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Texture and Flag Color Extraction in Backpropagation Neural Network Architecture

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Abstract: A flag is a rectangular or triangular piece of cloth or paper used as a symbol of the state, association, body, etc. or as a sign. It is often also used to symbolize a country to show its sovereignty. Along with the large number of countries, the country's flag also has many varieties and colors. The use of computers as a human aid is expected to the extent that the computer's ability can replace the limitations that humans have. Humans can recognize an object by using their eyes and brain, but if the eyes and brain cannot work properly it will hamper human work. In this research, training will be conducted on the Back Propagation Neural Network Architecture. Characteristic data for image recognition is obtained by extracting texture features and RGB color features. So that the network can recognize the flags by matching the feature data obtained from the training carried out. Characteristic data obtained from 24 data consisting of 16 training images and 8 testing images. From the results of the image network training can be identified properly, the accuracy rate of object identification is 87.50%. GUI users are able to identify flag images based on RGB text and color features.

Keywords: Artificial neural networks; Backpropagation; Flags; Texture extraction

Introduction

The state is an organization located in a certain territory, in which there are people and a legitimate government. a political thinker in the classical period argued that the state was a political institution as a substitute for the prophetic function of carrying out religious affairs and regulating world affairs (Suyadi & Sabiq, 2021; Wildan, 2023). A flag is a rectangular or triangular piece of cloth or paper as a symbol of a country, association, and so on. It is often also used to show its sovereignty. The country's flag is characterized by a special combination of colors. A flag is an object that can have various messages and meanings attached to it. The existence of a flag can also be related to the symbolic aspect of sovereignty (Medway et al., 2019; Zhuk, 2023).

So far, people have had difficulty recognizing the type of country's flag. This is because, of the number of national flags in the world, especially in terms of color, state flags have color combinations that are almost similar to each other for each country (Becker et al., 2017). Therefore, we need a system that is able to recognize state flags in a computerized manner, so that it can help people overcome these difficulties without having to memorize or remember the types of existing state flags that can be recognized easily (Blake & Castel, 2019).

A system that can display a selection of available objects to recognize various types of flags from each country in the world by combining RGB color characteristics and image texture. Research using color characteristics has been carried out by Jiale Ma et al. The proposed method has achieved very good performance in a self-made electrical equipment data set. It is worth noting that the proposed AAMS approach is general and can be used for weakly supervised semantics or instance segmentation for any heating object (Ma et al., 2020; Weng et al., 2023; Liu & Xu, 2023).

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In this research the author used the MATLAB R2018a application to carry out image processing in the form of a Graphical User Interface (GUI) for the pre-processing, segmentation, feature extraction stages in images and using algorithms for identification.

Method

When conducting research, a research model is needed to produce the new knowledge you want to achieve. In Figure 1 is the research model in this study.

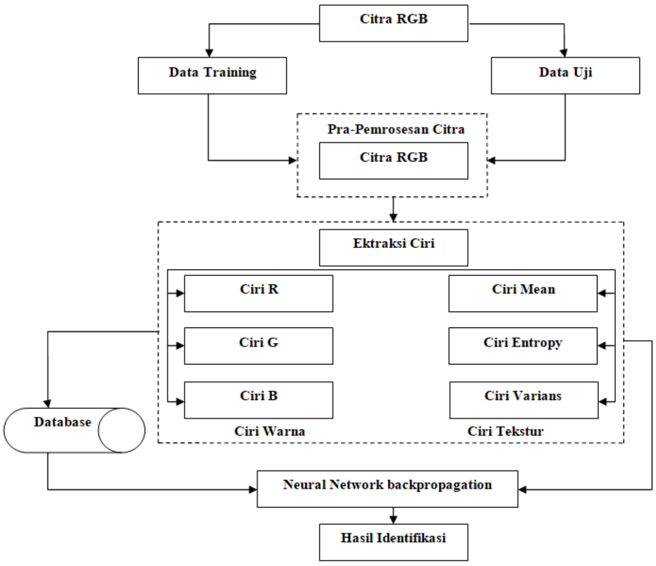


Figure 1. Research model

Data Collection

Data collection in this research was carried out by taking 6 types of flags from 5 countries:

Figure 2. Flag data as training data

In Figure 2 we can see the flags resulting from data collection which will be used for training data from the Artificial Neural Network. In Figure 3 we can see the flags that will be used for test data from the system we are designing.

Figure 3. Flag data as test data

Result and Discussion

The use of computers as human aids is highly expected to the extent that computer capabilities can replace the limitations possessed by humans (Trunk et al., 2020; Korteling et al., 2021). Humans can recognize an object using their eyes and brain, but if they cannot work well, it will hinder human work (Sun et al., 2020; Kreyenmeier et al., 2021). Artificial Neural Network (ANN) or Artificial Neural Network (ANN) is an information processing system with characteristics resembling the human nervous system which can solve SVM and KNN problems by training on large data and ANN has the ability to tolerate errors so it can produce predictions good (Putra & Ulfa Walmi, 2020; Nofitriyani et al., 2022). Neural Network or Artificial Neural Network (ANN) is a computational method that imitates biological neural network systems (Fachri et al., 2019; (Salah Alaloul et al., 2020). A quite important aspect that underlies various theories in artificial intelligence is the color recognition system which is part of the practical implementation of artificial neural networks. In Jegede et al.'s research (Vadivelu et al., 2021; Naaz et al., 2022), research by taking characteristics of the human body is known as biometric authentication.

Research related to Pulung Adi Nugroho et al's Artificial Neural Network researched human facial expressions, resulting in conclusions. From the experiments carried out, precision, recall and accuracy results were 65%. The Convolutional Neural Network (CNN) method is very suitable for testing an image, because the process is multi-layered, proven by 35 images, 28 images can be guessed correctly even though the expressions are only slightly different (Yamashita et al., 2018; Shafiq & Gu, 2022). The training algorithm that is popularly used in Artificial Neural Networks to improve weights is the backpropagation algorithm (Silaban et al., 2017; Cruz-Lopez et al., 2017).

Backpropagation is a training method that minimizes the total error in the output calculated by the network. Backpropagation trains the network to achieve a balance between the network's ability to recognize patterns used during training and the ability to respond correctly to input patterns that are similar but not the same as the patterns used during training (Aisyah et al., 2018; Fadlil et al., 2019). It is a feedforward network and can actualize nonlinear mapping between output and input precisely. BP is a generalization of Widrow-Hoff learning rules for multiple layers of feedforward networks. Conducted research on the classification of apple characteristics among three classifiers, CNN had the best performance with a detection accuracy of 98% for both apple varieties, followed by SVM and RF (Benmouna et al., 2022; Wu et al., 2023). This research shows that SIRI, coupled with machine learning algorithms, can be a new, versatile and effective modality for fruit defect detection (Elahi et al., 2023; Taner et al., 2024; Ukwuoma et al., 2022).

The objectives of this research are Designing a system that can recognize flag images using the backpropagation artificial neural network method; Knowing the level of accuracy of the system in recognizing flag images; Determine the optimal ANN architecture for the system to recognize flag images. In designing a flag image recognition system using ANN, another process is needed, namely digital image processing (Dalal et al., 2023; Al Ghamdi, 2023). Image processing is the processing of images, especially using computers, into images of better quality (Wiley & Lucas, 2018; Sarfraz, 2020). Digital image processing in this research is intended to recognize patterns in an image. Pattern recognition is grouping numerical and symbolic data (including images) automatically by a computer. The purpose of grouping is to recognize an object in the image (Taye, 2023; Sarker, 2021).

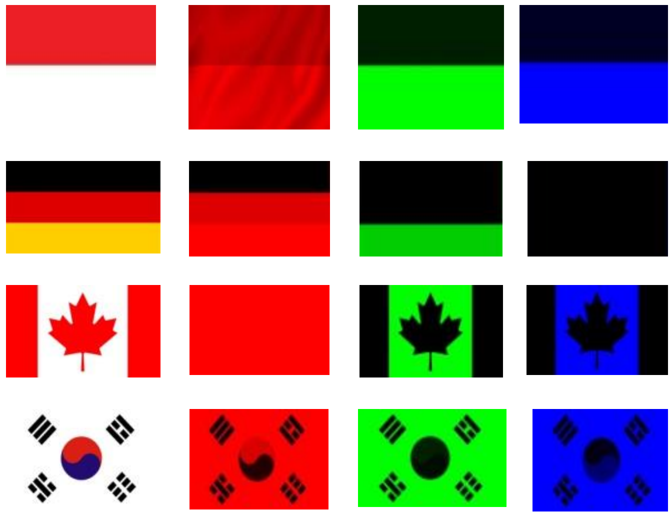
Image segmentation is a process or technique of partitioning a digital image into several sets of pixels (Goh et al., 2018; Senthilkumaran & Rajesh, 2009). This segmentation process is a fundamental step for image analysis, one of the techniques in image segmentation is threshold segmentation, which is computationally simpler than other existing algorithms, such as boundary detection or area-dependent techniques (Chen et al., 2017; Manakitsa et al., 2024). If the target can be clearly distinguished from the background. After the process of recognizing data characteristics has been carried out, the next thing that must be done is to determine how accurate the system is in recognizing the test data set.

RGB Color Feature Extraction

Is the stage of extracting information contained in an image object. This information is used to differentiate between one object and another at the image recognition or identification stage. Color feature extraction is carried out to obtain the average R-G-B value. Below in Table 1, the extraction results from one flag image training data are displayed.

Table 1. RGB Color Characteristic Extraction Table

Initial Image	Extraction		
	R	G	B



In Table 2, the average value of the training data extraction results for 16 flag images is displayed.

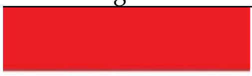
Table 2. Table of Average RGB Color Feature Extraction Values

Image	Extraction R	G	B
G1	0.78	0.44	0.45
G2	0.85	0.53	0.54
G3	0.79	0.47	0.50
G4	0.95	0.56	0.57
G5	0.62	0.26	0.00
G6	0.55	0.22	0.00
G7	0.59	0.42	0.31
G8	0.57	0.26	0.05
G9	0.99	0.42	0.42
G10	0.95	0.55	0.57
G11	0.82	0.45	0.42
G12	0.74	0.31	0.38
G13	0.86	0.83	0.84
G14	0.82	0.79	0.82
G15	0.65	0.61	0.63
G16	0.77	0.75	0.77

Texture Feature Extraction

The step before carrying out Texture Feature Extraction is a conversion from RBG to Grayscaling with the aim of changing the color image (RGB) into a gray image. Before doing the calculations to get the mean, entropy and variance values. Below in Table 1 the results of the RGB to Grayscaling conversion are shown.

Table 3. Conversion table from RGB to Grayscale

Initial Image	Grayscaling
	
	
	
	

In Table 4, the mean (average), entropy and variance values of the magnitude images extracted from training data from 16 flag images are displayed.

Table 4. Texture Extraction Value Table

	Extraction		
Image	Mean	Entropy	Variant
G1	0.10	5.00	0.01
G2	0.10	4.96	0.01
G3	0.14	5.39	0.02
G4	0.19	2.49	0.03
G5	0.15	2.74	0.04
G6	0.11	5.03	0.03
G7	0.34	6.95	0.09
G8	0.15	5.44	0.04
G9	0.09	2.82	0.01
G10	0.17	5.77	0.03
G11	0.09	5.27	0.01
G12	0.13	5.01	0.03
G13	0.14	2.96	0.01
G14	0.14	3.26	0.02
G15	0.13	6.20	0.01
G16	0.15	5.55	0.02

Identification Results

After obtaining the average values of R, G, B, mean, entropy, and variance, we proceed to the stage of image identification based on the characteristics we have obtained. In Table 5, image identification is displayed based on the average values of R, G, B, mean, entropy, and variance from the training data of 16 flag images, with the target country 1, country 2, country 3, or country 4 being the result of flag image identification.

Table 5. Flag image identification table

			Extraction			
R	G	B	Mean	Ent	Variance	Class
0.78	0.44	0.45	0.10	5.00	0.01	1
0.85	0.53	0.54	0.10	4.96	0.01	1
0.79	0.47	0.50	0.14	5.39	0.02	1
0.95	0.56	0.57	0.19	2.49	0.03	1
0.62	0.26	0.00	0.15	2.74	0.04	2
0.55	0.22	0.00	0.11	5.03	0.03	2
0.59	0.42	0.31	0.34	6.95	0.09	2
0.57	0.26	0.05	0.15	5.44	0.04	2
0.99	0.42	0.42	0.09	2.82	0.01	3
0.95	0.55	0.57	0.17	5.77	0.03	3
0.82	0.45	0.42	0.09	5.27	0.01	3
0.74	0.31	0.38	0.13	5.01	0.03	3
0.86	0.83	0.84	0.14	2.95	0.01	4
0.82	0.79	0.82	0.14	3.26	0.02	4
0.65	0.61	0.63	0.13	6.20	0.01	4
0.77	0.75	0.77	0.15	5.55	0.02	4

Backpropagation Network Training Results

Network training to achieve a balance between the network's ability to recognize patterns used during training and the network's ability to provide appropriate responses to input patterns that are similar but not the same as the patterns used during training is one of the characteristics of Backpropagation. A network with a 6-10-5-1 architecture, which means it has 6 input data, namely Average R, Average G, Average B, mean value (average), entropy and variance, has 2 hidden layers (hidden layer) where the first hidden layer contains 10 neurons and the second hidden layer contains 5 neurons. And has 1 output data, namely Country (Indonesia, Germany, Canada or Korea).

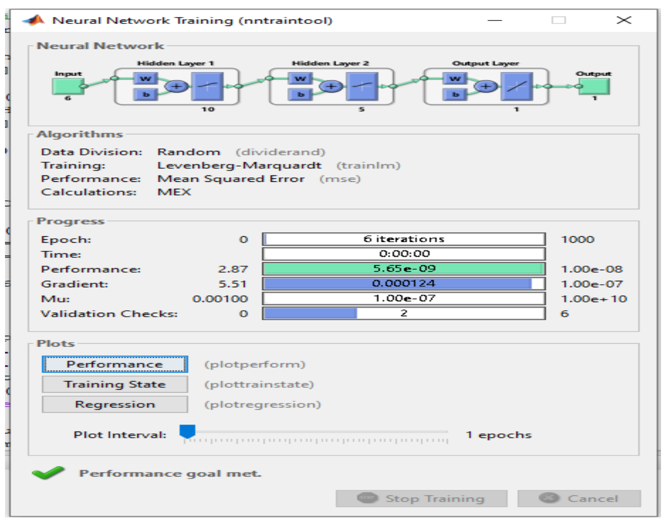


Figure 4. Artificial neural network training

In Figure 4 we can see that there are 6 iterations with accuracy levels that we can see in table 6 which will be used for test data for the system we are designing.

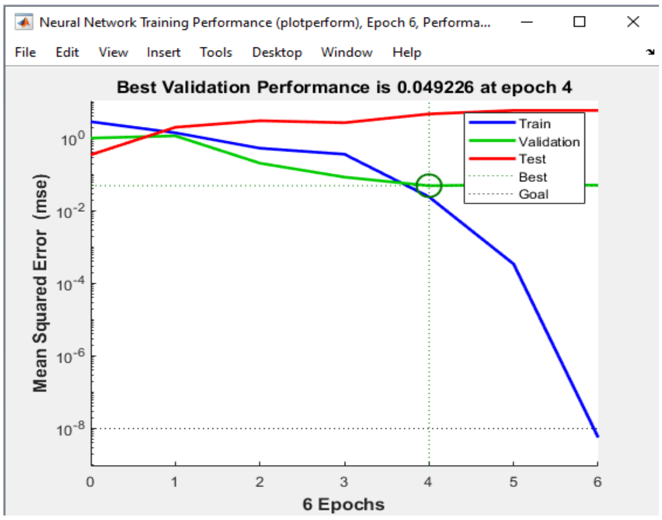


Figure 5. Artificial neural network testing

Performance

In Figure 5 it can be seen that there are 6 epochs and the best validation performance is 0.04 at the 4th epoch. After testing, the level of accuracy of the system being designed can be known. In Table 6, the level of match of the target data with the training results of the training data is shown.

Table 6. Test Results

Image	Target	Testing Results	Information
G1	1	1	Suitable
G2	1	1	Suitable
G3	1	1	Suitable
G4	1	1	Suitable
G5	2	2	Suitable
G6	2	2	Suitable
G7	2	2	Suitable
G8	2	2	Suitable
G9	3	3	Suitable
G10	3	1	Not suitable
G11	3	3	Suitable
G12	3	2	Not suitable
G13	4	4	Suitable
G14	4	4	Suitable
G15	4	4	Suitable
G16	4	4	Suitable

From the results of network testing with training data, an accuracy level of 87.50% was obtained. There was an identification error in the 10th and 12th training data. For testing with test data, it can be seen in table 7.

Table 7. Test Results

Image	Target	Testing Results	Information
G1	1	1	Suitable
G2	1	1	Suitable
G3	2	2	Suitable
G4	2	2	Suitable
G5	3	3	Suitable
G6	3	1	Not suitable
G7	4	4	Suitable
G8	4	4	Suitable

From the results of network testing with test data, an accuracy rate of 87.50% was obtained. With an error of 1 test data, namely the 6th test data. In figure 6, figure 7, figure 8, and figure 9 there is an image identification test with the GUI.

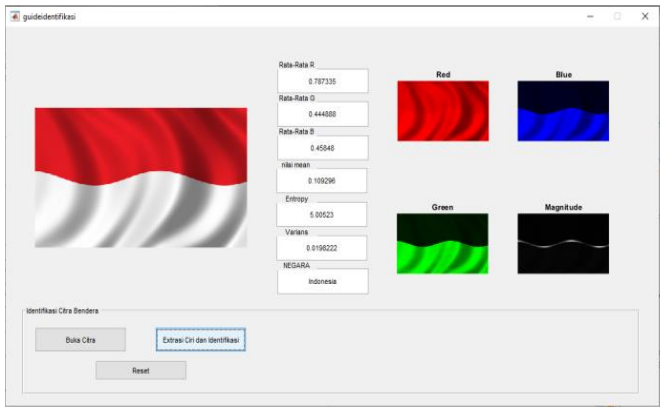


Figure 6. Testing with GUI

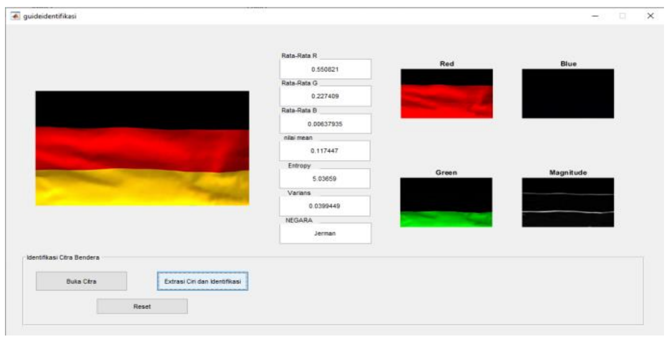


Figure 7. Testing with GUI

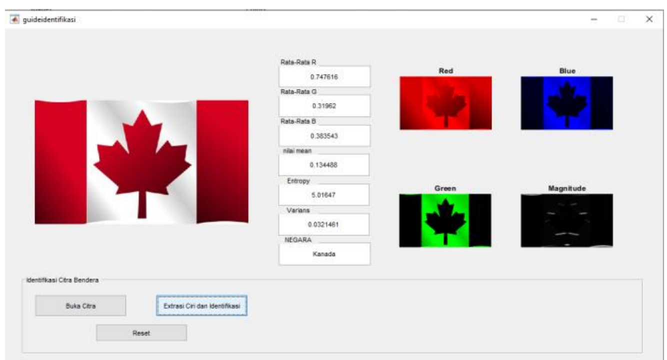


Figure 8. Testing with GUI

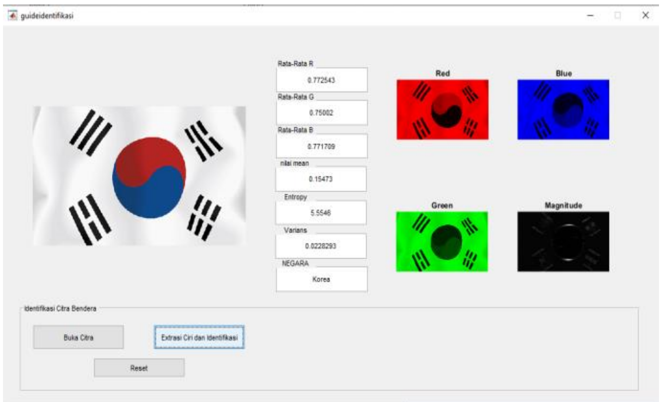


Figure 9. Testing with GUI

In testing with the GUI, the flag image can be recognized well.

Conclusion

Based on the research carried out on the problems drawn, it can be concluded that image recognition in flag images consists of 16 training image data and 8 testing image data using RGB texture and color characteristics and the back propagation artificial neural network training method of objects can be recognized with a level of accuracy. 87.50%. Combining color and texture characteristics can help increase accuracy in image recognition. Artificial neural network with a 6-10-5-1 architecture, which means it has 6 input data, namely Average R, Average G, Average B, mean value (average), entropy and variance, has two hidden layer, the first hidden layer contains 10 neurons and the second hidden layer contains 5 neurons. And it has 1 output data, namely the State can analyze image characteristics well. The GUI system can help users recognize flag images with flag image data.

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Author Contribution
Conceptualization, S. D. R., and S. D., validation, S. D. R.; formal analysis, S.D.; investigation, S. D. R resources, S. D and S. D. R; data curation, S. D.: writing—original draft preparation., S. D. R.; writing—review and editing, S. D.: visualization, S. D. R. All authors have read and approved the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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