrent layer, where long short-term memory(LSTM) is used for the recurrent operation. The architecture consists of five convolutional operations followed immediately by batch normalization and ReLU activation. Three of the ending convolutional operations are followed by max pooling to reduce the dimensions of the feature matrices. Thus, the final max pooling layer generates a feature matrix with the dimensions (32x32x64) pixels and marks the end of the convolutional part of the CRNN network. The 3D feature matrix was reshaped into 2D data (32x2048 pixels) to be fed as input to the following LSTM layer. Recurrent operation in the architecture, as previously mentioned, was performed using a combination of forward-and backward-propagating LSTM layers. Each LSTM layer consisted of 32 cells, thus generating the feature maps, which were flattened using a flatten operation. Finally, the fully connected layer at the end generated the output.

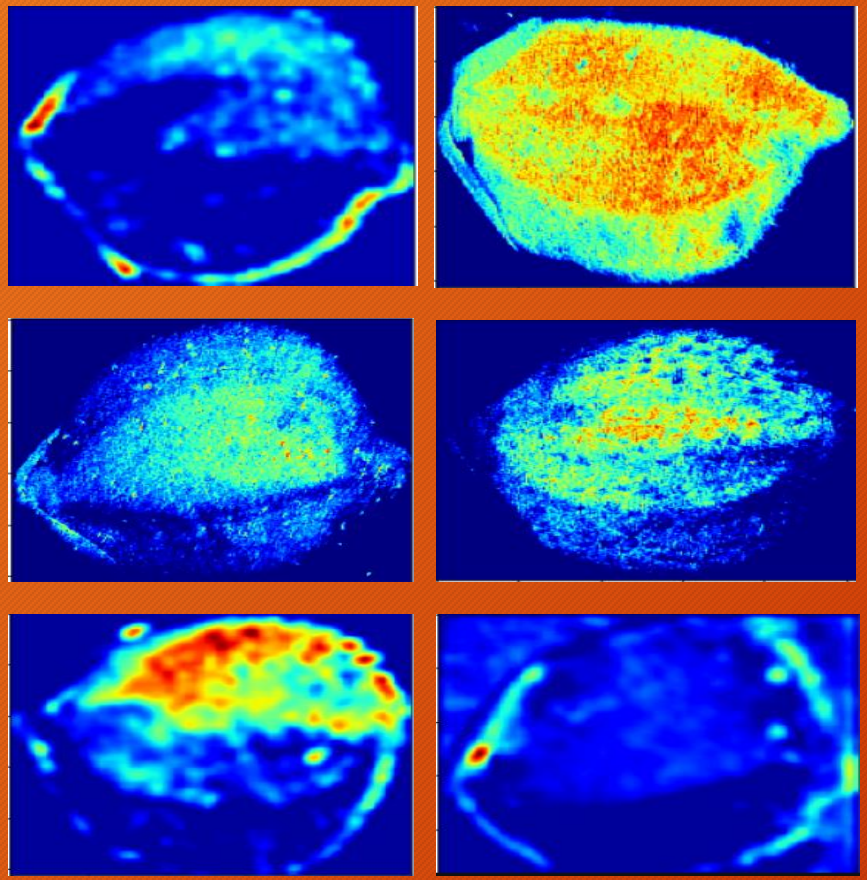
Result and Visualization

The training accuracy and the training loss curves for the five-fold cross-validation were performed using five subsets of the data, each consisting of 4,000 images.

It is clear from the training accuracy and loss for the individual folds or subsets that the proposed CRNN network converges optimally with state-of-the-art accuracy, making it much better in performance and identifying or classifying rice varieties. The proposed CRNN network thus excels in multi-class binary classification of the 20 different classes.



Feature-Map Visualization



The feature-map visualization was performed using gradient-weighted class activation maps (Grad-CAMS) on the proposed CRNN architecture. The heat-maps of the feature-maps were generated for the first activation following the first convolutional layer, and the last activation following the last convolution operation, to validate the optimal results obtained by the network for multi-class binary rice variety classification. The Grad-CAM is a visual explanation from deep networks via gradient-based localization. The Grad-CAMS generate the gradient-weighted heat map for extensive visualization and validation of the proposed CRNN network. The above visualizations show that the network has focused on the correct region of interest in the rice grain images for their optimal and extensive classification.

THANK YOU