PMA03 2003' International Symposium on Plant Growth modeling, simulation, visualization and their Applications.

Beijing October 13-16th. Advanced program

TUTORIAL SESSION PROGRAM (Monday, Oct.13th)

Course #1. The simulation of organogenesis of plant architecture.

Principles. Botanical backgrounds and mathematical basis.
The structural model. The dual scale automaton.
Plant architecture Simulation. The simulation of architectural models. Examples.
The VisualPlant Software. Examples, demonstrations and practice.

Course #2. Modelling the growth of cultivated plants based on the source-sink relationships.

Introduction to the GreenLab structural- functional model. Background and basis.
Model calibration under optimal conditions. From Principles and data acquisition to CornerFit software Tool
Model applications to cultivated plants. Examples on Sunflower, maize, winter wheat.
Practice session. Growth simulating of single-stem plants. Model calibration by using real data and simulated data.

Both Courses do include botanical, eco-physiological and mathematical basis relevant for these sessions
Material supplied: CD for every registered participant, which contains: the tutorial slide supports ; the application softwares VisualPlant and CornerFit for Windows NT/2000 with their user's manuals and example data sets; a collection of references.

INVITED TALKS. (OCT. 14TH -15TH)

Barthelemy D. (INRA/CIRAD, France) Botanical Background for Plant Architecture Analysis and Modelling
Heuveulink E. (Wageningen University, Netherlands) A photosynthesis-Driven Tomato Model: Two Case Studies
De Reffye P. (CIRAD/INRIA, France) Relevant qualitative and quantitative Choices for Building an Efficient Dynamic Plant Growth Model: GreenLab Case
Honjo T. (Chiba University, Japan Visualization of Landscape by Using Plant Modeling Technique

DETAILLED SCIENTIFIC PROGRAM SESSIONS (TENTATIVE, OCT. 14TH-OCTOBER 16TH)

Plant Growth modeling - Structural models

Invited Talk: Botanical background for plant architecture analysis and modelling. Barthelemy D.
GreenLab: Towards A New Methodology of Plant Structural- Functional Model -Structural Aspect. Hu B.-G., De Reffye P., Zhao X., Yan H.-P., Kang M.-Z.
D0L-systems Described by Production Tree. Wei M.-Z., Xie Z.-X.
PlantVR: An Algorithm for Generating Plant Shoot and Root Growth Using Applied Lindenmayer Systems. Chuai-Aree S., Jaeger, W., Bock H.G., Siripant S., Lursinsap C.
ADEL-Wheat: A 3D Architectural Model of Wheat Development. Fournier C., Andrieu B., Ljutovac S., Saint-Jean S.

Plant Growth modeling - Functional models - Physiology

Phenological effects on photosynthesis: suggestions for modelling. Urban L., Lechaudel M., Lu P.
Modelling asynchronous flowering. Normand F., Chadoeuf J., Habib R.

Plant Growth modeling - Functional and Structural models

Invited Talk: Relevant qualitative and quantitative Choices for Building an Efficient Dynamic Plant Growth Model: GreenLab Case. P. De Reffye P., Hu B.-G.
The Dynamic Equations of the Tree Morphogenesis GreenLab Model. De Reffye P., Goursat M., Quadrat J.P., Hu B.-G.
Study on Plant Growth Behaviors Simulated by the Functional-structural Plant Model-GreenLab. Yan H.-P., De Reffye P., Leroux J., Hu B.-G.

Simulation and visualization - Simulation

Could virtual plants be considered as Lambertian objects in dense canopies ? Chelle M.
A Method To Create Plant Based on Component Technique. Ding W.-L., Xiong F.-L.
Interactive Simulation of Plant Architecture Based on a Dual-Scale Automaton Model. Zhao X., De Reffye P., Barthelemy D., Hu B.-G.
Stochastic 3D Tree Simulation using Substructure Instancing. Kang M.-Z., De Reffye P., Barczi J.-F., Hu B.-G., Houllier F.

Simulation and visualization - Visualisation

Tree and Plant Volume imaging. An introductive study towards voxelized functional landscapes. Jaeger M., Teng J.
Progressive Polygon Foliage Simplification . Zhang X.-P., Blaise F.
High Performance Computing and Visualisation for Forestry Applications - Project SILVES. F. Blaise F. , Cavin X. , Paul J.-C.
Accurate Graphical Representation of Plant Leaves. Franzke O., Deussen O.
Particle Systems for plant modeling. Rodkaew Y., Chongstitvatana P., Siripant S., Lursinsap C.
3D digitisation and modeling of flower mutants of Arabidopsis thaliana. De Visser P.H.B., Marcelis L.F.M., Van der Heijden G.W.A.M., Angenent G.C.

Applications - Agronomy

Invited Talk:A photosynthesis-driven tomato model: Two case studies. Heuvelink E., Bakker M.J.
Fitting a Structural-Functional Model with Plant Architectural Data. Zhan Z.-G., De Reffye P., Houllier F., Hu B.-G.
Study on Modeling Tomato Growth Based on interaction of Its Structure-Function. Dong Q.-X., Wang Y.-M., Barczi J.F., De Reffye P., Hou J.-L.
Greenhouse Tomato Model and Its Simulation System. Sun Z.-F., Chen R.-J.
Modeling of Biomass Acquisition and Biomass Partitioning in the Architecture of Sunflower. Guo Y., De Reffye P., Song Y.-H., Zhan Z.-G., Li B.-G., Dingkuhn M.
Maize fruit sink reference based on GreenLab Model. Wu L., de Reffye P., Le Dimet F.X., Hu B.-G.
Influence of morphometric characteristics of the Hybrid Walnut tree crown (Juglans nigra x Juglans regia) on its radiative balance. Parveaud C.E., Sabatier S., Dauzat J.
Assimilation of high temporal frequency SPOT data to describe canopy functioning. Lauvernet C., Le Dimet F.X., Baret F.
Modeling yield and grain protein of Japanese wheat by DSSAT Cropping System Model. Anwar M.-R., Takahashi S., Itoh S., Nakatsuji T.
Analysis and modelling of the root system architecture of winter wheat seedlings. Zhang B.-G., De Reffye P., Liu L., Kang M.-Z., Li B.-G.
Modelling tillering in wheat (Triticum aestivum L.) using L-systems. Evers J.B., Vos J., Fournier C., Chelle M., Andrieu B.
A process & component-based wheat growth simulation system. Cao W.-X., Pan J., Zhu Y., Hu J-H., Zhuang H.-Y.

Applications - Forestry

Modelling and Sawing Simulation of Sugar Maple Logs: Application of Computer Tomography Images. Tong Q.-J., Zhang S.-Y., Levesque Y.
Tree shape measurement at the stand level for biomass, volume and wood properties assessment. Badia M., Hapca A., Constant T., Mothe F., Leban J.M., Saint-André L., Daquitaine R., Blaise F.
Sawing of Logs in Virtual Trees using 3D-Intersection Algorithms. Szafran N., Despreaux S., Biard L., Blaise F.
Application of Plant Models to Biomechanics. Fourcaud T., Dupuy L., Sellier D., Ancelin P., Lac P.

Applications - Land Use

Invited Talk:Visualization of Landscape by Using Plant Modeling Technique. Honjo T., Lim E.-M.
Coupling process models with GIS: two case studies in two scales. Huang Y.-F.
Graphic modeling and realistic computer approach, Visualization of peri-urban landscape. Alinat S., Carrie C., Auclair D.
Plant Modeling for Landscape Changes Visualization Application to a Peri-Urban Agricultural Area. Borne F., Satornkich J., Pages J., Anwar S.-M.

INVITED TALKS - ABSTRACTS

Invited Talk. Botanical background for plant architecture analysis and modelling.

Dr Daniel Barthélémy. Programme Amap Cirad-amis, Unité Mixte Cirad-Cnrs-Inra-Ird-Montpellier Univ.2 Montpellier (France)

The architecture of a plant depends on the nature and on the relative arrangement of each of its parts ; it is, at any given time, the expression of an equilibrium between endogenous growth processes and exogenous constraints exerted by the environment. The aim of architectural analysis is to identify and understand these endogenous processes by means of observation and sometimes experimentation. Considering the plant as a whole, from germination to death, architectural analysis is essentially a detailed, comprehensive and dynamic approach of plant development. Despite their recent origin, architectural concepts provide a powerful tool for studying plant form. Completed by precise morphological observations, recent researches in this field have deeply increased our understanding of plant structure and development and led to the establishment of a real conceptual and methodological framework for plant form study and modelling. This paper is a brief and summarised update of our knowledge on plant architecture and morphology.

Keys-words : plant morphology, plant architecture, level of organisation, differentiation, morphogenetical gradient, physiological age, meristem

Invited Talk. A Photosynthesis-Driven Tomato Model: Two Case Studies.

Dr Ep Heuvelink and Menno J. Baker. Wageningen University, Horticultural Production Chain Group, (The Netherlands)

A photosynthesis-driven model for potenial crop growth and yield in tomato, TOMSIM, was used in two case studies: (1) determination of the number of fruits per truss that results in maximum fruit yield for different greenhouse climatic conditions, cultivation practices and crop characteristics, and (2) studying the effect of salinity stress on optimum fruit number for maximum yield. Crop growth rate is simulated as daily crop gross assimilation rate minus maintenance respiration rate, multiplied by a conversion factor for assimilates to dry mass. Dry matter distribution is simulated based on the sink strength (demand for assimilates) of the plant organs, which is quantified by their potential growth rate, relative to the total sink strength of all sinks together. Within the plant, individual fruit trusses and vegetative units (three leaves and stem internodes between two trusses) are distinguished. Leaf area is simulated, based on simulated leaf dry mass and specific leaf area (SLA). SLA depends on the day of the year, being lowest in summer. Number of fruits per truss is an input to the model, hence, flower and/or fruit abortion is not simulated. Fruit yield is expected to show an optimum response to fruit load, as a higher fruit load increases partitioning to the fruit, possibly at the expense of total crop growth, because of reduced leaf area index (LAI). Optimum fruit number per truss was lower at reduced global radiation level, when no CO2-enrichment was applied, with earlier leaf picking, reduced SLA and larger potential fruit size. Salinity stress was implemented in the model as a reduction in SLA with increased salinity. Yield was strongly reduced as LAI was reduced. Optimum fruit number per truss decreased linearly with increasing salinity. At higher salinity levels maintaining optimum fruit numbers (less than seven) resulted in a reduction in yield loss, compared to maintaining a fixed number of seven fruits per truss. The model enables to quantify the relations between fruit load, total dry mass production and fruit yield under different conditions. It can evaluate conditions that cannot be attained experimentally, which may be important in theoretical studies. The model enables to quantify the relations between fruit load, total dry mass production and fruit yield under different conditions. It can evaluate conditions that cannot be attained experimentally, which may be important in theoretical studies.

Keys-words : model, leaf, extension, leaf picking strategy, simulation, tomato fruit yield, TOMSIM, optimum fruit number, salinity, salt stress, specific leaf aera

Invited Talk. Relevant qualitative and quantitative Choices for Building an Efficient Dynamic Plant Growth Model : Greenlab Case.

Dr Philippe de Reffye(1) and Prof. Baogang HU(2) (1)Cirad-Amis Montpellier and INRIA Rocquencourt, Metalau Project, (France). (2)LIAMA, Institute of Automation of CAS, Beijing (China).

Plant growth modelling rigorous study is a real challenge for researchers and scientists, due to the high level of multidisciplinary aspects to be integrated in. Through a mathematical formalism, a plant functional-structural model needs to be developped based on knowledge from botany, agronomy, forestry, eco-physiology and computer sciences. Specialists in each discipline have proposed variety models, but most of these models are limited to their own field. It is well recognized that the unfunctioning and the limitation of these models are due to their mono-disciplinary aspects. A dialogue between the various scientific domains involved in plant modelling is not obvious. It needs to chose, simplify and adapt the relevant knowledge from each other that is necessary and sufficient to build a plant structural-functional model. This needs also to define a right level of observations. Each notion is simplified, but the interactions between them give new theoritical results and applications. Several questions are discussed in this work. How can botany give keys to organize the multi level information inside the plant topological structure and eventually speed up the growth computing ? What kind of mathematical formalism is needed to introduce powerful tools of automatic control into plant modelling ? The goal of this paper is to propose some simple choices, from both biological and mathematical viewpoints, and adapt them to build an efficient dynamical model. With this model, it is possible to insure optimisation and control that are needed in agronomy.

Keys-words : plant growth, modeling, dynamic process, botany, agronomy, mathematics, relevant study

Invited Talk. Visualization of Landscape by Using Plant Modeling Technique.

Dr Tsuyoshio Honjo and Em-Mi Lim. Department of Environmental Science and Landscape Architecture, of Chiba University (Japan)

Recent progress of plant modeling technique enables the realistic modeling of plant shape and the realistic landscaping. In this study, applications of plant modeling technique on making realistic images for landscape planning are reviewed. Simulation of landscape by linking GIS (Geographic Information System) and plant modeling technique and application of VRML (Virtual Reality Modeling Language) for real-time walk-through in a virtual landscape are also explained.

Keywords: plant modeling, computer graphics, landscape simulation, virtual reality, VRML