



# Grading of Green Coffee Beans for Specialty Coffee using AI Based Image Processing Techniques

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This study trained an algorithm using image processing technology, a Raspberry Pi4, and a Pi camera to identify specialty-grade *Coffea arabica* beans. The algorithm, utilizing the OpenCV library and a dataset of 1,200 images, achieved an accuracy of 86.5% and a Matthews Correlation Coefficient of 0.738. It effectively rejected deformed, inert, blackened, broken, dried, and undersized beans.

## Introduction



Specialty-grade coffee is considered the premium grade in the coffee industry. The quality of specialty-grade coffee mainly relies on its grading process. According to the standards of the Specialty Coffee Association of America, grading coffee beans, especially after milling, is crucial. Traditional hand-picking for specialty-grade green coffee is labor-intensive and costly. As a solution, image processing technology offers the potential for automating this process beyond the capabilities of expensive color sorters. Therefore, this study aims to develop an automated, cost-effective coffee bean selection mechanism using image processing techniques for the specialty coffee industry.

## Results & Discussion

The test results of the optimal trained algorithm - using 100 specialty-grade and 100 defective beans.

**0.79 true positive rate**, indicated high effectiveness in identifying specialty-grade beans.

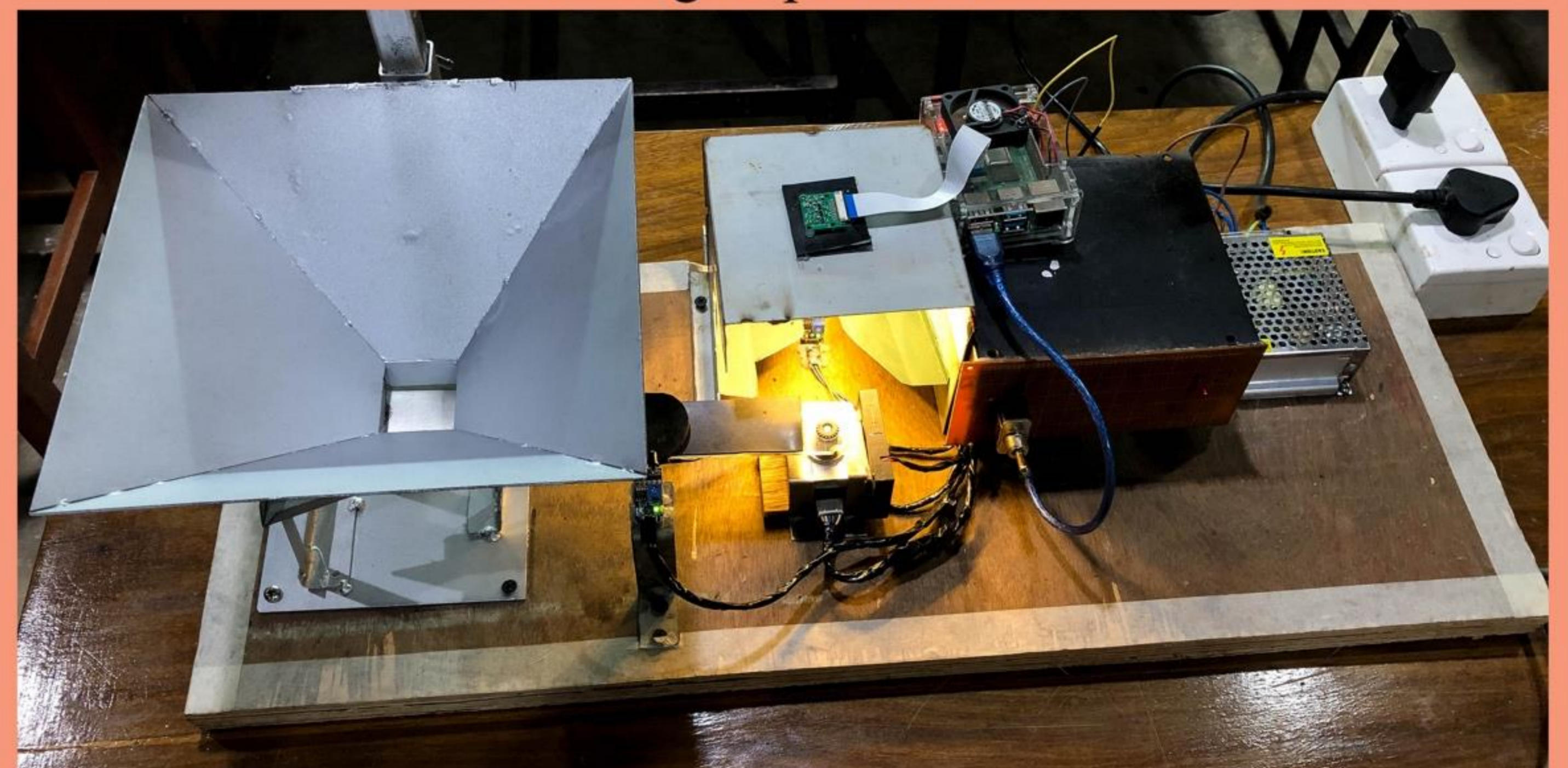
**0.94 true negative rate** showed successful rejection of defective beans.

**0.06 false positive rate** suggested minimal inclusion of defective beans.

**0.21 false negative rate** indicated some rejection of specialty beans.

The algorithm's overall **accuracy** was 86.5%.

**0.738 Matthews Correlation Coefficient (MCC)** value confirmed a strong performance, indicating consistent and meaningful predictions.



## Methodology



### Hardware Setup

Illumination box, Raspberry Pi4 & Pi camera

### Data Collection

600 photos of defected beans  
600 photos of specialty grade coffee beans



### Extraction of Features

Annotation of photos - OpenCV

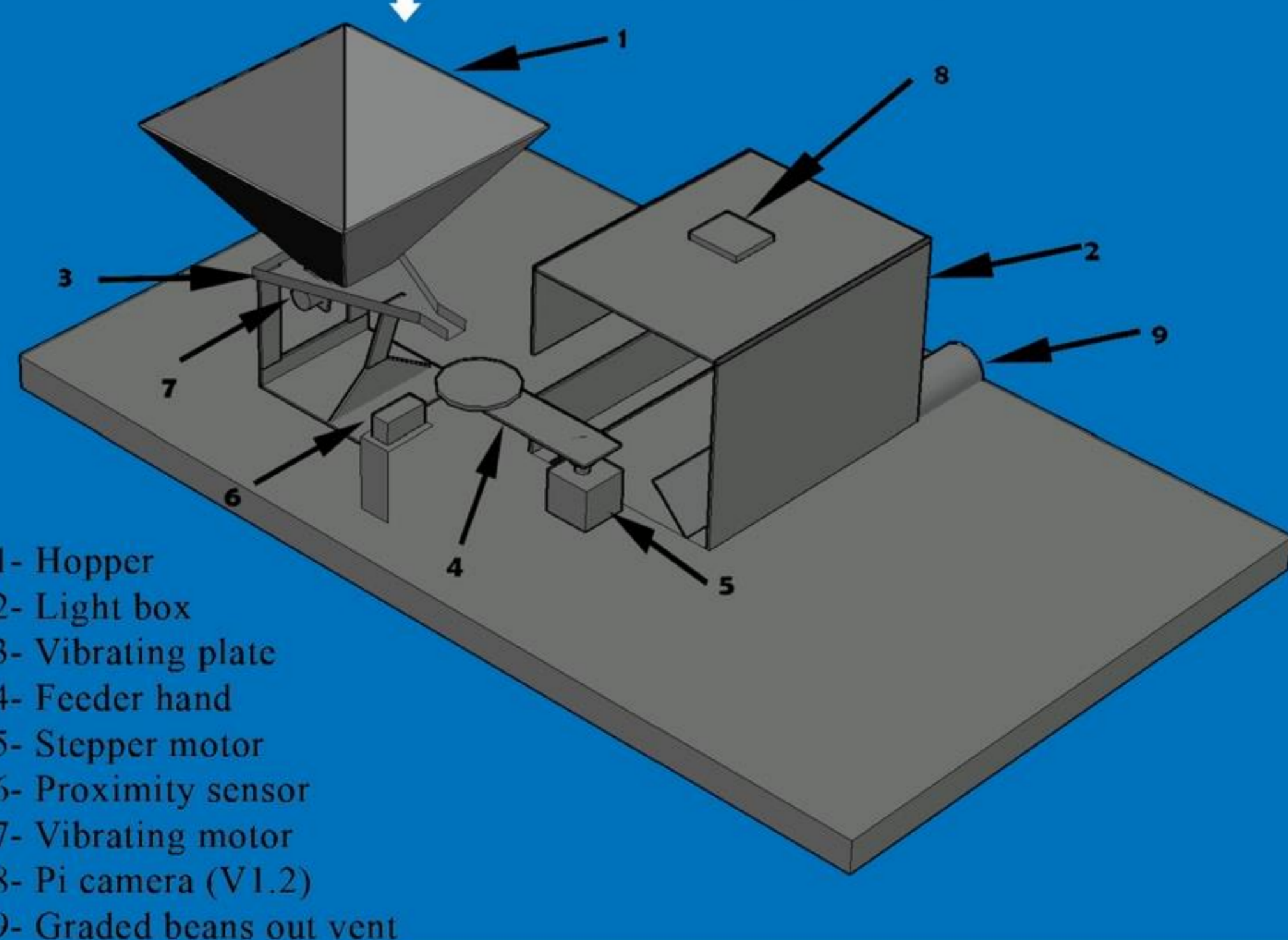
### Training the Data Set



### Trained model



### Sorter Machine



## Conclusion

This research developed an algorithm (AI) to identify specialty-grade green coffee beans based on their unique physical features. The algorithm achieved a true positive rate of 0.79, a true negative rate of 0.94, a false negative rate of 0.21, and a false positive rate of 0.06, with an overall accuracy of 86.5% and an MCC value of 0.738. These results demonstrate the potential of using image processing techniques for grading specialty coffee beans. This method can be further refined to grade *Coffea canephora* and *Coffea liberica* beans by training additional algorithms.

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