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## A Comparative Survey on Wood Species Recognition Systems

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**ABSTRACT:** Tropical rain-forests in South-East Asia are blessed with more than 15,000 different plant species of which about 3,000 species can be categorized as timber species. Wood plays an important role in the daily life for our human beings in all ages and become the most favourite material for furniture and indoor decoration. It is also a means of revenue for most countries in South-East Asia. The identification of wood species is a critical process, which not only leads to the proper utilization of woods, but also to the prevention of wood smuggling, as well as to the protection of several endangered tree species. Various feature extraction and classification methods exist for wood species recognition along with the help of neural networks, machine learning and artificial intelligence. Further, it can bring great benefits and significance to Timber Trade, Timber Production, Timber Processing, Furniture Manufacturing and many other fields.

**KEYWORDS:** Wood image retrieval, Pre-processing, Feature Extraction, Classification, Species Recognition.

### I. INTRODUCTION

Numerous wood species with various anatomical characteristics and physical properties are used in industry for the manufacture of a wide range of products. Depending on their properties, different wood species have different usage and, as a consequence, there is a great variation in their price. The identification of wood species is a critical process, which not only leads to the proper utilization of woods, but also to the prevention of wood smuggling, as well as to the protection of several endangered tree species. Therefore, wood materials need to be examined thoroughly before their usage in industry, while their import into any country is prohibited without verification and species identification, due to the risk of carrying and transferring harmful microorganisms that can threaten some native species.

The recognition of wood species is a laborious process, which is performed by experts, who attempt to distinguish the different species based on their macroscopic and microscopic characteristics. Most of these characteristics can be observed in the transverse or cross section of woods, which is the plane perpendicular to the long axis of the trunk. The next most important surface for wood species recognition is the tangential section, which is the plane parallel to the long axis and tangent to the growth rings, while significant information can also be acquired by the radial section of wood, i.e., the vertical plane from the pith towards the bark. Traditionally, experts use 10-power hand lens or magnifying glass to look the section that is being examined, while additional analysis of the physical characteristics of wood, such as the colour, weight, smell and grain pattern can also help experts identify the correct species. Since no two pieces of wood, even of the same species, look exactly alike, wood species recognition is a difficult task, which is performed only by experienced specialists. For this reason, the needs of reducing the cost and time required for the training of experts and at the same time enhancing the accuracy of recognition has significantly increased the research interest on automatic wood species recognition methods.

Based on the recent advances in the area of computer vision and pattern recognition, most researchers have proposed image-based approaches attempting to address the problem either in microscopic or macroscopic scale. Wood

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recognition is a crucial task for wood sciences and industries, since it leads to the identification of the anatomical features and physical properties of wood. Traditionally, the recognition process relies almost exclusively on human experts, who are based on various characteristics of wood, such as colour, structure and texture. However, there are numerous types of wood species in the nature that are difficult to be identified even by experienced scientists. Hence the need for wood species recognition has become extremely desirable.

## II. LITERATURE SURVEY

The problem of wood image species recognition has already received unique attention and many works were published on this topic.

The review of those related works are as follows:

L.Gurav, M.C.Timar [1] proposed image processing method as a supporting tool for wood species identification.

Imagej was used for this purpose. Micro-slides were prepared and light weight microscopy was used. The system used an objective and quantitative way of wood species recognition. Longitudinal, radial and tangential wood surfaces were used. But this system used only three species for identification purpose and was not automated.

Arvind R Yadav, R S Anand [2] proposed hardwood species classification with DWT based hybrid texture feature extraction techniques. Initially pre-processing was done. Decomposition was done using DWT using Daubechies (db3) wavelet as decomposition filter. FOS & LBP descriptors were used. SVM, RBF, RF were also used. It resulted with high performance and efficiency. This system worked only with hardwood species recognition.

Bremananth R, Nithya B [3] proposed a wood species recognition system in which pre-processing was done and feature extraction done using GLCM and classification using Correlation. This system is useful for commercial purposes and textural features are extracted. Only 10 species were recognised with this system.

P.L. Paula Filho, L.S. Oliveira [4] introduced forest species recognition using colour-based features. Here colour histograms were used. Feature extraction was done using GLCM. MLP was also trained. Mainly used for industrial applications and resulted in improved recognition performance. This system also used only few features for recognition.

Mohd Izaan Paiz Zamri, Florian Cordova [5] proposed tree species classification based on image analysis using Improved-Basic Gray Level Aura Matrix. Improved-Basic Gray Level Aura Matrix (I-BGLAM) was used. Back propagation and neural network was also used. Discriminative features were used and resulted in high performance. This system focused only on the grey level of the wood image and smaller feature dimension was used.

Marzuki Khalid, Rubiyah Yusof [6] proposed improved tropical wood species recognition based on multi-feature extractor and classifier. Pre-processing was done using homomorphic filter. Feature extraction was done using BGLAM & SPPD. Pre-Classification was done using Clustering and final classification was done using KNN & LDA. Hybrid usage of this system resulted in more accuracy, improved performance and reduced computation time. Variation in the number of clusters lead to classification accuracy rate to decrease.

Mohd Izaan Daiz, Bin Zamri [7] introduced statistical feature extraction method for wood species recognition system. Initially, pre-processing was done. Further feature extraction was done using pores extraction & fuzzy pores management. Statistical wood features were extracted. This system mimics the experts interpretation with high classification accuracy.

Jing Yi Tou, Phooi Yee Lau [8] proposed computer vision based wood recognition system. This is an embedded system model with GLCM was used with four orientations. Features were extracted and MLP was trained. Texture features are analysed. But only two species were tested with this system and more training samples resulted in low recognition rate.

Panagiotis Barmoutis [9] proposed contribution and combination of different wood sections in species recognition using image texture analysis methods. This system performed fusion of sections. Computer based texture analysis was done and further concatenation of different section features were done using PCA. This resulted in an highly effective and low computational cost system.

Shuaiqi Hu, Ke Li [10] proposed wood species recognition based on SIFT keypoint histogram in which SIFT was used. Clustering was done using  $k$ -means and  $k$ -means ++. Histograms were used and further classification was done

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using ANN, K-NN, SVM. This system resulted in better recognition, accuracy and texture features were extracted. Used only the core section of the wood image and no radial or tangential sections were used.

Luiz G. Hafemann, Luiz S. Oliveira [11] proposed forest species recognition using Deep Convolutional Neural Networks. Here the CNN architecture was used and training was done using random patches. Recognition was done by combining segments and resulted with 95.77%. The system had more accuracy rate and more capability. But only small patches of the image were used for training.

Kayoko Kobayashi, Masanori Akada [12] introduced automated recognition of wood used in traditional Japanese sculptures by texture analysis of their low-resolution computed tomography data. X-ray CT was used. Feature extraction was done using GLCM and classification using k-NN. This is an automated way and resulted in more accuracy.

Mohan S, K. Venkatachalapathy [13] introduced an intelligent recognition system for identification of wood species. Image enhancement was done initially and further image blocking was done. Feature extraction was done using GLCM and classification using correlation. This is a cost effective method by which we can yield high accuracy.

P.L. Paula Filho, L.S. Oliveira [14] proposed forest species recognition using colour-based features. GLCM was used here. Colour image processing was done using colour histograms. MLP was also trained. The system resulted in an efficient and good performance system.

Prasetyo, Rubiyah Yusof [15] had a comparative study on feature extraction methods for wood texture classification. In this, the feature extraction was done using GLCM, LBP, Wavelet, etc. Classification techniques include SVM, K-NN, NN, etc. Factors such as computational complexity, performance, running time etc. were used for the analysis. Finally, LBP and neural network combination was considered as the best recognition method.

J.A.M. Rojas, J. Alpuente [16] proposed wood species identification using stress wave analysis in the audible range. Information is obtained about the species of wood samples using stress-wave sources in the audible range generated by collision with a small pendulum. Non-invasive & non-destructive method which resulted in reduced cost and complexity.

Sourav Samanta, Debolina [17] introduced wooden surface classification based on Haralick and the Neural Networks. Texture analysis was done using GLCM and Haralick texture features were extracted. BPNN was used here. The system resulted in 94.10% accuracy.

E. Yuliasuti, S. Retno [18] proposed compact computer vision system for tropical wood species recognition based on pores and concentric curves. Pre-processing was done initially. Feature extraction was done using Gabor filter and ANN and MLP were also trained for recognition. The system resulted in a good rate of classification.

Zhao Peng [19] proposed robust wood species recognition using variable colour information. Pre-processing was done initially. Gray histograms were used. It resembled a snake model. Pattern recognition was done by comparing initial and final snakes. The system resulted in improved recognition accuracy and more effectiveness.

Kayoko Kobayashi, Takahiro Kegasa [20] proposed anatomical features of Fagaceae wood statistically extracted by computer vision approaches. SIFT and LDA were used here. Classification was done using K-NN, Logistic regression, SVM. Hierarchical clustering was also done.

### III. FUTURE WORKS

With the aid of this literature survey, various new methodologies can be done for wood species recognition including the feature extraction, classification methods and by using neural networks. A new methodology proposed as part of future work is illustrated below:

Methodology:

- Input: Wood Species Image of radial, cross-sectional, tangential sections
- Pre-processing stage includes histogram equalization, sharpening and enhancement methods
- Feature extraction is done using SURF
- Classification is done using SVM
- Output: Wood Species is recognised

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Apart from this, with the help of suitable neural networks available, we can train the system to perform wood species recognition.

## IV. CONCLUSION

Wood plays an important role in the daily life for our human beings in all ages and become the most favourite material for furniture and indoor decoration. In the meantime, due to the development of digital devices, computers and network technologies, huge amounts of wood images are available and easy to be obtained. Consequently, the need for technology capable of retrieving wood images accurately from database has become extremely desirable. Because of the advent and increasing popularity of hand-held devices, the technology of wood images retrieval running on these devices can bring great benefits and significance to Timber Trade, Timber Production, Timber Processing, Furniture Manufacturing and many other fields.

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