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3D Plant Reconstruction and Biometric Measurement

IP Status: Issued US Patent; 11,275,941

Reliable Corn Plant 3D Segmentation

An automated methodology provides detailed and reliable information from 3D models of corn canopies. High resolution images of corn stalks are collected and used to obtain 3D models of plants of interest. The 3D model focuses on maize in growth stages where the plants are still susceptible to treatment, and the 3D crop reconstructions provide measurements with a granularity and frequency not previously available to the agriculture community.

Estimates Leaf Area Index, Plant Height and Leaves per Plant

3D reconstruction of small batches of corn plants provides an alternative to existing cumbersome biometric estimation methodologies. The methodology estimates biometrics of a group of plants using their 3D models and provides a low-cost, mobile, and easily deployable solution for automated computation of the plant's biometrics. Self-Organized Map (SOM), a computationally efficient algorithm, calculates several biometrics based on extracted 3D point clouds. SOM is an unsupervised algorithm that uses two fully connected layers of a neural network to create a grid that organizes itself to capture the topology of provided data. The SOM algorithm is particularly robust, adapts to data and provides a leaf-like shape. It can estimate biometrics such as Leaf Area Index (LAI), height, and/or number of leaves of each plant. In addition, the same algorithm can be used for biometrics that depend on the 3D points where a leaf and the stem meet (i.e., leaf count, leaf angle with respect to the stem, and inter-nodal distance).

Improved Biomass Calculations and Biometric Measurements

Current methods for calculating biomass and measuring biometrics suffer from a number of drawbacks. Planar methods suffer from reduced loss attributed to leaf occlusions, invasive methods for accurate biomass calculation rely on plant deconstruction, and biometrics based on mathematical models and sparse measurements collected randomly throughout the field provide results that reflect only an average of several measurements characterizing a wide area. This new technology uses 3D models to increase accuracy of collected information, and its non-invasive methodology leaves crops intact. For broadleaf plants such as corn, LAI is currently computed either directly or indirectly. Direct methodologies produce accurate results but are time consuming and destructive, while indirect methodologies require human handling, making measurement collecting field prohibitive, costly and inaccurate. Remote sensing offers promising indirect approaches for measuring spatial variability in LAI, and by using detailed 3D models of individual crops, this new approach alleviates many of the current shortcomings. This new technique provides LAI measurements useful for daily updates of crop growth models and enhances the ability to estimate crop nutrient requirements. In addition, the robust SOM algorithm overcomes limitations such as noise, small number of points and sparse reconstruction.

BENEFITS AND FEATURES:

Technology ID

20180265-20180266

Category

Engineering & Physical Sciences/Instrumentation, Sensors & Controls
Engineering & Physical Sciences/Robotics
Software & IT/Algorithms
Software & IT/Simulation & Modeling
Agriculture & Veterinary/Ag Biotechnology

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- 3D models provide detailed and reliable information
- Provides measurements with a granularity and frequency not previously available to the agriculture community
- Estimates plant biometrics using 3D models
- Low-cost, mobile, and easily deployable automated biometric computation
- Self-Organized Map (SOM), a computationally efficient algorithm
- Algorithm is robust, adapts to data and provides a leaf-like shape
- Estimates Leaf Area Index (LAI), height, and/or number of leaves of each plant
- Higher granularity to potential treatment strategies
- Non-invasive and non-destructive

APPLICATIONS:

- Crop biometrics
- Crop growth models and nutrient requirements
- Corn crops

Phase of Development - Prototype developed

Researchers

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