A Comparative Classification of Wheat Grains for Artificial Neural Network and Extreme Learning Machine

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ABSTRACT

In this study, classification of two types of wheat grains into bread and durum was carried out. The species of wheat grains in this dataset are bread and durum and these species have equal samples in the dataset as 100 instances. Seven features, including width, height, area, perimeter, roundness, width and perimeter/area were extracted from each wheat grains. Classification was separately conducted by Artificial Neural Network (ANN) and Extreme Learning Machine (ELM) artificial intelligence techniques. Then the performances of models are compared each other. The accuracy of testing was calculated 97.89% and 96.79% for ANN and ELM, respectively.

Keywords: Classification**,** Wheat Grains, Artificial Neural Network, Extreme Learning Machine

1. INTRODUCTION

Wheat, a basic nutrient used in flour and feeding production, is a single annual herbaceous plant that is produced all over the world from a family of wheatgrass. It is the second largest planted cereal in the world. Wheat, which is the raw material of bread and pasta, is the most basic food source. Wheat is the main ingredient of bread. It is used in bread and other floury foods as well as in the food sector as grain bulgur. It has a large planting area in Turkey. A large part of Turkey's daily nutritional needs is provided by wheat [1-2]. Therefore, wheat is an important food source in terms of production and consumption. Studies on the quality and cost of wheat carry great importance. Different types of wheat are used for macaroni and bread production. Because the quality of wheat affects the quality of the flour used in bread and macaroni. The mixing of wheat types causes both the quality of the macaroni to decrease and the cost of the seed to increase [3]. Therefore, both wheat varieties need to be classified precisely. It is very important to determine the quality of the products in the marketing of wheat products. Protein is the most important factor affecting the quality of wheat varieties. For this reason, it is necessary to classify wheat varieties and to use each wheat varieties to produce suitable crops. Therefore, the classification of wheat varieties is important both for producers and consumers due to the quality of the crop. Traditional classification methods are both slow and difficult. Furthermore, the results obtained from the classification are not at the desired level. For this reason, such classification processes have been carried out automatically by computer-aided systems in recent years. In this way, faster and more reliable results are obtained [4].

Several works have been presented in recent years to automatically classify grain products. By Olgun et al., the Dense Scale Invariant Features (DSIFT) method was used for feature extraction. The features obtained from this feature detector are classified by Support Vector Machines (SVM). In this study there are 40 classes and 160 properties of each class are obtained. As a result, an accuracy rate of 88.3% was obtained [5]. In a study by Taner et al., an ANN model was developed to classify durum wheat varieties. As the input parameters, thousand kernel weight, geometric mean diameter, sphericity, grain volume, surface area, volume weight, specific gravity, porosity and color output parameter were used. For the M-1 model, the R2 value was found to be 99.99%, the RMSE value was 0.00074 and the mean relative error value was 0.009%. All the results obtained with the M-1 model were found to be compatible with the actual data [1]. Babalik et al. have worked on determining the vitreous of durum wheat grains using image processing techniques [6]. Hernandez and Gil were used discriminative analysis and K-nearest neighborhood algorithms in the classification of wheat and barley seeds and obtained successful results [7]. Pazoki et al. used adaptive networks based on fuzzy neural networks and fuzzy logic systems in the classification of rice grain. The morphological characteristics of the rice grains were applied as an input to the net and they made five kinds of rice classification [8]. In the application of Abdullah and Quteishat, the proposed system aims to classify three different wheat seeds. The proposed system uses Multilayer Artificial Neural Networks for classification. Features given as input to ANN system are area, minor axis length, main axis length, equivalent diameter, environment and entropy. The features obtained from image processing. Experimental results show that the proposed classification system is able to classify wheat seeds with a test accuracy of approximately 95% [9]. In the study performed by Yasar et al., the types of wheat seeds were classified by ANN approach. The ANN system used 7 inputs, 10 hidden neurons and one output. Kama, Rosa and Canadian wheat varieties were analyzed by measuring the geometrical properties obtained by X-ray technique. The properties obtained are area, environment, core length, asymmetry coefficient, compactness. As a result of the ANN, the train result was 99.99% and the test result was 99.78% in the regression process of 210 data [10]. Finally, Bagheri and Nikparast mentioned the significance of computer-based seed identification in the revision study and the various studies made in this subject. For artificial learning, they describe the use of morphological features such as shape, size, color and texture in the identification of seeds, as well as the approaches used for seed identification [11].

The classification process was performed with a program prepared in the Matlab GUI interface. 200 wheat grains were used in classification process. With the help of image processing techniques, seven features were extracted from each wheat grains. Width, height, area, perimeter, roundness, width//height and perimeter/area were used as input for training and testing. Classification of wheat grains was carried out by the ANN and ELM models. Then the performances of these methods are compared with each other.

2. MATERIAL AND METHODS

2.1. Obtaining Data and Production of Pictures

The wheat used in this study is cultivated in Konya, Turkey. As shown Fig. 1, a mechanism is established to obtain the shape characteristics (width, height, area, perimeter, roundness, width//height and perimeter/area). of durum and bread wheat grains Computer, camera, box and lighting system are used in this mechanism. The computer has an Intel Core i7 CPU with 3.1 GHz and 8 GB DDR3 RAM. The camera is full HD with 15 MP resolutions.

Figure 1. System designed to produce images

2.2. Image Processing and Future Extraction

RGB images of 200 wheat grains (100 for bread and 100 for durum) were obtained and these images were then digitized. Image features were obtained using image processing techniques. For this reason, each image obtained is converted from RGB color space to gray color space. Then, the threshold value was determined with the Otsu method [12] to obtain a black and white image. Thus, each wheat image is transformed into binary values (black (0) - white (1)). Morphological operations [13] were applied to these images to reduce noise. Then, each wheat grain was counted and the properties of each of these wheat grains were extracted. These features are given as input to ANN and ELM methods. The images obtained by image processing techniques are shown in Fig. 2.

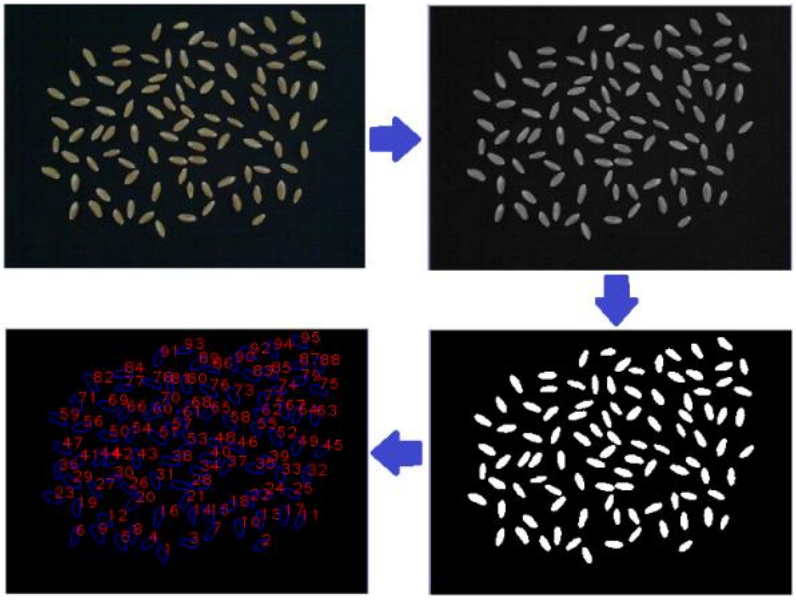

Figure 2. Steps of image processing techniques

2.3. Matlab Graphical Interface (GUI)

Matlab is a software development tool designed for the analysis and solution of technical calculations and mathematical problems. Matlab GUI is an interface that allows the user to interact with the program by using visual objects (button, edit text, static text, etc.). In this study, the accuracy values of ANN and ELM models were obtained using a GUI interface and graphically plotted and the prepared GUI interface is shown in Fig. 3.

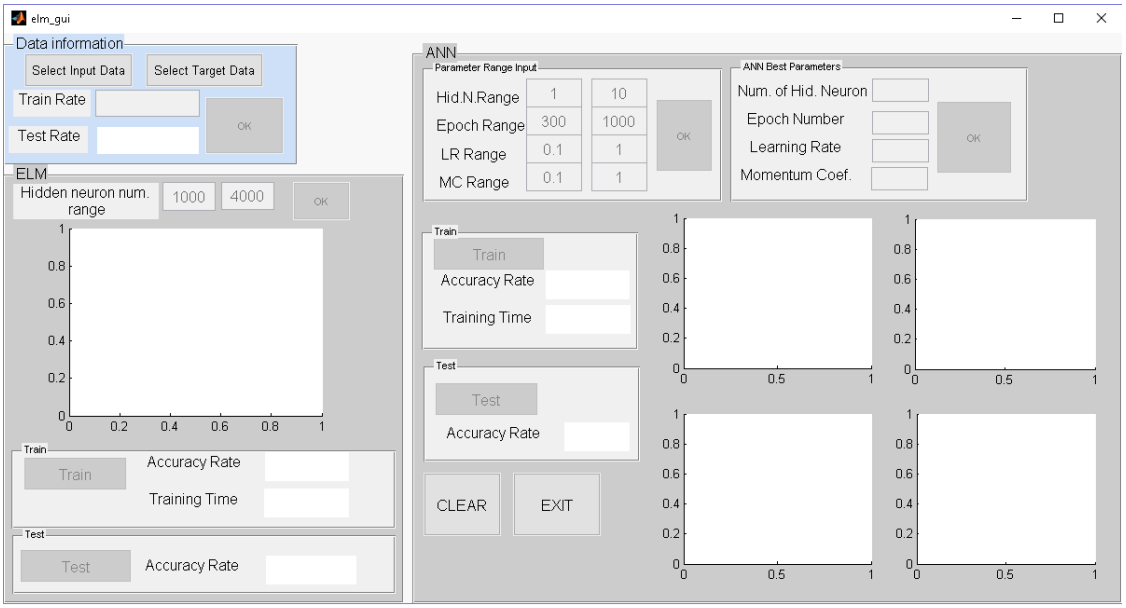

Figure 3. Designed GUI interface

2.4. Artificial Neural Network

ANN is a research field of artificial intelligence technique. Processing of information in ANN is performed through neurons. The neurons are connected to each other by weighted connections (see Fig. 4). An ANN basically consists of an input layer, a hidden layer, and an output layer. Input data is applied directly to the input layer, that is, the number of input neurons must be equal to the number of each different input sample. Then, this data passes from operations such as addition, multiplication and activation function reaching the output layer. Finally, these data are given directly to the output layer. More than one hidden layer can be used in ANN depending on transaction complexity. One hidden layer was used in our work. The basic structure of ANN is presented in Fig. 4 and each circle represents a neuron.

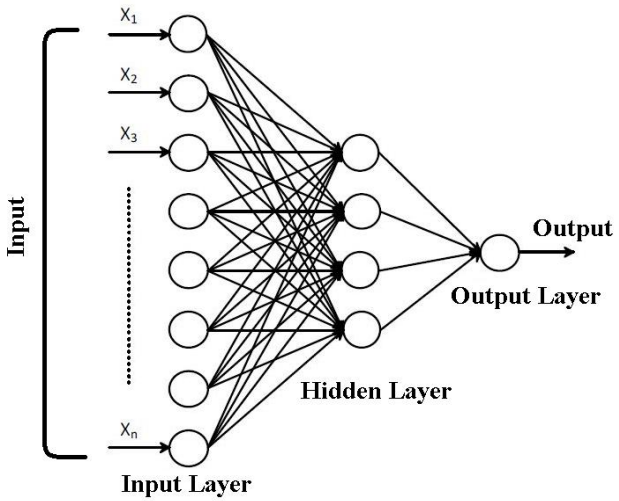

Figure 4. ANN structure

In our study, as input data, the width, height, area, perimeter, roundness, width//height, and perimeter/area properties obtained from each grain were used. For training and testing data,

these seven features were used as input. 70% and 30% of the wheat dataset were used for training and testing process, respectively.

2.5. Extreme Learning Machines

In this work, ELM, which is the supervised learning method, is used for wheat classification. This section will briefly discuss the ELM method introduced by Huang et al. [14]. This method is used in classification and regression processes. It is a method that allows extremely fast training and testing operations. It does not have limitations used in ANN such as learning rate, local minimum, moment coefficient. It has advantages over other methods in terms of fastness and high accuracy.

ELM actually has an ANN network structure with a single hidden layer (see Fig. 5). Weights and thresholds are assigned randomly. These weights are not changed afterwards. Operations are performed according to the initial weights and threshold values.
Inputs in the ELM are features derived from the data available. The data used as the output is also the target data. Since the weights are also randomly assigned, the main purpose here is to find the Beta coefficient (see Fig. 5). Beta coefficients are generated during the train phase and then the same coefficient is used during the test phase. Moore-Penrose generalized inverse is used to find beta coefficients [14]. As a result of obtaining the Beta coefficients, the network becomes trained. That is, there is no iterative calculation in the ELM. For this reason, it has a great advantage in terms of train speed.

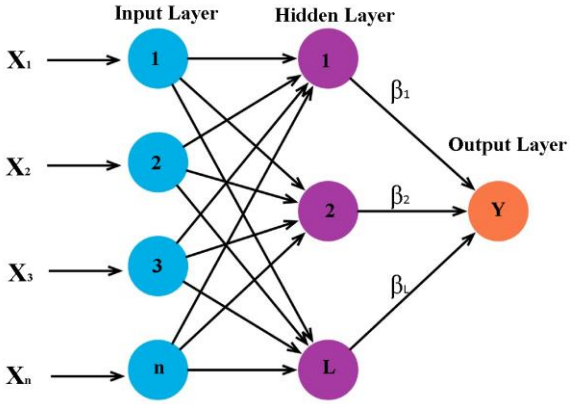

Figure 5. ELM structure

3. RESULTS AND DISCUSSION

The prepared GUI interface and result values are shown in Fig. 6. More than one hidden layer can be used in ANN depending on transaction complexity. One hidden layer was used in our work. In ANN there are parameters directly affecting the performance of the system. By changing these parameters, it is tried to create systems with least faults. These parameters are learning rate, momentum coefficient, number of hidden neuron, and iteration number. In our work, the range of these values is entered into the GUI interface, and the best accuracy values are calculated. Then, the average accuracy value is obtained by taking the average of these accuracy values. The accuracy values according to changing parameters for ANN are illustrated in Fig.7.

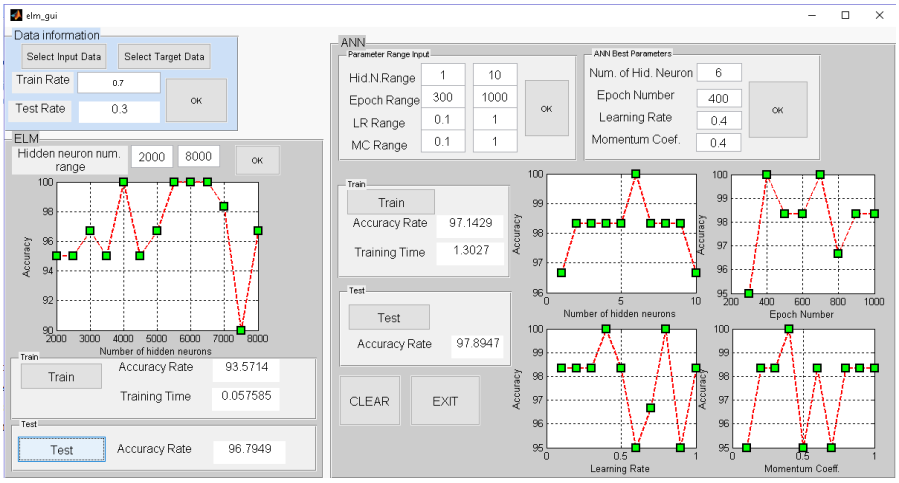

Figure 6. Designed GUI and accuracy values

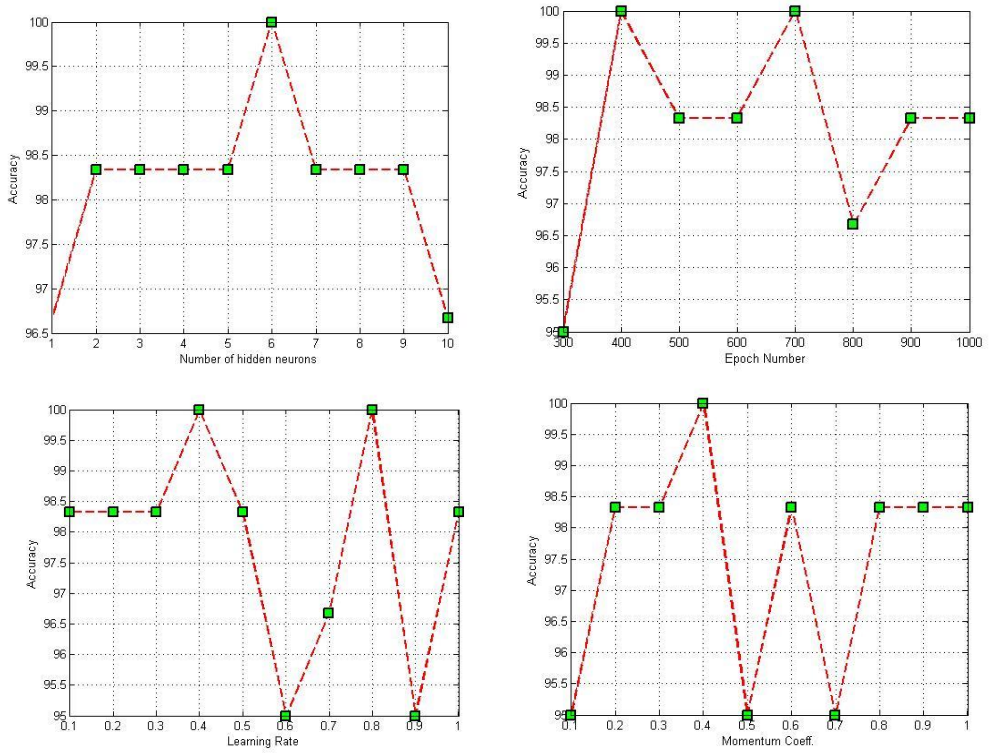

Figure 7. The accuracy values according to changing parameters for ANN

In the ELM method, there are no parameter limitations which is used in ANN. Because ELM is not a method based on iteration. Beta values are calculated directly, without iteration. The number of hidden neurons is the factor that affects performance in the ELM method. The accuracy graph obtained by changing the number of hidden neurons within a certain range is shown in Fig. 8. When the graphs were examined, high accuracy values are obtained with both learning methods. Then, the average accuracy values are obtained by averaging the accuracy values.

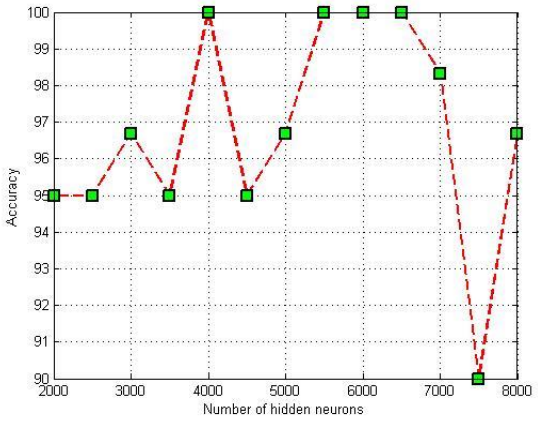

Figure 8. Accuracy values according to number of hidden neurons for ELM

4. CONCLUSION

The accuracy values are achieved as 97.89% for ANN and 96.79% for ELM in calculation time of 1.3 seconds and 0.0575 seconds respectively. As it is clear from the values, among these models ANN gives best accuracy than ELM but ELM has a great advantage over time in terms of ANN. The results achieved in this work show us that both ANN and ELM models can be used to classify the wheat grains into bread and durum.

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