PlantScan3D

Reconstruction of a geometric 3D plant model from laser data (PlantScan3D)

ABSTRACT

The Plantscan3D project was interested in the reconstruction of plant architecture from laser scanner data. Indeed, the automatic acquisition of plant phenotypes, and in particular of architecture traits, constitutes a major bottleneck of the construction of quantitative models of plant development. The research group of this project join plant scientists, modellers and computer scientists in order to setup a complete methodology of acquisition and reconstruction using laser scanner device. A first action of the project was a comparative test of several laser devices including a Konica Minolta, a Leica and an Artech 3D Walle. Different resolution and noise level were characterized. Additionally a database of scans of plant were made and used for the test of reconstruction algorithms. This database includes some grass plants (Alfalfa, Yucca, Fescue, etc.), some trees at different growth stage (poplar, citrus tree, olive tree, grapevine, pine, apple tree with and without leaf, cherry tree). It is freely available on the web and may be used all the scientific community to test new reconstruction pipelines. A first pipeline for the reconstruction of the architecture of plant was built in the context of the PhD of C. Preuksakarn. Due to multi-resolution nature of trees, measuring them with laser scanners produces data at different levels of precision. Points set are usually dense on the surface of the trunk and of the main branches, but only sparsely cover thin branches and small twigs. While previous methods typically loose accuracy by populating sparse-points regions with plausible structures, we propose the first faithful reconstruction of the tree skeletal structure. This is achieved thanks to a method locally adaptive to the different level of precision of the data that combines a contraction phase and a local point tracking algorithm. Good results were achieved on a variety of trees with various complexities. In addition, we developed a quantitative evaluation procedure enabling us to compare our reconstructions against expert-defined structures of real plants. We use it to assess the accuracy of our reconstruction algorithm and compare it with previous algorithms. These pipelines are implemented and distributed as open source software in the OpenAlea platform (http://openalea.gforge.inria.fr). Finally, in the context of the PhD of M. Balduzzi, a pipeline for reconstructing the geometry of the foliage of trees is currently investigated. In this second study, the point cloud information is combined with the intensity of the reflected laser beam to set up a method for leaves segmentation and digitizing. This intensity is highly dependent on the object geometries. It is used to detect outlier points and to reconstruct and segment leaves in an optimized manner.

Keywords : Plant, Ecophysio/architecture/phenotyping, Operation, Architecture, Method/tool/technic, Model, Phyolgeny, Tomato

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PERSPECTIVES

The release of an evaluation pipeline to the scientific community will makes it possible to validate and compare the different method that will be further proposed in the literature. A on-going project is to adapt the reconstruction pipeline for the plant architecture to quantify rapidly the evolution of architectural traits of different phenotypes. This project should provide biologist tools to resolve partially the high throughput phenotyping of plants. Similarly, the pipeline for reconstructing foliage, once finalized, should makes it possible to better characterize the dynamic of the spreading of light intercepting surfaces of a plant and thus feeds with realistic data ecophysiological models. Finally coupling laser scans data with thermal imaging should makes it possible to better interpret the measured temperature of the canopy. This last topic is the challenge of an Inra project that follows the PlantScan3D project.