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Identification of Fresh and Unfresh Fish Based on Eye Image Using The Self-Organizing Maps (SOM) Method

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ABSTRACT
Fish is a common protein source and easy to obtain in Indonesia, but because of its high-water content, fish quickly spoils. Fish freshness can be detected using several conventional methods, such as chemical analysis, biochemistry, microbiological analysis, and sensory examination. Another identification method involves observing the color of the fish's eyes. Fish identification is crucial before any further processing, ensuring that the fish's quality delivered to consumers remains high. To tackle the problem of differentiating between fresh and non-fresh fish, this research employs Self-Organizing Maps (SOM) as the primary methodology. This research focuses on identifying fresh and non-fresh fish using the SOM method, using actual data involving tilapia as the research object. The data includes eye images of new and non-fresh fish, and various procedures are required to obtain the desired data. This data is then used as training and testing data. The process continues with the preprocessing stage, which is a data modification process to improve performance in subsequent steps and feature extraction using HSV color histograms. Classification of processed data is carried out using the SOM method. Once completed, the identification results are displayed. This research produces a system for identifying fresh and non-fresh fish based on eye images using SOM, which achieves a good accuracy of 85.71%.

INTRODUCTION

Fish is the most common and easy source of protein for Indonesian people to obtain, but because of its high-water content, fish quickly spoils. With abundant fishing, the speed of identification of fish freshness is essential in processing large fish. Fresh fish have the same characteristics, color, smell, and texture as live fish, often seen through changes in the color of the fish's eyes (Mohammadi Lalabadi et al., 2020; Ranjan et al., 2023; Rezende-de-Souza et al., 2022; Yang et al., 2022).

The freshness of fish can be detected using several conventional methods, namely chemical or biochemical analysis of fish, analysis of microbiological content in fish, and sensory examination methods (Maulida et al., 2021; Wang et al., 2022). Another identification method is to look directly at the color of the fish's eyes. This method can provide accurate fish quality information and quantitative results but requires more time and experienced people. It is a complicated process, requires high costs, and requires human physical strength, which is quite vulnerable and quickly tired so that it can interfere with fish identification activities (ElMasry et al., 2016; Jahanbakht et al., 2023; Tokunaga et al., 2020).

Much research has been carried out regarding fish identification. These studies include (David et al., 2022; Uraini, 2022; Pariyandani et al., 2019; Wanti, 2021). Research by David (2022), titled Application of Formalin Fish Recognition Through Eye Detection Using the Template Matching Method and KNN Classification Method. This research discusses how introducing fresh fish and formalin can be carried out using the KNN (k-nearest Neighbor) classification method (Putra, 2016). Initially, a

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thresholding process was carried out to separate the fish object from the background image. The fisheye detection process was carried out automatically using the Template Matching method (S. Li et al., 2020; T. Li et al., 2018; Moreira et al., 2021). After the fisheye image is detected, a traininand recognition stages are carried out. The application can catch fresh or formalin-treated fish by detecting the location of the fish's eyes using the template matching method and measuring the proximity distance between the image of the fish's vision and the image of the fish's eye with and without formalin in the database (Penczak et al., 2012; Quijano et al., 2023; Tsai et al., 2017).

Other related research is entitled Implementing Artificial Neural Networks Using the Self-Organizing Map Method in Image Classification of Snapper Fish Types (Triwibowo & Sela, 2023). This research aims to implement an artificial neural network using the Self Organizing Map (SOM) method, which is used to classify types of snappers based on each snapper's color and texture characteristics (Asri & Wulanningrum, 2021; Kim et al., 2023). This research has several stages: image acquisition, image segmentation, color and texture feature extraction, image classification using a Self-Organizing Map, and testing the existing model (Cui et al., 2023; Shi et al., 2022).

Based on several related studies, fish identification is important before the fish is further processed. By doing this, consumers can get fish that is in good condition.

To overcome errors in identifying fresh and non-fresh fish. This research uses Self Organizing Maps (SOM) as the methodology that will be used. Self-Organizing Maps (SOM) is a neural network trained using unsupervised learning. This network can produce a separate representation of the input space of low-dimensional (usually two-dimensional) training samples. This representation is then referred to as a "map." This research also uses Hue Saturation Value (HSV) feature extraction to reduce the error rate in identifying fish.

METHODS

This research has initial conditions, namely that the identification method used is less effective because it requires much time, is a complicated process, requires a large amount of money, and requires human physical strength, which is quite vulnerable and quickly gets tired so that it can interfere with fish identification activities. So, a system was designed to assist in the fish identification process. This research proposes using the Self Organizing Maps method for classification. The final condition expected from this research is correct classification results with high accuracy.

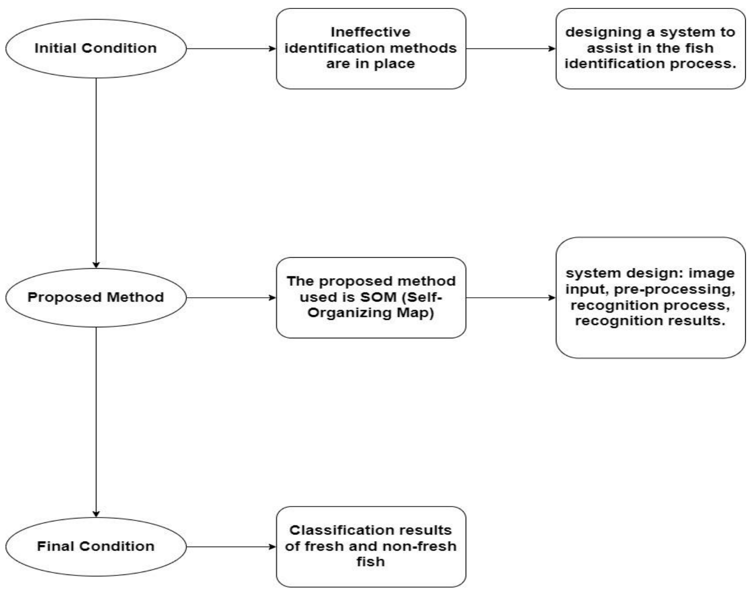

Figure 1. Research Framework

The topic discussed in this research is identifying fresh and non-fresh fish using the Self Organizing Maps (SOM) method. This research uses accurate data using tilapia as the research object. The data used is images of fresh and non-fresh fisheyes. The data is correct, so several procedures are needed to get the desired data. The following method is used:

a. Data was obtained by taking photos of the fish, then cropping them and leaving only the eyes of fresh and non-fresh fish.
b. Data sources come from direct observations, experiments and documentation carried out by researchers independently.
c. Data was obtained from tilapia fish from the Garongan area's fish market. The data collection process took approximately 9 hours, counting from the death of the fish.
d. Data collection was carried out on October 29, 2022. At 07.30 WIB or half past eight in the morning, until 16.30 WIB or half past five in the afternoon.

The collected data will be used as training data and test data. Next is the pre-processing stage; at this stage, the data will undergo several modifications to improve performance in the next stage. The next stage is the feature extraction process in the data. The feature extraction used is the HSV color histogram. The next stage is classifying the data that has been processed. At this stage, the data will be arranged according to the predictions. This stage uses the Self Organizing Maps (SOM) method as the classification method. Once the process is complete, it will display the identification results of the data selected for testing. The model architecture of this research can be seen in Figure 2.

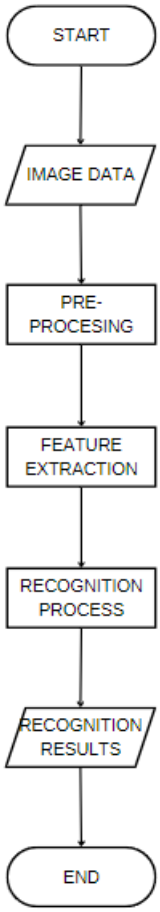

Figure 2. Model architecture

RESULTS

This research produces a system for identifying fresh and non-fresh fish based on eye images using the Self Organizing Maps (SOM) method. This process begins by preparing image data, usually called a dataset. The number of shots used as a dataset is 48, with 24 pictures each for fresh fish and 24 ideas for non-fresh fish. The dataset will then be divided into 2 for each file. 70% is used as training data, and 30% as test data. After the data has been prepared properly, the next step in applying the Self self-organizing maps method is to prepare the model used for training. The model that will be built will later be used for training. This research uses Visual Studio Code software for the training and testing process. The following is the process carried out in classifying fresh and non-fresh fish.

Preprocessing

This is the initial process where all the image data held is changed to be suitable for further analysis. The process that occurs is to crop the image of the fish you have and only leave the eye part of the image. This process can be done directly after the picture is taken or by using other software that can help. The image cropping process in this research was carried out manually using the Adobe Photoshop application. It produced a fisheye image with a width of 480 pixels and a height of 450 pixels. An example of the processed image can be seen in Figure 3.

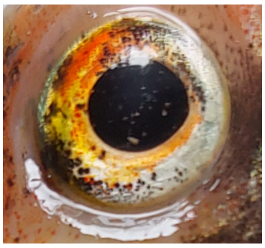

Figure 3. Image of processing results

Feature Extraction

Feature extraction is carried out to obtain information contained in the fish image. HSV color histogram feature extraction is used to identify fresh and non-fresh fish. The HSV histogram value is obtained by equation (1).

$$CapHistogram(H,S,V) = hist(H,S,V) \tag{1}$$

The hist in equation (1) can be searched for with equation (2).

$$hist(H,S,V) = nH\ x\ nS\ x\ nV \tag{2}$$

Information:
H = Hue component of each image pixel
S = Saturation component of each image pixel
V = Value component of each image pixel
nH = number of bins used on Hue= 8
no = number of containers used at Saturation= 8
nV = number of containers used at Value= 8

An example of an HSV histogram graph can be seen in Figure 4.

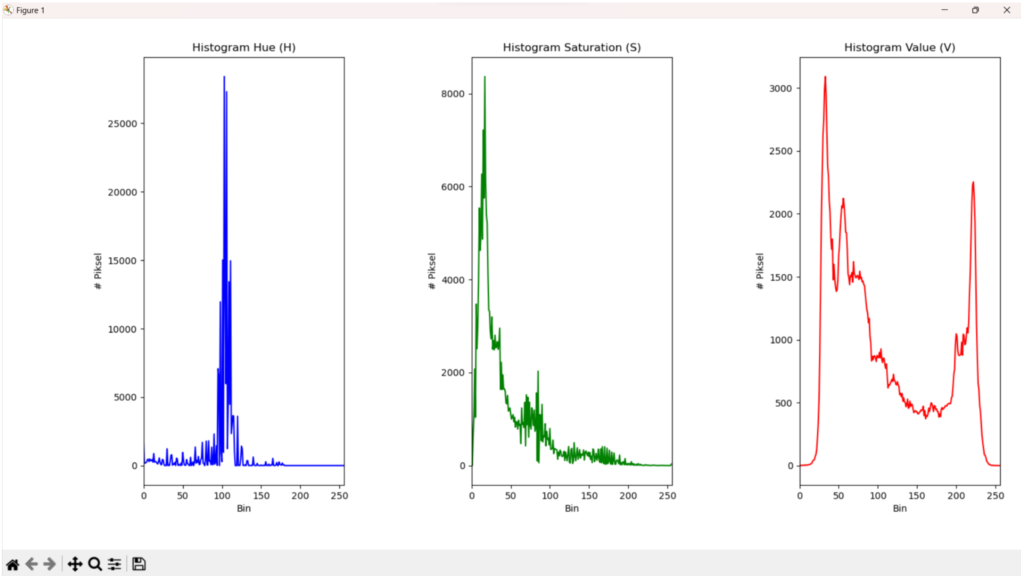

Figure 4. Graph Histogram HSV

The features that have gone through extraction will then be normalized and converted into a one-dimensional array. Converting it to a 1-dimensional array helps avoid errors in identifying fish later. An example of feature values that have been converted into a 1-dimensional array can be seen in Figure 5.

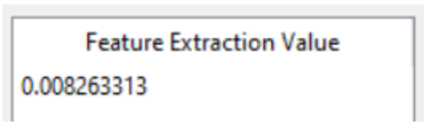

Figure 5. Feature Extraction Value

Implementation of Self-Organizing Map

The method used to identify fresh and non-fresh fish is the Self Organizing Map. This process goes through several stages, from dataset normalization to SOM initialization and class identification. Normalize the dataset using Min-Max Scaler, and the results are obtained with equation (3).

$$X_{normalized} = \frac{X - X_{min}}{X_{max} - X_{min}} \quad (3)$$

Self-organizing maps is a type of artificial neural network that is trained using the unsupervised learning method. This network can produce a separate representation of the input space of low-dimensional (usually two-dimensional) training samples. This representation is then referred to as a "map." SOM is also a method for performing dimensionality reduction on trained models. In general, updating the weights in the SOM can use equation (4).

$$Subscript(t+1) = IN_{ij}(t) + a(t) \times h(i,j,b) \times (X(t) - IN_{ij}(t)) \quad (4)$$

The training process will be carried out first to form a model, which will also be used for the testing process later. The system in this research also creates a save model button, which saves the model resulting from the training process, and a load model button, which works to upload the model you want to use later in the testing process. Based on the explanation of the system created in this research, users create a GUI that uses the Tkinter library to make things easier for users. An example of a GUI display can be seen in Figure 6.

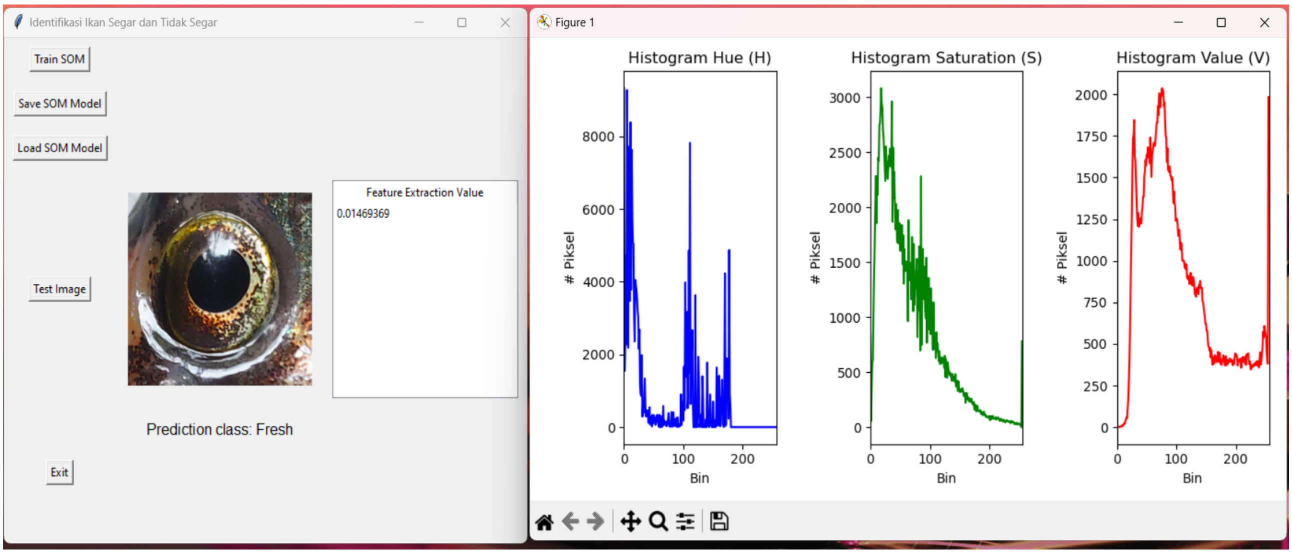

Figure 6. Fish Identification System Interface Display

Model Testing

Model testing can use newly trained models or previously trained models. This test is carried out to determine the performance of the chosen model. The test data consists of 14 fisheye images, where each fresh and non-fresh fish will be tested with seven shots. Testing is carried out by matching the results of the identification carried out by the system with existing factual data. Accuracy is determined using equation (5).

$$Accuracy = \frac{\sum \quad System\ Prediction}{\sum \quad Total\ Data} \qquad (5)$$

The test results for identifying fresh and non-fresh fish can be seen in Table 1.

Table 1. Accuracy Test Results

Fish Criteria	Number of Test Data	Number of Correct Identifications	Accuracy (%)
Fresh fish	7	6	85.71%
Fish Not Fresh	7	6	85.71%
Total	**14**	**12**	**85.71%**

Table 1 shows the accuracy of the fresh and non-fresh fish identification system, created by matching the system's identification results with the factual image data being tested. The accuracy results have been calculated using equation (5), producing 85.71% for fresh fish image accuracy and 85.71% for non-fresh fish image accuracy. The total accuracy of the system is 85.71%

CONCLUSION

This research has applied the Self Organizing Map (SOM) method to identify fresh and non-fresh fish based on eye images. This research uses HSV feature extraction, where the HSV values are obtained from the photos used. The feature extraction can extract information from the picture, making it easier to identify the fish. The feature extraction results are then converted into a 1-dimensional array to help avoid errors in the identification process. The feature extraction results obtained are used as input for the SOM algorithm to identify fish. The system's accuracy is also good, with a value of 85.71%.

However, fish identification results can be even better by increasing the image data available. Improve the performance of feature extraction to identify fish better and more accurately. Improve the Self Organizing Map (SOM) algorithm used or use another more modern algorithm with back-processing features to minimize fish identification errors and optimize accuracy.

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