Geophysical Research Abstracts
Vol. 12, EGU2010-4270, 2010
EGU General Assembly 2010
© Author(s) 2010

Validation of a COMSOL Multiphysics based soil model using imaging techniques

Robert Hayes (1,*), Paul Newill (1), Frank Podd (1), Oliver Dorn (2), Trevor York (1), and Bruce Grieve (1)

(1) SSUIC, School of Electrical and Electronic Engineering, University of Manchester, UK, (2) Inverse Problems Group, School of Mathematics, University of Manchester, UK, (*) Author for correspondance, email: robert.hayes@postgrad.manchester.ac.uk

In the face of climate change the ability to rapidly identify new plant varieties that will be tolerant to drought, and other stresses, is going to be key to breeding the food crops of tomorrow. Currently, above soil features (phenotypes) are monitored in industrial greenhouses and field trials during seed breeding programmes so as to provide an indication of which plants have the most likely preferential genetics to thrive in the future global environments. These indicators of "plant vigour" are often based on loosely related features which may be straightforward to examine, such as an additional ear of corn on a maize plant, but which are labour intensive and often lacking in direct linkage to the required crop features.

A new visualisation tool is being developed for seed breeders, providing on-line data for each individual plant in a screening programme indicating how efficiently each plant utilises the water and nutrients available in the surrounding soil. It will be used as an in-field tool for early detection of desirable genetic traits with the aim of increased efficiency in identification and delivery of tomorrow's drought tolerant food crops.

Visualisation takes the form of Electrical Impedance Tomography (EIT), a non-destructive and non-intrusive imaging technique. The measurement space is typical of medical and industrial process monitoring i.e. on a small spatial scale as opposed to that of typical geophysical applications. EIT measurements are obtained for an individual plant thus allowing water and nutrient absorption levels for an individual specimen to be inferred from the resistance distribution image obtained. In addition to traditional soft-field image reconstruction techniques the inverse problem is solved using mathematical models for the mobility of water and solutes in soil.

The University of Manchester/Syngenta LCT2 (Low Cost Tomography 2) instrument has been integrated into crop growth studies under highly controlled soil, nutrient and environmental conditions. X-ray imaging has been used to observe the water content of soil for various saturation levels under controlled environmental conditions. The resultant images are compared with those obtained from the Richard's equations solution using a finite element model (FEM). EIT images are also taken under the same controlled conditions to provide an in field replacement for x-rays.

These early studies stand as a proof-of-concept and have given the research team an understanding of the technical challenges that must now be addressed to take the current instrumentation into the world of agri-science and food supply.