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Classification Using Artificial Neural Network of Knot Images on Wood

Ibrahim CETINER[a,1] (cetiner51@gmail.com)
A.Ali VAR[b] (alivar@sdu.edu.tr)
Halit CETINER[c] (halitcetiner@sdu.edu.tr)

[a]*Keciborlu Vocational School, Department of Motor Vehicles and Transportation Technologies, Isparta, Turkey,*
[b]*Faculty of Forestry, Department of Forest Industry Engineering, Isparta, Turkey*
[c]*Keciborlu Vocational School, Department of Computer Technology, Isparta, Turkey,*

Abstract –In recently, there is a large increase in the development and research of automatic classification methods and systems especially in wood-rich countries. One of the main reasons for this increase is knots which are found in wood obtained from the trees. Allocated to the class according to the different types of knots by an expert is a huge waste of time and constitute failure. To eliminate this problem, classify the knots in the wood floorboards using artificial neural network in this study is aimed. As the first to do this, features of knot images with two-dimensional discrete wavelet method are extracted. Then, these features are classified with back propagation multilayer neural networks. Haar, Daubechies, Bior, Coif, Symlet type wavelet methods in feature extraction are used and effects on their classification are determined. Classification rate with used methods are tried to highest level, at the same time reviews are conducted in terms of process time by taking into importance of calculation time in the industry applications.

Keywords -
Knot, feature, ANN, wavelet, training.

1. Section One

Industry, getting information about objects in the image with more entering the digital device and interpretation subject of the means from this obtained information has become gradually increase the popularity. Perception system of human has been imitated continuous in realized applications, but the ability to see the people are not given to a

[1]***Corresponding Author***

machine [1]. Scientist men try to understand the structure given the named pattern by following each other on a regular basis to gain the ability to see into the smart device.

The meaningful conclusions extraction process from the patterns contains information such as wood defects, temperature data, audio signals, remote sensing data, human face, retina tissue, the characters within an image, images obtained from biomedical devices, fingerprints is called pattern recognition [2]. In order to speed up the production at industrial environments, patterns must be fast and accurate classification of high rates.

In order to create highly accurate and fast classification, developed system must be given quick decisions about objects. Decision, received images from outside world in the considering ability to think of human are processing and recognized with symbols. At the same time, when the decided capable system see the object using the knowledge with these symbols, it forms an idea about object [3].

We are able to save the sight of people to machines with computer algorithms. For example; when wood surfaces represents the set of images, knots represent the patterns in this set. In order to detect patterns, each pattern in this set must be represented by a vector form processing by the computer.

These vectors are generated using a different conversion method. Patterns comes form that can handle computer after conversion. Conversion process, separating the categories and would be considered to have the features that represent the best in its category [3]. In the literature, there are many studies on related with many different industrial classification applications and automations with neural networks.

In study of Shahnorbanun and etc al. (2010), Spiking learning vector is trained by supervised learning vector quantization algorithms [4].

Selman (2011) proposed a system to classify wood knot. First, Adaboost algorithm which is supervised classifier as a classifier is used. Then, extracted features from image objects with methods such as dynamic programming, integral image and Hough transform in the extraction of the color of the stain-type defect are combined. The experiments are applied on wood surface images and the effectiveness of the proposed approach is shown in the results [5].

Yu-Hua Gu etc al. (2010) focused on the automatically classification of wood defects [6].

Zhang and Ye (2009) used in the defects of material surface, potential uses and values in order to classify wood [7].

Mahram etc al. (2012) tried to identify wood knots and cracks to classify [8].

Athilakshmi etc al. (2010) focused on the quality control of wood by using statistical and textural feature extraction techniques with high accuracy and reliability. Wood defect recognition system is preferred well-defined features of wood types in order to classification. The most technique used in order to textural classification Gray-level Co-occurrence Matrices (GLCM). Thus, features from processed images are extracted by using GLCM [9].

Zheng and Zhang (2010), proposed a new approach to non-negative matrix factorization (NMF). NMF can be formulated as a minimization problem with bound constraints [10]. This study compares the classification results of different wavelet method. The results are compared by using a neural network classification.

We first determine category number in the knot recognition process. This number shows that the patterns divided into several groups. Images obtained from the camera are divided into seven different knot groups. All knots are not divided into a group outside the 7 different types of knots. When knot image is given as input to system, one of 7 different knot types as the class is assigned. Figure 1 shows the pattern recognition process in the form of the block diagram of the implemented method.

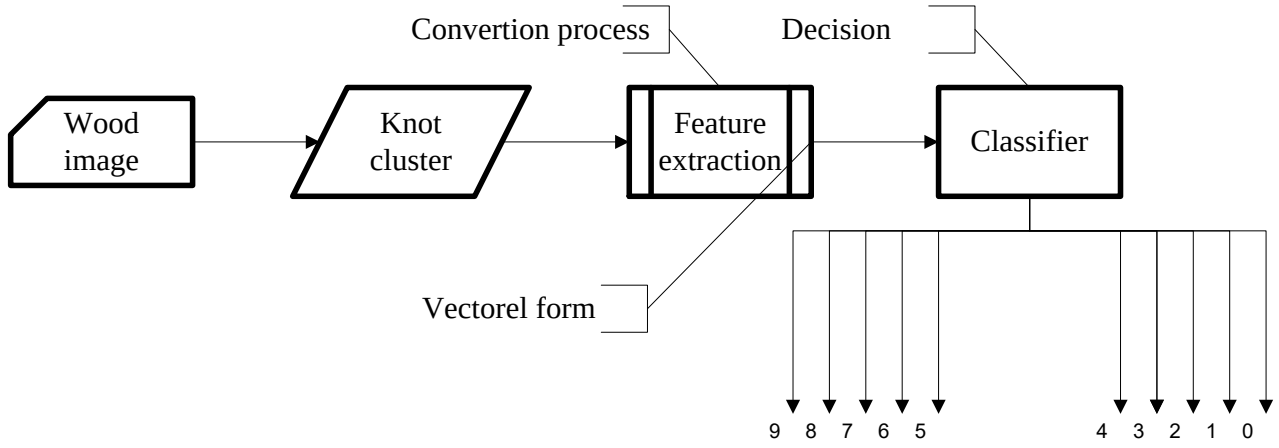

Figure 1: Pattern recognition process

Pattern recognition process is mainly considered in three stages: Obtained from the camera of the pattern, feature extraction, classification.

The value of wood is directly related to the quality of the wood. The quality can be found by considering the number and distribution of defects [11]. These defects are divided into 7 classes: Dry, Encased, Sound, Leaf, Edge, Horn and Decayed defect types.

2. Materials and Methods

2.1. Materials

The defects can occur due to the nature of natural wood. One of the defects is knot. Knot found within wood surface is a portion directly affecting the quality of wood material. Knots is adversely affected the strength of wood material.

Wood species have significant differences among themselves. These differences create difficulties in the classification of knots in a wood material. There is no wood exactly the same features such as color and tissue. These difficulties are not only limited with color and tissue differences. Even in the wood cut from the same log are very large differences. The shape, size and color of defects can be shown a lot of variety even for the same defect.

Woods in the sawmill is obtained from various wood materials. These woods are used in respectively construction, furniture and other manufacturing industries.

In principle, timber inspection and quality classification is simple: quality class of each wood depends on the number and distribution of defects as determined by quality standards.

In general, Europe, Finland and Turkey determines respectively 400, 30, 46 defect types including solid, dry and rotten type knots, resin cavities, crevices, tree bark, mold log defects [12].

Knots play an important role in the classification of wood. Knots have large differences with regard to the shape and appearance. For example, dry knots have narrow dark rings within limits. A boiled knot contains several different regions. Horn knot is a leaf knot which is settled on the edge of boards.

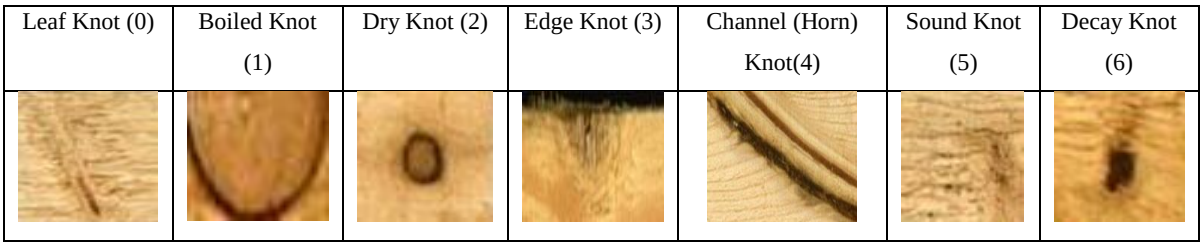

Figure 2: Example of different type knots in wood

Figure 2 shows different knot types on wood.

3. Experimental Results and Discussion

3.1. System Algorithm and Classification

Humankind lived intertwined with nature and developed solutions to the problems that face inspired from them. These solutions have brought to the very advanced by using computer technologies. Some of the developed methods are made by taking samples of living organisms [13]. The Artificial Neural Network (ANN) was developed considering the structure of human neurons. Classification and knot recognition process of features obtained using the method are performed with determined algorithm at Figure 3.

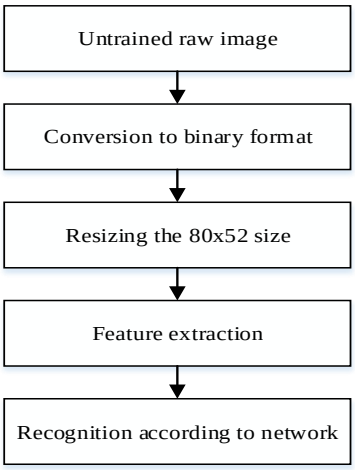

Figure 3**:** *System Algorithm*

The original knot images used in application are taken from the Oulu University knot dataset [14]. 180 images were obtained from each class. There are different classes of 7 knots in total. The number of used image in data sets is 1260.

Input samples are presented in a certain network in the learning phase of ANN classification algorithm. Each working example is spread in layers until further calculates the output sample. The calculated output is accepted as an error by comparing the difference between the expected output. The errors are used as inputs at the feedback link is made of the synaptic adjustment in layers. Figure 4 shows that modified multi-layer feed forward network in order to back propagation. When links to backward used only for the learning phase, forward linkages are used for the purpose of both learning and operational phases.

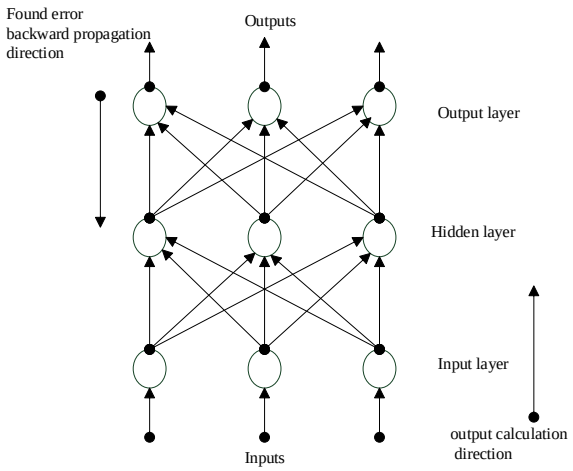

Figure 4*:* Back propagation network structure

In this study, multi-layer ANN model consists of input, hidden and output layers are used. After obtained knot features that may be encountered on the knot, ANN model was created in order to recognition with the ANN. When a row matrix so as to constitute input half the number of 1260x108 features for each knot ANN training, outputs are determined output classes that are indicating the 7 knot defect type.

The obtained input and output files are conducted network training by using ANN training. Block diagram of the implemented method is given in the Figure 5. Thus, a model of recognition with the success of a knot feature vector given to the input is obtained. The model consists of an input matrix so as to constitute half the number of 1260x108 feature numbers, 20 hidden neuron, 180 neurons in the output layer (the number of images in the data set for each type of knot), 4000 steps, 7 output classes. At the same time, log-sigmoid activity function is used in the hidden layer of the network. Log-sigmoid activity function is the event function used in the application due to continuous and nonlinear function, derivatives can be taken. This function produces a value between 0 and 1 to each input. The experimental works have been effective in the specified number of hidden neurons, number of neurons in the output layer and activation function in hidden neuron.

Specified parameter values to obtain the best results in experimental works carried out on MATLAB are changed in the ANN training stage. Our aim is to measure the impact of these changes in classification of network training results.

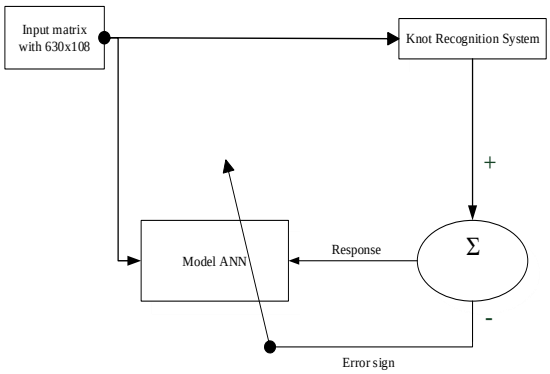

Figure 5: Block diagram in order to ANN training

Knot recognition process is performed at the 92% rate with algorithm in the Figure 3 by using test knot images according to this network.

3.2. Selection of Training Algorithm

To a problem, it is very difficult to identify the fastest training algorithm. It depends on many factors. These factors include the complexity of the problem, the number of data points in the training set, the number of weight and value of the deviation on the network, the use of pattern recognition or function approach of network and targeted error value. The results of the various training algorithms are compared at this point.

The successes in the knot feature vector classifying of 4 different training algorithms in the application are compared. Table 1 shows that the results of 4 different training algorithms.

Table 1: Classification results obtained by using 3. level approach coeffiecints from Daubechies ‘db2’ type of knots

Algorithm	**Training time(second)**	**Training (%)**	**Test (%)**
Scaled conjugate gradient backpropagation	508.12	97.6190	91.2698

(trainscg)			
Resilient backpropagation (trainrp)	242.35	78.7302	76.9841
Conjugate gradient backpropagation with Powell-Beale (traincgb)	628.07	96.3492	89.6825
Conjugate gradient backpropagation with Polak-Ribiére (traincgp)	424.87	97.1429	91.7460

Detail coefficients in the classification results with neural network of features obtained by using 3. level approach coefficients from Daubechies 'db2' type of knots are not used due to distinguishing information are not including.

The features are extracted by using wavelet transform algorithms which are classified with Conjugate gradient back propagation with Polak-Ribiére. The obtained classification results are given in Table 2.

Table 2: Training time, training and testing recognition rates according to wavelet type

Algorithm	Training time(second)	Training (%)	Test (%)
Db1 (Haar)	519.697542	90.1587	83.9683
Db2	493.989896	95.0794	88.0952
Bior3.3	516.014927	97.9365	90.6349
Bior3.9	692.498414	97.4603	92.2222
Coif1	511.754902	94.7619	86.3492
Sym2	576.397309	96.0317	89.6825

4. Results and Discussion

Knots are classified by using seven different knot-type features in this study. Test operations on vectors derived from different feature types are carried during classification.

The highest success rate in the evaluation results of the tests is provided with extracted features from Bior 3.3. The traincgp algorithm is used due to there are few other training algorithms of training time and high of success in the test processes as training algorithm. Bior3.9 (92.22%) in the testing and Bior3.3 (97.93%) in the training according to classification results obtained by using this training algorithm successes rates are reached. Bior3.9 (92.22%) in the testing and Bior3.9 (97.46%) in the training generally successes rates are reached.

The average success rate of 92% is performed within the classification according to knot type of wood materials with these results. We suggest to perform a selection process

without losing the uniqueness of knots features in the future works. We aim to develop a new algorithm for that feature selectors. Because the feature selection will allow the removal of non-distinctive features of the feature vector. In this case, a quicker and more efficient way of working as real time in the large data sets of the application will allow.

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