The Future of Farming: Depth Anything Model for Yield Forecasting

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Objective

The objective of this research is to refine mid-season strawberry yield forecasting by harnessing the Depth Anything Model (DAM) for automating canopy volume measurements from 2D images. We aim to eliminate the laborious and error-prone manual methods, leveraging these automated metrics to bolster the precision of a Multivariate Time Series Model. Ultimately, our goal is to provide farmers with accurate, timely data for labor scheduling and resource optimization, setting a new benchmark in precision agriculture.

Methodology

Data Collection:
- Weekly image capture, 2023-2024 season
- Manual counts: flower/fruit stages (green, white, pink, red)
- Yield/area data for the 16 weeks

Depth Information Extraction:
- Depth Anything Model (DAM) application
- Relative depth data to estimate canopy volume

Image Filtering:
- Statistical techniques post-DAM
- Removal of non-plant depth data (e.g., beds, background)

Canopy Volume Measurement:
- Filtered image analysis for weekly volume tracking
- Consistent, non-manual measurement method

Multivariate Time Series Forecasting:
- Model with growth stage counts, canopy volume inputs
- Yield prediction for the following week

Field Setup & Data Collection

Figure 1: Field Layout

Figure 2: Image Data Acquisition

Preliminary Depth Anything Model's (DAM) Canopy Volume Estimation Results

Figure 3: RGB Image Acquisition

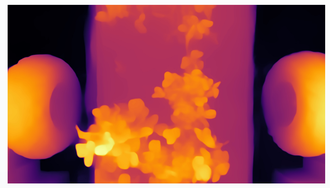

Figure 4: DAM Depth Estimated Image

Figure 5: Filtered Depth Estimated Image

Figure 6: RGB Image Acquisition

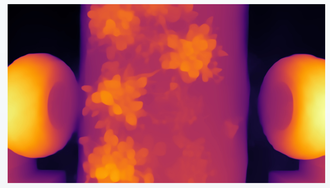

Figure 7: DAM Depth Estimated Image

Figure 8: Filtered Depth Estimated Image

Preliminary Yield Data Analysis & Forecasting Model Results

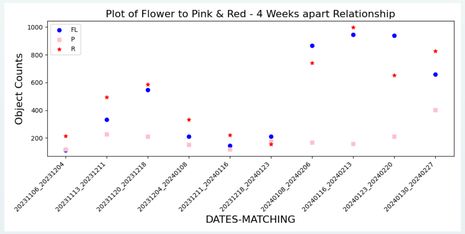

Figure 9: Flower to Pink & Red 4 weeks apart Relationship

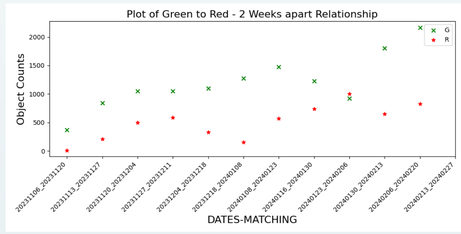

Figure 10: Green to Red 2 weeks apart Relationship

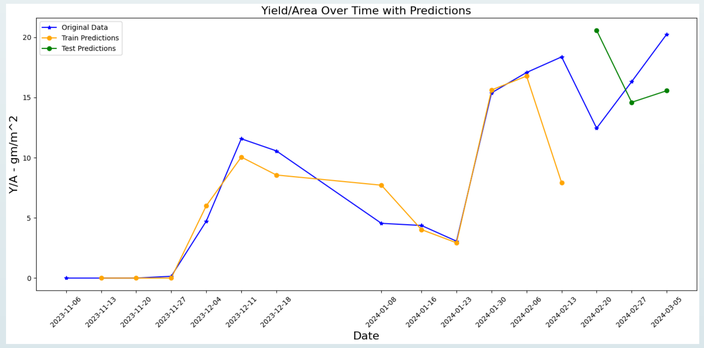

Figure 11: Crop Yield Predictions v/s Actual Strawberry Yield Data

Preliminary Results

Our multivariate time series forecasting model shows promising results in predicting weekly strawberry yields. The training phase yielded an MSE (Mean Square Error) of 10.6(gm/m^2), and an MAE (Mean Absolute Error) of 1.6(gm/m^2), indicating strong accuracy. However, on unseen data, the model's MSE increased to 30.3(gm/m^2) and MAE to 4.8(gm/m^2), suggesting a decrease in predictive reliability. These findings highlight the need for further model optimization to enhance performance on new data.

Conclusion

The combination of the Depth Anything Model (DAM) and a multivariate time series model delivers reliable strawberry yield forecasts, maintaining robustness amidst imperfect image data. This showcases the potential for improved agricultural decision-making and indicates a promising direction for enhancing object detection-counting & image-filtering methods.

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References

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[2] Depth Anything: Unleashing the Power of Large-Scale Unlabeled Data, https://doi.org/10.48550/arXiv.2401.10891.