Spatio-temporal generation of morphological Plant features for yield prediction before harvest from Visual Image input using *Progressively Growing GANs*

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1 Abstract

Recent Innovations in Precision Agriculture (PA) are driven by Computer Vision and Data Processing systems to quantify plant parameters. Quantitative analysis of Plant Phenotyping in PA and monitoring morphological traits is a protracting process, precluding the objective and phenotyping pipeline. Greenhouses growing Genetically Modified (GM) crops need to be maintained at constant environmental and simulated conditions. Multiple parameters have to be controlled and regulated inside a greenhouse for effective growth of crops and yield maximisation. Not at all times are these factors derived and so, yield maximisation in greenhouse is an experimental approach to new varieties. For deduced environmental parameters and conditions for certain crops, few other biotic and abiotic factors can hinder or affect growth in certain ways that are not always factored in during calculating parameters conducive for plant growth. Such factors may not always be affecting parametral calculations, but transpose visual cues on plant growth environment such as spectral change in soil values, or minute changes like leaf reflectance or visible changes in plant stimuli to biotic factors. Plant growth is inclusive of multiple environmental variables, and yield maximisation approaches are experimental to finding the optimum derived value for these variables. Computer Vision provides a catalytic approach to predicting optimum parameters for yield maximization in phenomics. Computer Vision and Generative Adversarial Networks (GAN)'s offer a catalytic approach to the time-consuming process, providing a solution to the phenotyping bottleneck. This research proposes a concept of curating data of plant growth over time to predict conditional growth and responsive stimuli of the plant under different situations and how this can affect crop yield. The method proposed here is a non-invasive approach to the existing destructive biomass estimation methods and Frameworks. This methodology of the research focuses on utilizing image parameters modelled using a time series *Progressively Growing Generative Adversarial Networks PGGAN* to map plant growth patterns and progressive variance in biomass of plant in the Spatio-Temporal Domain. These Generative networks evaluate and predict based on merely raw pixel input excluding dependence on further constraints, feature vectors or parameters influencing data.

1.1 Fast-Forward Session Slide

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Introduction:

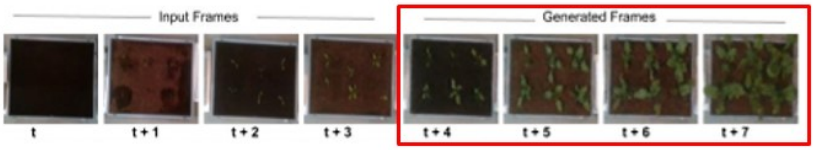
Greenhouses and Vertical farms need to be maintained at constant environmental conditions for optimum plant growth and calculating these environmental variables is a slow process.

Research Aim:

To develop an automated solution to generate visual future plant growth frames months before harvest using just RGB image input and Generative Adversarial Networks (GAN).

Result:

Developed a GAN model on *Beta vulgaris* and *Arabidopsis thaliana* and showed 98% overall accuracy in predicting plant growth and suitable environment providing maximum plant yield in Greenhouses and Vertical Farms.



For an Input of 4 images in the *Beta vulgaris* model, it was able to generate 4 frames into future.

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