Preliminary Full-Scale Tests of the Center for Automated Processing of Hardwoods' Auto-Image Detection and Computer-Based Grading and Cutup System

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Abstract

Automated lumber grading and yield optimization using computer controlled saws will be plausible for hardwoods if and when lumber scanning systems can reliably identify all defects by type. Existing computer programs could then be used to grade the lumber, identify the best cut-up solution, and control the sawing machines. The potential value of a scanning grading system depends on the accuracy and reliability of the computer-assigned grades compared to the performance of human graders. The potential worth of any scanning cut-up system is largely dependent on the parts recovered compared to today's standard rough mill processing systems.

The Center for Automated Processing of Hardwoods' (CAPH) scanning system is a color line-scan camera-based image processing system. We compared the system's scanning-grader performance with the NHLA grades assigned by company graders. The scanning-grader results indicated that 4 of 15 company graded boards were graded too high. In total, 67 percent of the boards were manually misgraded. Initial results indicate that the CAPH system is missing small sections of some defects and is misclassifying some clear wood as defective.

We also compared the CAPH system's scanning-optimization system to a rip-first rough mill processing system. The scanning-optimization results indicated a potential increase in rough part yield of 5 percent might be realized with the CAPH system.

Introduction

Over the past several years we have been developing an automatic image detection system (2,6) at the Center for Automated Processing of Hardwoods (CAPH) at Virginia Tech. The CAPH Center is an activity of the Southeastern Forest Experiment Station in cooperation with the Northeastern Forest Experiment Station, and the Bradley Department of Electrical Engineering and the Department of Wood Science and Forest Products at Virginia Tech.

Our goals are to develop image detection systems and link them to application software that we also are developing within CAPH with cooperators at West Virginia University to provide consistent automated processing systems for the wood products industry. We are developing software to locate and label surface and internal defects and wood characteristics with three different scanning devices (color line-scan camera system, laser scan-based imaging system, and x-ray system). Some applications will require more than one type of scanning device. We also are developing software to automatically grade the scanned material and to process the scanned material into products.

We present the results of some preliminary testing of our color line-scan camera in this paper. Scanning accuracy will be explored. We will also determine the relative yield performance of the Center for Automated Processing of Hardwoods' scanning-optimization system (color line-scan camera only) compared to a rip-first rough mill processing system. Results are also given on the performance of the scanning-grading system to that of NHLA lumber company graded lumber.

The Sample Boards

The sample boards were taken from two large samples of 4/4 red oak boards collected from two secondary manufacturers. We selected 15 boards (6 - 2A Common, 7-1 Common, 1- lFace, and 1- FAS) for this test. The boards were abrasive planed, and clean. We chose boards for this sample that contained knots with sharply contrasting color compared to the clear wood. This was a best case scenario for testing the CAPH system.

Scanning Accuracy

The CAPH color line-scan camera and software were able to reconstruct, recognize and label defects with good accuracy. The system labeled most defects correctly (knots, holes, splits, bark pockets, wane, and checks) and properly sized the defects. The system did miss parts of some of the splits and small checks. It also recognized some stains that we did not declare as grading defects or defects in cuttings.

This information will be used to calibrate the scanning software so that this type of board discoloration will be overlooked in cases where it is not objectionable.

Application Processing Results

Table 1 shows the CAPH system-based lumber grade and cut-up optimization results and the results from manual grading and cut-up operations.

Table 1. Results of no-scan and scan-based procedures for grading lumber (NHLA rules) and processing lumber to parts with a gang-rip-first system.

Board Number	Supplier's Grade	Computer Scan Grade	Fixed Gang-rip Yield (%)	Optimal Fixed Gang-rip Yield(%)
106	lC	Sel	84.7	84.7
107	lC	Sel	59.8	67.0
112	2AC	3AC	22.5	39.6
113	lC	2AC	31.5	39.8
114	FAS	lC	62.7	68.3
117	lC	lC	57.0	57.0
118	2AC	3AC	50.9	56.0
119	lC	lC	82.4	82.4
120	lFace	lC	74.1	74.1
121	lC	2AC	52.6	57.6
233	2AC	3AC	44.0	52.8
238	lC	Sel	55.2	55.2
240	2AC	2AC	66.4	70.0
241	2AC	2AC	53.7	60.2
242	2AC	2AC	50.6	58.4
Total			57.2	62.0

When comparing the supplier's grades to the computer determined NHLA lumber grades (3,4,5) we found large discrepancies. Sixty-seven percent of the boards were

assigned different grades. The scanning-grader found 4 of 15 boards graded too high by company graders.

The scanning-optimizer automated gang-rip-first system produced a 5 percent increase in yield over the no-scan manual gang-rip system. To determine yields, we fed the board data into AGARIS (7). AGARIS is a gang-rip-first cut-up simulator. We estimated the potential yield impact of the CAPH scanning-optimizer by comparing AGARIS fixed-arbor gang-rip yields (simulating a no-scan manual cut-up system) and AGARIS optimizing fixed-arbor yields (simulating a scanning-optimizer-based automated system). For both simulation runs we produced 2" parts in standard lengths developed by Araman, Gatchell, and Reynolds (1) (15, 18, 21, 25, 29, 33, 38, 45, 50, 60, 75, and 100"). By knowing the defect locations on the boards, we were able to utilize the optimizing-fixed-width version of AGARIS. The simulation results showed that 10 of 15 boards had higher yields with the scanning-optimizer-based optimizing fixed-arbor AGARIS processing option. Without the scan information, this is not possible.

For Now

The CAPH color line scan camera system for clean, planed, good contrast red oak lumber is very effective in finding and properly labeling defects. It is actually too good at times; we need to filter some of the characteristics that it is finding. This preliminary test on a sample of 15 boards indicated that the CAPH scanning system can generate significant yield improvements and more accurate lumber grading. We will be performing larger scale and more rigorous tests on both the color-line-scan camera imaging system and the other scanning devices over the next 6 months.

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