# AI and Computer Vision Techniques in Flower Analysis for Peanut Cultivation

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## Introduction

This project focuses on the three-dimensional reconstruction and flower detection of peanut plants using video footage. The aim is to create an accurate 3D model of the plants and identify the spatial positioning and distribution of the flowers. This approach is significant for in-depth plant phenotyping, offering insights into flower growth.

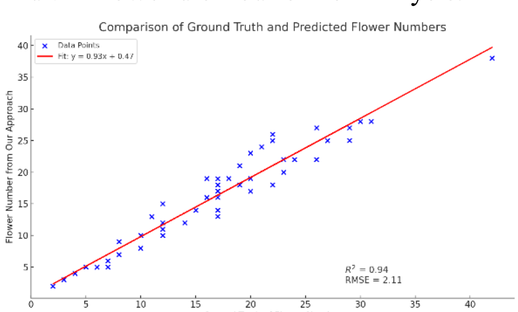
## Implementation Process

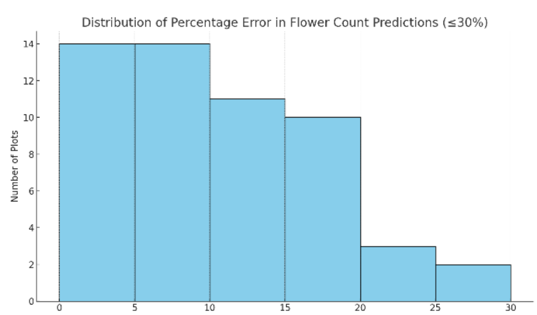
The project begins with capturing video footage that pans along rows of peanut plants, covering them from multiple angles for detailed modeling. Using FFmpeg, images are extracted at 0.1-second intervals to provide diverse perspectives. Ground truth data is collected through manual flower counting, complemented by automated detection from our algorithm. On average, each plot has 16.19 flowers, with a median of 17 and a mode of 17. The flower count ranges from 2 to 42, with most plots (27) containing 10 to 20 flowers and 15 plots having over 20.

Images are processed with Colmap, a Structure from Motion (SfM) tool, to create a 3D point cloud and retrieve camera settings. The model is refined using 3D Gaussian Splatting and converted into a mesh. Depth maps are generated by projecting image pixels onto the 3D model to calculate how far each point is from the camera. A neural network detects flowers in the images, identifying their 2D positions. Combining these with depth and camera data, we calculate the flowers' 3D locations. Redundant detections are removed using Hierarchical Clustering for accuracy. The final 3D flower distribution is saved as a point cloud, and a histogram shows the error rates between predicted and actual values, focusing on errors within 0–30% to evaluate performance, a majority of which falling within 10%.

## Results and Data Analysis

The flower detection algorithm shows strong accuracy, with an $R^2$ value of 0.94, meaning 94% of the variance in actual counts is explained by the model. The RMSE is 2.11, indicating low average deviation from true counts. A linear regression ($y = 0.93x + 0.47$) confirms a strong correlation between predictions and actual values. Most errors are within 0–30%, with the majority under 10%, demonstrating high reliability. The comparison with manual counts (shown below) confirms the accuracy of both the detection and 3D flower distribution for analysis.




## Conclusion

This project adeptly combines techniques from videography, AI, computer vision, and 3D modeling to analyze peanut plants for agricultural research. By reconstructing the plants in three dimensions and accurately mapping the location of flowers, it provides a valuable tool for studying plant growth and development. The data analysis confirms the robustness of the detection algorithm, showcasing its potential for large-scale agricultural applications.