Characterization of Wood Features Using Color, Shape, and Density Parameters

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(ABSTRACT)

Automated defect detection methods allow the forest products industry to better utilize its resources by improving yield, reducing labor costs, and allowing minimum lumber grades to be utilized more intelligently. While many methods have been proposed on what sensors and processing methods should be used to detect and classify wood features, there exists a lack of understanding of what parameters are best used to differentiate wood features.

The goal of this research is to demonstrate that by having an in depth knowledge of how wood features are represented by color, shape, and density parameters, more accurate classification methods can be developed. This goal was achieved through describing wood features using parameters derived from color and x-ray images and characterizing the variability and interrelationships of these parameters, determining the effect of resolution and species on these relationships, and determining the importance and contribution of each parameter for differentiating between wood features using a statistical prediction model relating feature types to the parameters. Knots, bark pockets, stain and mineral streak, and clearwood were selected as features from red oak, (*Quercus rubra)*, hard maple, (*Acer saccharum)*, and Eastern white pine (*Pinus stobus*). Color (RGB and HSI), shape (eccentricity and roundness), and density (gray-scale values) parameters were measured.

Parameters were measured for each wood feature from images and parameter differences between feature types were tested using analysis of variance techniques (ANOVA) and Tukey's pairwise comparisons with α=0.05. Discriminant classifiers were then developed to demonstrate that an in-depth knowledge of how parameters relate between feature types could be used to develop the best possible classification methods. Classifiers developed using the knowledge of parameter relationships were found to provide higher classification

accuracies for all features and species than those which used all parameters and where variable selection procedures had been used.

It was determined that differences exist between all feature types and can be characterized and classified based on two color means, one color standard deviation, the mean density, and a shape parameter. A reduction in image resolution was determined not to affect the relationship of parameters. For different species, the intensity of features was to be related to the intensity of clearwood. The ability to explain classification errors using the knowledge gained about feature parameters was demonstrated. This knowledge could be used to reduce future classification errors.

It was determined that combining parameters collected using multiple sensors increases classification accuracy of wood features. Shape and density were found not to provide good classification variables for features when used separately, but were found to contribute to classification of features when used with other parameters. The ability to differentiate between the feature types examined in this research was found be equal when using the RGB or HSI colorspace.