DEEP LEARNING APPROACH FOR GRAIN QUALITY ANALYSIS

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Objective

The objective of a rice grain quality detection system using deep learning is to accurately and efficiently classify rice grains based on various quality parameters, such as colour, size, shape, and presence of impurities. The system leverages YOLO to analyze images of rice grains and identify the different types of rice grains and the number of rice grains of each kind to determine the quality of the rice sample. This automation aims to replace manual inspection, which is time-consuming, subjective, and prone to errors. Currently, the approach is primarily focused on separating coloured rice from good rice.

Preparing Dataset

1. **Capture Images**
   Images were captured using a standard phone camera from a fixed height, with around 20 grains in each photo, with a good ratio of white and coloured rice. Four such photos were taken. These photos were later augmented to increase the size of the dataset. Note that the coloured photos in this case were rice grains dyed yellow for research purposes.

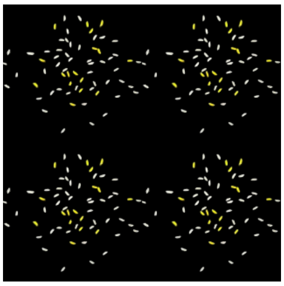
   

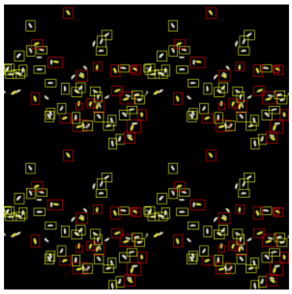
2. **Resize the Images**
   For standard image quality, all images were resized to a 250x250 dimension, using an automated Python script. The latency of this task for all four images was less that 0.5 seconds.

3. **Remove Background**
   Trial and error had proved that often, the graininess of the background could impact model training and lead to misclassification, with textures in the background also being classified as rice grains. Thus, to mitigate this issue, the backgrounds of all images were removed using an AI tool, and the background was replaced with an opaque black background. Black was chosen to also increase contrast between the rice grains and the background.

4. **Rotate the Images**
   This was the first step in the data augmentation process. Each image was rotated three times, by 90, 180 and 270 degrees respectively to get 3 new images. Thus, the dataset size increased from 4 images to 16 images. This was automated using a Python script.

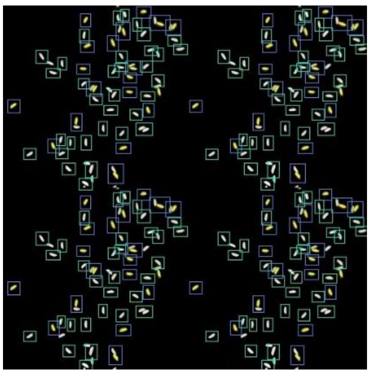
5. **Stitch the Images**
   The system, in real time, captures many more rice grains that just 20 in one frame. Thus, to increase the number of rice grains in each photo, each photo was stitched with itself four times to create a 2x2 grid. Thus, 16 photos with about 100 rice grains in each were created. This was automatically done using a Python script.





6. **Annotate the Images**
   The images were then annotated.A Python script was utilised, that used OpenCV to detect and draw bounding boxes around the rice grains, and create suitable labels that were stored in a labels.txt file. The Python script utilised OpenCV libraries to detect the rice grain and draw bounding boxes around them in a loose rectangular fashion. Each detected rice grain was then labelled as good-rice or coloured-rice. The labelling process was relatively simple here due to the obvious colour differences in the rice grain. However, labelling in scenarious where the distinction between the different types of rice grains is not so obvious may require manual annotation. Some grains that didn't get recognized were manually annotated using Roboflow. The annotated image is shown above on the right.

7. **Train**
   The YOLOv5 model was trained on this dataset of 16 images using the Roboflow notebook. Similarly, Roboflow Train was used as well to train an internal model. This YOLOv5 and Roboflow Train model both showed similar results, with the exception that Roboflow Train was allowed to train on more images, due to the in-built augmentation methods that it allows. Overall, the results were fairly satisfactory. Accuracy values were low because of small dataset size, yet the recall and mAP values were above 85% percent, showing a fairly decent model working.



Inference results produced by the deep learning model on a random image it was not trained on. As seen, the model works fairly well will proper classifications of rice grains into good and coloured rice.