The Model LIGNUM

The model LIGNUM presents coniferous and deciduous trees with simple structural units, called stems, branches, (B) and leaf (L) that have close shown to real tree parts. The main functioning unit is the cylindrical tree segment consisting of heartwood, sapwood and foliage. Figure Ia introduces a model tree for conifer and Figure Ib is simulated Scots pine. Figure IIa reveals a model tree with required leaves for deciduous species and Figure IIb is a simulated sugar maple.

We present the ongoing work in LIGNUM regarding the modelling of the tree architecture with Lindenmayer systems and the assessment of the radiation regime using a discrete representation of the growth space.

Lindenmayer Systems

Lindenmayer systems, or L-systems for short, invented in 1968 by Aristid Lindenmayer, are term rewriting systems defined by an alphabet and a set of rewriting rules on a determining all the possible words, so-called terms, that can be generated by the system. The rewriting begins from a special string called axiom. For example, for the following (A) and two rewriting rules A>B and B>A, assigning B as the axiom the first five words generated by the L-system are A B A B A BB AB ABB ABBA ABBAB... (Prusinkiewicz and Lindenmayer, 1990). Note that the rewriting develops in parallel.

In the context of plant modelling the alphabet of an L-system will describe different tree species and their 3D orientation in space. The rules will describe the architectural development of the plant in time.

Several tools have been developed based on the L-systems. These tools not only implement the rewriting mechanisms but provide other programming constructions like variables, parameters, user defined functions etc. In LIGNUM we have implemented systems using a subset of the language L (Prusinkiewicz et al, 1999).

The language L integrates to the C++ language all the constructs of a modern computer programming language can be used by the user. The user can extend the L-system with own functions and classes as well.

LIGNUM has already been used to a number of research tasks, e.g.: 1) The applications for Scots pine (Perttunen et al, 1996) and Jack pine (Perttunen et al, 2001). 2) The applications for sugar maple (Perttunen et al, 2001). 3) The applications for sugar maple plants in forest gaps (Perttunen et al 2001).

The recent work with the Lindenmayer systems and the discrete radiation regime models is intended to extend the capabilities of LIGNUM in the study of the ecological and functional interactions of plants in different forest stands.

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