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DISCRETE EVENT SIMULATION OF WOOD HARVESTING PROCESSES

Thomas Wolferstetter

Technische Universität München TUM
Academic Chair of Forest Work Science and Applied Computer Science
Hans-Carl-von-Carlowitz-Platz 2
85354 Freising
e-mail: wolferstetter@wzw.tum.de

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Abstract: *Discrete event simulation is used in industrial applications as an effective information system to support decision-makers, especially in logistics of manufacturing processes. Evidentially this can work in forest operation planning as well, while accepting the challenges of the huge variety of forest conditions. Based on the preliminary works of Bruchner (2003) and Hemm (2006) this contribution is about the illustration of wood harvesting processes in a discrete event simulation software based on the model of the Virtual Forest of North Rhine-Westphalia.*

1. Introduction

The German sector of forest and wood business developed highly dynamical in recent years. This demands a great deal of management and process engineering within the forestal supply chain. Forest men should work sustainable and customer oriented but under high cost pressure and in a challenging environment of a multifunctional forest. A pre-condition for good decisions in managing wood harvesting processes is the accurate knowledge of this environment on the one hand and of the production factors on the other hand. Therefore the federal state of North Rhine-Westphalia in Germany is developing the so called Virtual Forest. Designed as a big database it provides all informations of the existing stands up to the attributes of the single tree. Its accurate transformation of the real environment offers the possibility of close to reality simulation in step with actual practice.

2. The Virtual Forest of North Rhine-Westphalia

The database of the Virtual Forest arises from highly developed remote sensing data. The High Resolution Stereo Camera (HRSC) delivers RGB- and Orthophotos. They are adjusted by an extra infra red channel of the satellite SPOT. A complete gathering of the surface by laser scanning together with the stereoscopic analysis of the photos allows to achieve a detailed copy of stand and terrain structure. Already existing digital maps are added which provide attributes like water balance, type of soil or even properties (Rossmann et al., 2007). Nearly every tree in North Rhine-Westphalia should be captured this way in the next years.

3. Discrete Event Simulation based on the model of the Virtual Forest

Due to the information density of the Virtual Forest it is obvious to use the database as a model for simulation. The development of the Virtual Forest is therefore accompanied by the design of a simulation tool. It displays the processes of harvesting systems represented by harvester, forwarder, skidder and motormanual work. The ground base is a process model which aligns the logical sequence of processes. Main actors of the process are the single trees and respectively the single logs. By passing the single working steps of the different resources they are changing attributes and type of state.

Figure 1. The process model aligning the sequence of processes

For every working step the data of scientific time studies is deposited as a formula of time consumption depending on the attributes of its environment. A first result of a simulation run is the protocol of a resource which delivers the working step with time consumption assigned to the specific tree or log. The protocols as well as further analysis of the simulation run is designed with the software Microsoft Excel. The final analysis contains detailed information about the work progress of every resource and the results of the whole harvesting operation.

	A	B	C	D	E	F	G	H
1	Time	Step	Tree_Nr	Distance	Operating Status			
2	1	0	6063	5,17	Processing			
3	3	0	6063	5,17	Processing			
4	3	1	6063	5,17	Processing			
5	25	4	6063	5,17	Processing			
6	29	5	6063	5,17	Processing			
7	35	7	6063	5,17	Processing			
8	53	0	6059	11,9	Processing			
9	55	0	6059	11,9	Processing			
10	55	1	6059	11,9	Processing			
11	83	4	6059	11,9	Processing			
12	86	5	6059	11,9	Processing			
13	92	7	6059	11,9	Processing			
14	108	0	6055	13,16	Processing			
15	108	0	6055	13,16	Processing			
16	108	1	6055	13,16	Processing			
17	142	4	6055	13,16	Processing			
18	147	5	6055	13,16	Processing			
19	154	7	6055	13,16	Processing			
20	172	0	6043	26,58	Processing			
21	176	0	6043	26,58	Processing			

Figure 2. Protocol of the harvester’s work progress in MS Excel

4. The Automatic Routing System

One main challenge is the development of an automatic routing system, which allows the logical procedure of the harvesting resources in different scenarios. This cannot be solved perfectly. While handling the traveling salesman problem this routing system must also deal with collision avoidance, unidirectional trafficability of inclined skid roads and many other restrictions (Gritzmann et al. 2009). Therefore an iterative method was favored that provides good solutions of routing in the vast majority of scenarios. Every tree which is to harvest in the scenario gets its own stop on the appropriate skidding road. These stops of a scenario are clustered in a special manner to achieve a spanning tree which allows the appliance of one routing rule for the harvesting resource.

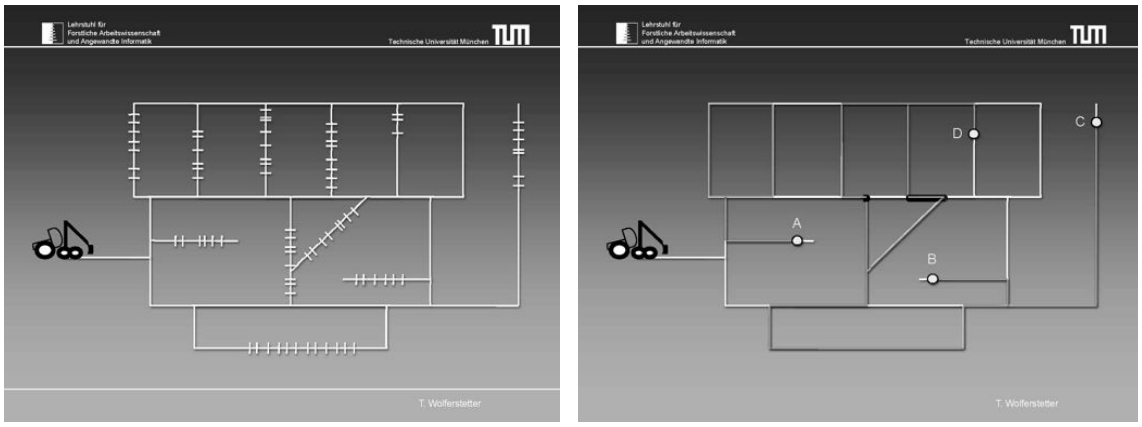

Fig. 3: Clustering of stops of a scenario

5. Future Prospects

The assignment of the current project is to increase the reliability of simulation results by consolidating the performance data of the harvesting resources. Scientific time studies cannot cope with the diversity of forest conditions on their own. Therefore, automatic monitoring systems modern machines run with, are to be analyzed if they are useful to stabilize the database.

References

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