News

Precision Forestry Cooperative

College of Forest Resources
University of Washington
Fall 2002

From the Executive Director
Doug St. John

At the Precision Forestry Cooperative we have been focusing on achieving results in the last several months and have some great successes to share. We received funding from the Federal Joint Fire Science Program to develop, in cooperation with the U.S.D.A. Forest Service Pacific Northwest Research Station, how LIDAR (Light Detection And Ranging) and IFSAR (Interferometric Synthetic Aperture Radar) can be used to measure forest fire behavior variables. In May we completed field work in Capitol Forest working with the Applanix corporation, traveling through the forest with an inertial measurement unit.

Field testing with Applanix. See story on page 3.

Recently we have taken Radio Frequency Identification (RFID) tagging technologies into the field. In February we worked with forester John Trobaugh to tag tree seedlings. In early August we finished our implementing RFID technology to the Brockman Memorial Tree Tour here on the University of Washington Seattle campus to demonstrate this technology. This self guided tour is now interactive with the tour goer via a personal digital assistant (PDA). We continue to look for and identify the best technologies to apply to forest management and forest product processing. A key to this success is the involvement of our partners. We would like to thank those that continue to work with us and look forward to developing new partnerships with others. We anticipate starting the search for a permanent director and assistant professor for the PFC in Autumn 2002.

The Precision Forestry Cooperative is proud to announce that on December 12th we were notified that our project on "The Use of High-Resolution Remotely Sensed Data in Estimating Crown Fire Behavior Variables" was selected for funding by the Department of the Interior – Department of Agriculture, Forest Service, Joint Fire Science Program. Prof. Gerard Schreuder, Prof. Jim Agee, and Doug St. John are the principal investigators on the project in cooperation with Steve Reutebuch of the U.S.D.A. Forest Service Pacific Northwest Research Station. The project will investigate and develop the use of two high-resolution, aircraft based remote sensing technologies to assess forest canopy characteristics critical to forest fire behavior: LIDAR (Light Detection And Ranging) and IFSAR (Interferometric Synthetic Aperture Radar). This funding totals $700,000 over the three year project period.

Second International Precision Forestry Symposium June 15-18, 2003

The 2nd International Precision Forestry Symposium will be held on June 15-18, 2003 at Kane Hall on the UW campus. The symposium will focus on four session topics:

- Remote Sensing of Forest Land and Vegetation
- Terrestrial Sensing, Measuring, and Monitoring
- Precision Operations and Equipment
- Design Tools and Decision Support Systems

Along with the University of Washington, College of Forest Resources, the Forest Engineering Research Institute of Canada (FERIC) and the USDA Forest Service PNW Research Station have offered to be co-sponsors of the 2003 symposium. We look forward to the opportunity of working with both organizations.

Those wishing to present a paper or poster should email a title and abstract to Forestry Continuing Education at ForestCE@u.washington.edu by October 15, 2002. The Symposium Scientific Committee will review submitted abstracts as an oral or poster presentation. More inofrmation regarding the symposium can be found on the CFR website: www.cfr.washington.edu/Outreach/PreFor/ondex.html and on the Precision Forestry website: www.precisionforestry.org.

RFID Update

Sean Hoyt
Graduate Student, College of Engineering, University of Washington

Sean Hoyt and Melissa Brown tagging trees for the Brockman Tree Tour.

For the past six months, I have been busy constructing a FSK reader to interface TI glass tags and for future moisture, density, and diameter research. I also have continued my work towards the UW Brockman Tree Tour. Much work has gone into the construction of UW map navigation, database lookup, and media presentation via a Pocket PC device for the tree tour. We hope to have the tree tour up and running by August 2002. Visit the PFC website for updates.

In February PFC visited Plum Creek's Cottage Grove tree nursery with some RFID (Radio Frequency Identification) tags and readers. An RFID tag provided a method to have a unique identification, or serial number for each tree. With the help of Plum Creek nusery and Jerry Barnes with the Tree Improvement Enterprises, we place sealed glass RFID tags in 2 year old seedlings. Our expectation is that as the tree grows the tag will be secured inside the tree, but still readily readable.

RFID tagged two year old seedling just after being grafted with a new leader

RFID tagged seedling six months after tag was inserted in graf.

Sean Hoyt
UW Graduate Student

Sean Hoyt working at the UW Engineering lab

I graduated high school in Enumclaw Washington in 1995, got an AA degree in Engineering from Green River Community College in 1997, received a BS degree in Electrical Engineering from the University of Washington in 2002 and will earn my MS degree in Electrical Engineering from the University of Washington in the summer of 2002. While working towards my MS degree, I did research in the distributed microsystem laboratory for UW Professor, Denise Wilson. My research is in applications for radio frequency identification within forestry, RFID for the Brockman Tree Tour.

During the current work week, I can be found in a lab working on projects involving radio frequency identification, designing robots to play air hockey, and trying to finish my thesis about converting color to sound.

I am a longtime resident of the west coast. Seattle is my favorite city so far, but recent travels through Europe made it a hard decision. On the weekends, you can find me biking, drawing, inventing, gardening, and shooting photographs. I always take my camera everywhere with me. I also love to do design work. Mainly, this means creating web sites and graphics. Right now, I am doing work on my personal website, www.supersean.com. On the 25th of May 2003, I am to marry my fiancee, Candice Swift in her hometown of Williamstown, Mass. We have been together two years now and from day one I knew we were right. I have fun every minute we are together, even when we fight about time traveling theories.

Anyhow, if you see me around campus or anywhere for that matter, I'm always in the mood for a chat about anything.

News

Joel Gillet from Applanix with inertial navigation backpack unit on. The staff he is holding is for balance when doing a zero

Field Trials with Applanix's Inertial Navigation Unit

In May the PFC went to Capitol Forest to navigate through the woods with no tape, no chain, no compass, and no GPS. We came back with data of survey level accuracy. How did we do this? With an inertial navigation unit provided by the Applanix Corporation of Richmond Hill, Ontario. Because of inconsistent satellite reception under forest canopy, making GPS unreliable, the PFC has been investigating inertial navigation systems which use gyroscopes and accelerometers to calculate which direction the user travels and how far. We are now processing that data but we had great initial results in the field. We were able to find a wooden survey stake that was put in 3 years ago, but had become obscured by grass. The Applanix unit was able to identify the location of the stake and within minutes of digging in the grass we found the stake. For more information on the Applanix corporation please visit their web site:http://*www.applanix.com/index.html.*

The Applanix inertial navigation unit indicated the original survey stake was in this clump of grass, a little digging proved that it was. The stake on the left was a guess after the original stake was obscured.

Analysis of Three-dimensional Forest Structure from Airborne Laser Scanner Data

Hans-Erik Andersen, PhD Student
College of Forest Resources, University of Washington

Objective: Extraction of detailed forest structure information, including stem density, tree heights, crown dimensions, crown form characteristics, and foliage density, is important for a variety of forest management applications, including resource inventory, harvest planning, and fire fuels monitoring. The emergence of high-resolution remotely sensed data, such as LIDAR, allows for many forest measurement tasks to be (at least partially) automated. The automated extraction of forest measurement information from remotely sensed data can potentially decrease inventory costs and support more precise and intensive approaches to resource monitoring and management.

Methods: Algorithms are currently being developed to extract crown dimensions and locations directly from "raw" (unfiltered) LIDAR data. These algorithms build upon promising results of a mathematical morphology-based approach developed and presented last year. In addition, algorithms are being developed to infer canopy coverage and the distribution of crown bulk density (important for canopy fuels monitoring) across the landscape. Field data has been acquired at study areas within the Blue Ridge installation at Capitol State Forest and Fort Lewis Military Reservation.

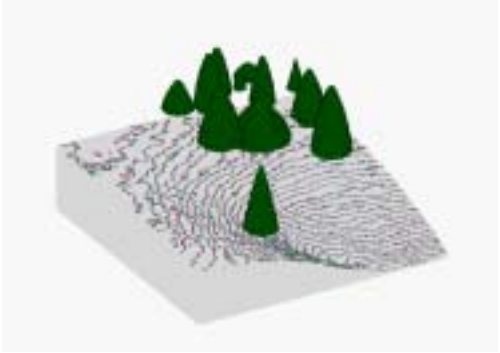

Figure 1: Example of output from automated LIDAR-based forest measurement algorithm for 0.2 ha area within two-age unit of Capitol Forest study area.

Results: Output of one algorithm applied to a small (0.2 ha) area is shown graphically in Figure 1. The algorithm is currently being applied to selected areas within the Capitol Forest study area to compare automated measurements to field-based measurements within numerous georeferenced growth plots.

Addressing the Adjacency Problem within the Hierarchical Approach to Land Use Management

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The harvest scheduling problem often involves green-up requirements. Consequently, the adjacency problem, which requires integer programming must be solved. Local optimization methods have largely been rejected because they do not consider enough of the feasible solution space. However, in general local optimization methods are, computationally, much faster than the global heuristic methods often applied to the adjacency problem. The objective of the study outlined in this briefing was to test a developed local optimization heuristic using the University of Washington's experimental forest: Pack Forest.

A local optimization method, employing 1-opt and 2-opt moves was developed to simultaneously schedule harvest units over multiple time periods in the presence of adjacency constraints. Pack Forest supplied a 158-harvest-unit problem to test the developed algorithm. In this study, adjacency constraints preclude the harvest of any two adjacent stands in the same 10-year time period. A linear program (LP) with an objective function specified by discounted revenue and a constraint matrix consisting of relaxed adjacency constraints (type I) and harvest flow restrictions was used to specify volume targets for six stand types in seven time periods. The optimal value of this LP served as an upper bound for the desired integer solution. To approximate the cost of the adjacency constraints, the same LP as above was solved again with the adjacency constraints removed. The LP with relaxed adjacency constraints present produced 89.5% of the net present value of the LP without the adjacency constraints. Table 1 displays the proportion of the allowable harvest, with active integer constraints relative to the upper bound targets supplied by the relaxed problem. Hence, the found integer solution schedules at least 99.23% of the volume that is possible with green up restrictions.

On a machine with 128 MB of RAM and a 750 Mhz processor, it took 1.87s to generate the matrix and solve the LP with no adjacency constraints, 45.6s to generate the matrix and solve the relaxed problem, and 26.5s to produce an integral solution using 1-opt and 2-opt moves.

Solving one problem does not demonstrate that local optimization methods will work well all the time; this would require a large sample of problems. However, since it is always simple to compare the optimal value to a bound produced from a relaxed problem and since these methods cost little CPU time, they can cheaply be explored on any problem.

Table 1. Proportion Of Volume Scheduled Relative To The Upper Bound Targets

	Harvest Unit Type						
Period	Cottonw ood (4)	Douglas-fir (136)	Alder (12)	Cedar (4)	Redw ood (1)	Hemlock (1)	all species (158)
1	0	0.9999	1.0819	0.9918	1.3333	0	0.9912
2	1.373	1.0002	0.9916	1.0172	0	0	0.9982
3	2	1	1.0087	0	0	0	1.0025
4	0	1.0005	0.976	0	0	0	0.9795
5	1.0929	1.0007	1.2866	0	0	0	0.9863
6	0	1.0001	1.2017	0	0	0	0.9988
7	0	1.0003	0	0	0	0	0.9997
all periods	0.6962	1.0002	1.0093	1.0017	0.9863	0	0.9923