HASIL CEK_Sabarudin Saputra, Anton Yudhana, Rusydi Umar

by Sabarudin Saputra, Anton Yudhana, Rusydi Umar Implementation Of Naïve Bayes For Fish Freshness

Submission date: 10-Nov-2022 01:42PM (UTC+0700)

Submission ID: 1949973826

File name: Cek_3.pdf (729.13K)

Word count: 6247

Character count: 30920

Accredited Ranking SINTA 2
Decree of the Director General of Higher Education, Research, and Technology, No. 158/E/KPT/2021
Validity period from Volume 5 Number 2 of 2021 to Volume 10 Number 1 of 2026

Published online on: **http://jurnal.iaii.or.id**

JURNAL RESTI
(Rekayasa Sistem dan Teknologi Informasi)
Vol. 6 No. 3 (2022) 412 – 420 ISSN Media Electronic: 2580-0760

Implementation of Naïve Bayes for Fish Freshness Identification Based on Image Processing

Sabarudin Saputra[1], Anton Yudhana[2], Rusydi Umar[3]
[1,3] Master Program of Informatics, Ahmad Dahlan University
[2] Departement of Electrical Engineering, Ahmad Dahlan University
[1]sicoccinela@gmail.com, [2]eyudhana@ee.uad.ac.id*, [3]rusydi@mti.uad.ac.id

Abstract

Consumption of fish as a food requirement for the fulfillment of community nutrition is increasing. This was followed by an increase in the amount of fish caught that were sold at fish markets. Market managers must be concerned about the dispersion of huge amounts of fish in the market in order to determine the freshness of the fish before it reaches the hands of consumers. So far, market managers have relied on traditional ways to determine the freshness of fish in circulation. The issue is that traditional solutions, such as the use expert assessment, demand a human physique that quickly experiences fatigue. Technological developments can be a solution to these problems, such as utilizing image processing techniques classification method. Image processing with the use of color features is an effective method to determine the freshness of fish. The classification method used in this research is the Naive Bayes method. This study aims to identify the freshness of fish based on digital images and determine the performance level of the method. The identification process uses the RGB color value feature of fisheye images. The stages of fish freshness identification include cropping, segmentation, RGB value extraction, training, and testing. The classification data are 210 RGB value of extraction images which are divided into 147 data for training and 63 data for testing. The research data were divided into fresh class, started to rot class, and rotted class. The research shows that the Naive Bayes algorithm can be used in the process of identifying the freshness level of fish based on fisheye images with a test accuracy rate of 79.37%.

Keywords: Identification, image, fisheye, naïve bayes, RGB

1. Introduction

Fish and the utilization of fish processing products have increased in the last few decades [1]. Fish consumption in the world has increased by an average of 20.5 kg per capita per year from 2014 to 2019 [2] followed by an increase in fish demand in Indonesia which is estimated by the Ministry of Maritime Affairs and Fisheries to reach 62.50 kg per capita per year [3]. Fish contains nutrients that the body needs such as minerals, protein, and vitamins to reduce the risk of coronary heart disease and stroke, reduce the risk of cancer, treat blood pressure, increase the ability of the movement system and IQ (intelligence quotient) [3, 4]. The government and market managers must be concerned about the increasing demand for fish when sorting caught fish for sale to consumers. Market managers need to ensure that the quality and freshness of fish is maintained before being purchased by consumers [5, 6].

The process of sorting fish needs to be done quickly and precisely [7] because of the perishable state of fish due to bacterial reproduction in fish, chemical reaction and biochemical processes that take place in the fish's body[8, 9]. Fish sorting is closely related to the ability of market managers to identify the freshness of fish to be marketed to consumers [10]. The sorting process needs to be carried out considering that consumer expectations and concerns about the quality of fresh fish have also increased [1].

Identification of fish freshness in the sorting process can be done by various conventional methods such as chemical or biochemical analysis of fish, analysis of microbiological content in fish, sensory inspection methods [11, 12], expert assessment [1], using thermal sensors [13], using Arduino based color sensors [14], using odor sensors [15], and using a microcontroller [16]. These methods have high accuracy but require more time, cost more, are complicated processes, and require a human

Accepted: 04-05-2022 | Received in revised: 17-06-2022 | Published: 30-06-2022

physique that quickly experiences fatigue [1], [10,11], [17].

The development of technology in life is very rapid [18]–[20]. The image processing method is one example of technological developments that have been used in various fields [21]. Image processing can be a solution to overcome the weaknesses of conventional methods [22]–[24] for managing and sorting fish [25]. Image processing is one of the main parts in the development of machine vision to recognize and analyze the information contained in an image [25], [26]. The processed images can be identified by classification methods namely *Back-propagation*, *Linear regression*, *Random Forest, Support Vector Machines*, *Naive Bayesian*, *Rocchio Method*, *Decision Tree*, *k-Nearest Neighbor*, *Logistic Regression*, and *Neural Network* [27]. Image processing with the use of color features is an effective method to determine the freshness of fish [5]. Research using image processing and classification methods to identify fish freshness has been carried out by several previous researchers, namely the research of Indrabayu, Niswar, and Aman who classified fish freshness by developing a fish freshness detection system. An LDR sensor, a microcontroller, and a Raspberry Pi are used in the fish freshness detection system. The system generates RGB values from the input image. Based on the fish image, the RGB values were analyzed using the *Euclid equation* method to determine the freshness of the fish. The results showed that the system could detect 10 fresh fish samples with 100% accuracy and 10 non-fresh fish samples with 80% accuracy [17].

Another method used for the identification process of fish freshness is *k-Nearest Neighbor* (kNN) method. The kNN method is used to classify fish freshness based on RGB color in fisheye images. The object of research is 150 fisheye images which are divided into training data and testing data. The results showed that the kNN method could identify fish freshness based on fisheye images. The value of the accuracy of the identification process on the test data is 93.33% [24].

According to Prayogi, Wibisono, and Abror's research, the *Support Vector Machine* (SVM) method can detect the freshness of fish. The image of a milkfish with the red color parameter on the RGB color channel is the subject of this research. The results of the tests show that the freshness of the fish can be determined with a test accuracy rate of 98.2% [28].

Previous studies have shown that the identification of fish freshness can be done using the kNN classification method, SVM, and *Euclid equation*. The method used in previous studies has high accuracy in the classification process. The Naive Bayes method is still used in the classification process to determine the performance of the method in the fish freshness classification process. The Naive Bayes method is still used in the classification process to determine the performance of the method in the fish freshness classification process based on research [29,30] which shows that the Naive Bayes method has a high accuracy value in the classification process. Previous studies have been carried out but there are no related studies that use the Naive Bayes method to identify fish freshness based on the RGB value of fisheye images.

Based on these previous studies, this research was conducted using the Naïve Bayes method as a classification method to identify the freshness of fish based on digital images and determine the performance level of the method. *Naïve Bayes* can be used for the identification process because *Naïve Bayes* is a classification method based on Bayes' theorem to estimate the possibility of grouping class members [31,32]. The identification process uses RGB value data of fisheye images that have passed image processing in the form of cropping and segmentation.

2. Research Methods

The research method is a series of processes carried out to obtain results. The object of research is a digital image of a fish's eye with an RGB (*red, green, blue*) color scheme. An overview of the research stages can be seen in Figure 1.

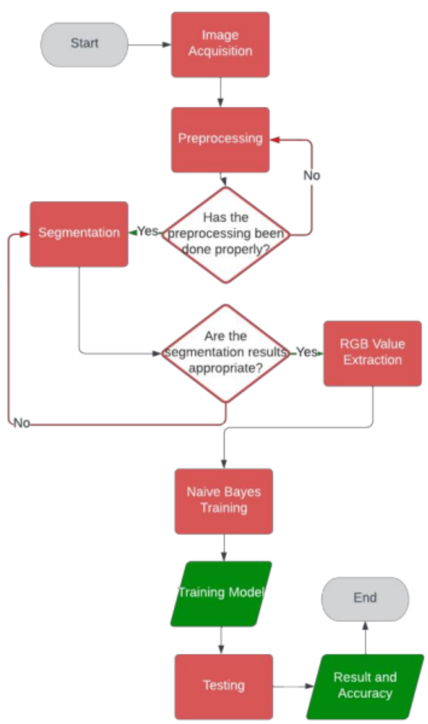

Figure 1. Research stages

DOI: https://doi.org/10.29207/resti.v6i3.4062

Based on Figure 1 it can be explained that this research was conducted based on several stages of the process, namely the acquisition of research objects, preprocessing, image segmentation, feature value extraction, training, and testing. The tools used in the fish freshness identification process are MATLAB R2015a and Corel Draw X7 2019 software.

2.1 Image Acquisition

The fish identification stage begins with image acquisition. The acquisition stage is carried out to obtain digital images of fish as research data and find methods to obtain them [33]. Image capture of fish using a Canon EOS M100 digital camera. This research using 210 fisheye digital images which are divided into training data and testing data. The total data of the fisheye image is divided by a ratio of 70% for training data and 30% for testing data [34].

The training data is used to obtain the RGB value as a training parameter that produces a training model. Testing data is a collection of acquired images that are used as objects to obtain RGB value parameters that will be classified using a training model. The training data and testing data consist of three groups of classification classes, namely fresh fish class, fish start to rot class, and fish have rotted class.

2.2 *Preprocessing*

Preprocessing is carried out in two stages, namely cropping and equalizing the size of all cropped images. Cropping is a technique used to remove parts of an image that are not required for identification [34]. Image cropping process using CorelDraw X7 2019 software.

Equalizing the size of all images aims to obtain an image with the same number of pixels in the identification process. The cropped and equalized images are stored in the training data and testing data folders.

2.3 Segmentation

The cropped fisheye image is then segmented to get a fisheye image without a background. Segmentation is a way to separate the image into main parts that are important to be used as sources of information [35]. The image segmentation process goes through several stages, namely converting RGB images into *grayscale* images, converting *grayscale* images into *binary* images, *complement* operations, and *morphological* operations.

The image segmentation process is carried out using MATLAB R2015a. The segmentation process goes through the morphology operations to reduce noise in the image. Furthermore, the extraction of RGB values on each segmented image is carried out.

2.4 RGB Value Extraction

Feature extraction aims to obtain differences in patterns so that it will be easier to separate class categories for the classification process [36]. Color, shape, geometry, size, and texture are all examples of characteristics or features [34]. This study's feature extraction is based on RGB (red, green, blue) color characteristics.

RGB color is a color component in a pixel image consisting of *red* (R), *green* (G), and *blue* (B). An image that has RGB color uses an eight-bit system for each component so that an RGB image uses a 24-bit system. Each color pixel in an RGB image has a color intensity range from 0 to 255 [34]. RGB value extraction process is carried out using MATLAB R2015a. The results of the extraction process are stored in a database table and then classified using the *Naive Bayes* method so as to produce a training model that will be used in the testing process.

2.5 Training and Testing

This study uses the *Naive Bayes* classification method for training stage in the identification process based on digital images. *Naive Bayes* is one of the methods in machine learning to predict a phenomenon [37] and classify data that does not yet have a class into the class that has the most similar characteristics through training and testing [38]. Bayes' theorem is shown in equation (1)

$$P(h|x) = \frac{P(x|h)P(h)}{P(x)} \quad (1)$$

where, x is data that does not have a class, h is data hypothesis x is a specific class, $P(h|x)$ is probability of h hypothesis based on x condition, $P(h)$ is probability of h hypothesis, $P(x|h)$ is probability of x based on its condition, $P(x)$ is probability of x.

The testing process is carried out by calling the previously saved *Naive Bayes* training model. After being analyzed, the testing process will show the results of fish freshness identification and the level of accuracy. The stages of training, testing, and calculating accuracy are carried out using MATLAB. Accuracy in the testing process can be calculated using equation (2)

$$Accuracy = \frac{Correct\ amount\ of\ data}{The\ amount\ of\ data} \times 100\% \quad (2)$$

3. Results and Discussions

3.1 Image Acquisition

The image is taken on fish stored at room temperature to be included in each class folder that has been determined, namely fresh fish class, fish that started to rot class, and fish that had rotted class. The acquisition process is taking fish images using a digital camera with results as shown in Figure 2.

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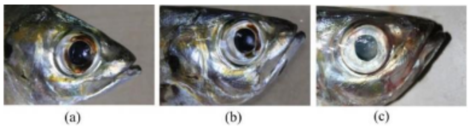

Figure 2. Sample of image acquisition (a) fresh, (b) started to rot, and (c) rotted

The image of fresh fish is fish that has just been caught as shown in Figure 2(a), fish that have started to rot are fish that have been stored for five hours at room temperature as shown in Figure 2(b), and fish that have rotted are fish that have been was stored for 10 hours at room temperature as shown in Figure 2(c). The total results of image acquisition to be used as training data are 120 images consisting of 40 images in each class and 30 images for testing consisting of 10 images in each class.

3.2 *Preprocessing*

The preprocessing stage begins with the image cropping process. The cropping process is carried out to obtain a more detailed and centralized image of the fish's eye. The fisheye image cropping process uses the manual method using CorelDraw X7 2019 software. All cropped images are then resized to 900x900 pixels. The preprocessed image is shown in Figure 3.

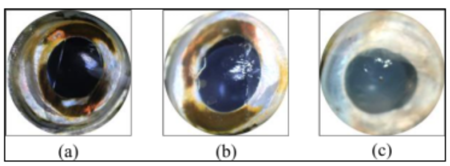

Figure 3. Results of cropping (a) fresh, (b) started to rot, and (c) rotted

Figure 3 shows that the cropped image still has a white background after being saved in the '.jpg' image format. The background in the image can affect the extraction process of RGB color values so it is necessary to do an image segmentation process to get an image without a background.

3.3 Image Segmentation

The cropped fisheye image is then segmented using MATLAB R2015a to get a fisheye image without a background. The process begins with entering or reading training and testing data into the system. The segmentation stage begins by converting the RGB image into a grayscale image. The result of conversion shown in Figure 4.

Converting an RGB image to a grayscale image is done in Matlab with the "rgb2gray" command. The image shown in Figure 4 has one channel to display the intensity value or known as the degree of gray. Converting an RGB image into a grayscale image is an important process in the segmentation process. The image that has been converted to grayscale is then converted again to a binary image. The result of the conversion to a binary image is shown in Figure 5.

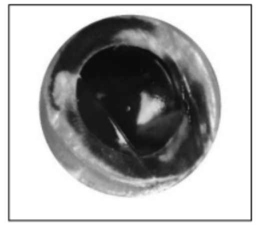

Figure 4. Result of RGB image conversion to grayscale image

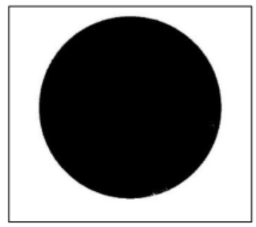

Figure 5. Result of grayscale conversion to binary image

Figure 5 shows that the binary image is represented as a black and white image. A binary image has only two possible values for each pixel, namely 1 and 0. Pixels with a value of 1 are displayed as white and pixels with a value of 0 are displayed as black. The binary image is generated through a thresholding process at the grayscale image threshold value. The threshold value used at this stage is determined at 0.9. The conversion process to a binary image uses the "im2bw" function command in the MATLAB work system. The next step is to perform a complement operation to swap the black part occupying the background and the white part occupying the object part. Complement operations in the MATLAB work system use the "imcomplement" function command. The results of the binary image complement operation are shown in Figure 6.

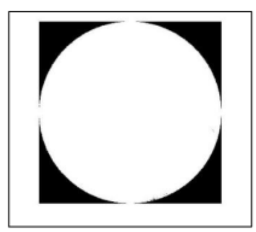

Figure 6. Complementary binary image results

The results of the complement of the binary image in Figure 6 show the presence of noise. Noise in the image needs to be removed so that it does not affect the process of extracting fisheye image values. Removing noise in the complement image can use morphological operations. At this stage the morphological operations

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used are filling holes and opening. The *filling holes* operation in the MATLAB work system uses the "imfill" function command to fill the color pixels in the noise with the dominating color pixels, while the *opening* operation is performed by running the "bwareaopen" function command to open the area where the dominating pixel values are intact. The results of the *morphological* operations are shown in Figure 7.

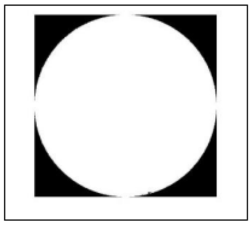

Figure 7. Results of the morphological process

The results of the morphological process in Figure 8 show that the noise area in the white object area has been minimized so that it can optimize the RGB value extraction process. The final stage of the segmentation process is to display the fisheye image object to be extracted as shown in Figure 8. The image segmentation process is carried out on each class image of training data and test data. Figure 8 shows that the background of the image is now black with a pixel value of 0 so that the RGB value extraction process is focused on the fish's eye image.

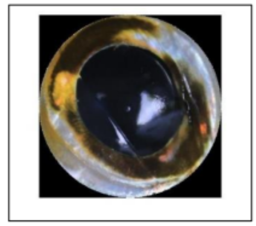

Figure 8. The results of the fish eye image segmentation process

3.4 RGB Color Feature Extraction

The image extraction process is carried out to obtain RGB values for each class of fish freshness. Based on this, it is necessary to know the level of RGB color intensity of the segmented image in each freshness class. The distribution of the intensity of the RGB values of segmented images in each class of fish freshness is shown in Figure 9.

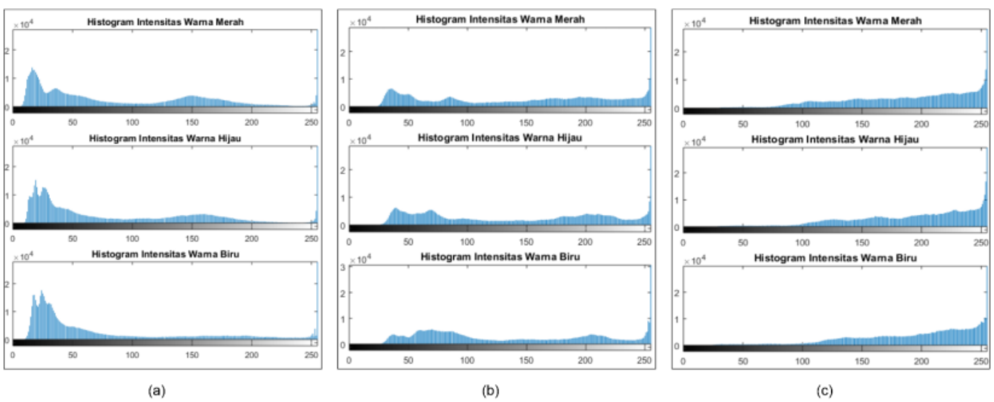

Figure 9. Distribution of RGB color intensity histograms (a) fresh, (b) started to rot, and (c) rotted

Figure 9 shows that the segmented fisheye image in each freshness class shows differences in RGB color intensity. Figure 9 shows that the RGB color intensity in the fresh fish class (Figure 9a) is more widely distributed in the dark color intensity or close to the 0 intensity value, the intensity of the RGB color appears to be spreading evenly in the rotting fish class (Figure 9b), and the intensity of the RGB color appears to be higher in the rotten fish class (Figure 9c), as indicated by the distribution of RGB values being more to the right, approaching the value of 255. Based on the comparison of the RGB color intensity distribution, it is possible to conclude that the decay of fish can affect the value of the RGB color intensity in the fisheye image. The RGB value extraction process is based on the distribution of these values.

The segmented image is then extracted to get the value of the RGB color feature. The process of extracting the segmented image is carried out in the MATLAB work system by averaging all the red, green, and blue pixel values. All the average RGB values extracted from the training data are stored in the extraction table for training data and RGB values extracted from the testing data are stored in the extraction table for testing data. The data used are 210 RGB values of fisheye extraction images which are divided into 147 data for training and 63 data for testing. Five samples of extracted data in each class in the training data are shown in Table 1 and five samples of extracted data in each class in the testing data are shown in Table 2.

Table 1. Sample Extracted from RGB Values in Training Data

Image	Red	Green	Blue	Class
1	0.254	0.244	0.237	Fresh
2	0.197	0.185	0.170	Fresh
3	0.297	0.292	0.293	Fresh
4	0.256	0.254	0.253	Fresh
5	0.261	0.259	0.257	Fresh
.	.	.	.	.
.	.	.	.	.
66	0.247	0.253	0.267	Started to rot
67	0.275	0.276	0.288	Started to rot
68	0.262	0.265	0.280	Started to rot
69	0.320	0.320	0.332	Started to rot
70	0.228	0.227	0.239	Started to rot
.	.	.	.	.
.	.	.	.	.
143	0.419	0.424	0.405	Rotted
144	0.488	0.497	0.472	Rotted
145	0.449	0.459	0.445	Rotted
146	0.418	0.431	0.420	Rotted
147	0.345	0.319	0.285	Rotted

Table 2. Sample Extracted from RGB Values in Testing Data

Image	Red	Green	Blue	Class
1	0.254	0.244	0.237	Fresh
2	0.197	0.185	0.170	Fresh
3	0.297	0.292	0.293	Fresh
4	0.256	0.254	0.253	Fresh
5	0.261	0.259	0.257	Fresh
.	.	.	.	.
.	.	.	.	.
31	0.357	0.347	0.337	Started to rot
32	0.283	0.286	0.304	Started to rot
33	0.415	0.400	0.392	Started to rot
34	0.366	0.355	0.361	Started to rot
35	0.247	0.253	0.267	Started to rot
.	.	.	.	.
.	.	.	.	.
59	0.456	0.460	0.456	Rotted
60	0.393	0.421	0.430	Rotted
61	0.271	0.263	0.236	Rotted
62	0.460	0.477	0.461	Rotted
63	0.542	0.565	0.571	Rotted

3.5 Training and Testing

The training process occurs in the system by creating a *Naive Bayes* classification model for the training data extracted from the RGB values in the training table of each class into the training target class. The command to perform classification in the MATLAB system is shown in Figure 10.

Figure 10 shows that the training process begins by declaring "ciri_latih" dan "target_latih" variable. "ciri_latih" is the RGB value in the training data, while "target_latih" is the training target. The training stage is carried out using the "fitcnb" command to match the "ciri_latih" value to the "target_latih" value. The training process on the system produces a training model "Mdl.mat" so that it can be used in the testing process. Training model is saved using the "save" command.

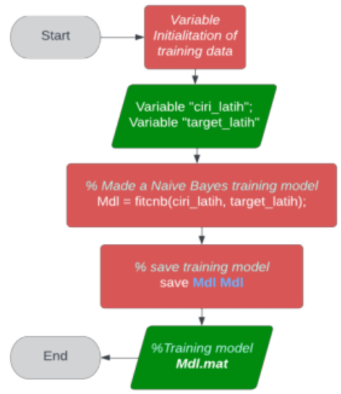

Figure 10. Command for training

The testing phase begins with the process of inputting test data into the matlab system. The next process is to classify the testing data into the target class by using the training model that has been stored previously. The command to perform the test is shown in Figure 11.

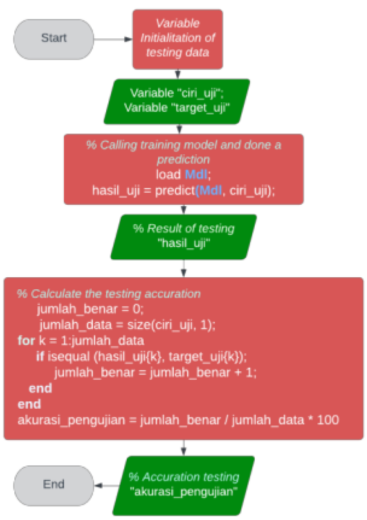

Figure 11. Command for testing

Figure 11 shows that the testing process begins by declaring "ciri_uji" and "target_uji" variable. "ciri_uji" is the RGB value in the testing data, while "target_uji" is the classification target. Testing process is carried out by calling the previously saved training model using the "load" command. Furthermore, "hasil_uji" is obtained by predicting "ciri_uji" based on the "Mdl" model. Prediction is done using the "predict" command. The

DOI: https://doi.org/10.29207/resti.v6i3.4062

results of the classification in the testing process are shown in Table 3.

Table 3. Testing Results of Classification

Image	Target	Result	Value
1	Fresh	Fresh	True
2	Fresh	Fresh	True
3	Fresh	Started to rot	False
4	Fresh	Fresh	True
5	Fresh	Fresh	True
6	Fresh	Started to rot	False
7	Fresh	Fresh	True
8	Fresh	Fresh	True
9	Fresh	Fresh	True
10	Fresh	Fresh	True
11	Fresh	Started to rot	False
12	Fresh	Fresh	True
13	Fresh	Fresh	True
14	Fresh	Fresh	True
15	Fresh	Fresh	True
16	Fresh	Fresh	True
17	Fresh	Fresh	True
18	Fresh	Fresh	True
19	Fresh	Started to rot	False
20	Fresh	Fresh	True
21	Fresh	Fresh	True
22	Started to rot	Fresh	False
23	Started to rot	Started to rot	True
24	Started to rot	Started to rot	True
25	Started to rot	Started to rot	True
26	Started to rot	Started to rot	True
27	Started to rot	Started to rot	True
28	Started to rot	Fresh	False
29	Started to rot	Started to rot	True
30	Started to rot	Started to rot	True
31	Started to rot	Started to rot	True
32	Started to rot	Started to rot	True
33	Started to rot	Rotted	False
34	Started to rot	Started to rot	True
35	Started to rot	Fresh	False
36	Started to rot	Started to rot	True
37	Started to rot	Started to rot	True
38	Started to rot	Rotted	False
39	Started to rot	Started to rot	True
40	Started to rot	Fresh	False
41	Started to rot	Started to rot	True
42	Started to rot	Started to rot	True
43	Rotted	Started to rot	False
44	Rotted	Rotted	True
45	Rotted	Rotted	True
46	Rotted	Rotted	True
47	Rotted	Rotted	True
48	Rotted	Rotted	True
49	Rotted	Rotted	True
50	Rotted	Rotted	True
51	Rotted	Rotted	True
52	Rotted	Rotted	True
53	Rotted	Rotted	True
54	Rotted	Rotted	True
55	Rotted	Rotted	True
56	Rotted	Rotted	True
57	Rotted	Started to rot	False
58	Rotted	Rotted	True
59	Rotted	Rotted	True
60	Rotted	Rotted	True
61	Rotted	Fresh	False
62	Rotted	Rotted	True
63	Rotted	Rotted	True

The test results in Table 2 show that the RGB values of numbers 3, 6, 11, 19, 22, 28, 33, 35, 38, 40, 43, 57, and 61 are classified as not in accordance with the test target. The test accuracy value can be calculated as follows:

$$Accuracy = \frac{Correct\ amount\ of\ data}{The\ amount\ of\ data} \times 100\%$$

$$Accuracy = \frac{50}{63} \times 100\%$$

$$Accuracy = 79.37\%$$

Based on the results of these calculations, it can be stated that the results of the classification using the *Naïve Bayes* method based on the RGB color value of the fish's eye have a lower accuracy value than the method used in previous studies. The comparison of performance based on the classification accuracy of this study with previous studies is shown in Figure 12.

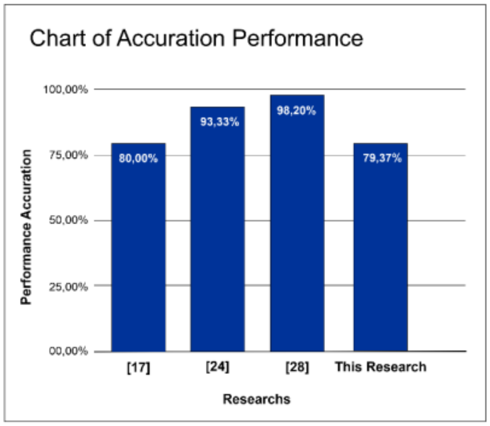

Figure 12. Comparison of performance accuracy levels

4. Conclusion

The research shows that the *Naive Bayes* algorithm can be used in the process of identifying the freshness level of fish based on fish eye images. The testing process using the *Naive Bayes* training model based on the previously stored training model showed an accuracy of 79.37%. The test accuracy value is calculated based on the comparison of the number of classifications on target with the number of classifications not on target. Based on the results of the study, there were thirteen data that were not in accordance with the test target from a total of 63 data used for testing. Based on the results and discussion, it can be concluded that the classification using the *Naïve Bayes* method based on the fisheye RGB value has a lower level of performance compared to other methods.

In general, each stage of research is an important part that is interrelated. This study uses a fish eye image object using the *Naive Bayes* method. The process of segmentation and classification of RGB values using MATLAB software as a tool. This research can be

DOI: https://doi.org/10.29207/resti.v6i3.4062

continued or developed using different tools, methods, and parameters to obtain more accurate and effective fish freshness identification results.

Reference

[1] M. Saberioon, A. Gholizadeh, P. Cisar, A. Pautsina, and J. Urban, "Application of machine vision systems in aquaculture with emphasis on fish: state-of-the-art and key issues," *Rev. Aquac.*, vol. 9, no. 4, pp. 369–387, 2017, doi: 10.1111/raq.12143.

[2] J. Guillen *et al.*, "Global seafood consumption footprint," *Ambio*, vol. 48, no. 2, pp. 111–122, 2019, doi: 10.1007/s13280-018-1060-9.

[3] K. U. Henggu, Y. R. Tega, F. Meiyasa, S. Ndahawali, N. Tarugan, and Y. Nurdiyansyah, "Fish Consumption Analysis of East Sumba Coastal Communities," *Bul. Ilm. "MARINA" Sos. Ekon. Kelaut. dan Perikan.*, vol. 7, no. 2, pp. 103–114, 2021.

[4] P. K. Prabhakar, S. Vatsa, P. P. Srivastav, and S. S. Pathak, "A comprehensive review on freshness of fish and assessment: Analytical methods and recent innovations," *Food Res. Int.*, vol. 133, no. March, p. 109157, 2020, doi: 10.1016/j.foodres.2020.109157.

[5] M. K. Dutta, A. Issac, N. Minhas, and B. Sarkar, "Image processing based method to assess fish quality and freshness," *J. Food Eng.*, vol. 177, pp. 50–58, 2016, doi: 10.1016/j.jfoodeng.2015.12.018.

[6] N. Sengar, M. K. Dutta, and B. Sarkar, "Computer vision based technique for identification of fish quality after pesticide exposure," *Int. J. Food Prop.*, vol. 20, no. 2, pp. 2192–2206, 2017, doi: 10.1080/10942912.2017.1368553.

[7] A. Taheri-Garavand, A. Nasiri, A. Banan, and Y. D. Zhang, "Smart deep learning-based approach for non-destructive freshness diagnosis of common carp fish," *J. Food Eng.*, vol. 278, no. January, p. 109930, 2020, doi: 10.1016/j.jfoodeng.2020.109930.

[8] T. Wu, L. Yang, J. Zhou, D. C. Lai, and N. Zhong, "An improved nondestructive measurement method for salmon freshness based on spectral and image information fusion," *Comput. Electron. Agric.*, vol. 158, no. October 2018, pp. 11–19, 2019, doi: 10.1016/j.compag.2019.01.039.

[9] S. Grassi, S. Benedetti, M. Opizzio, E. Di Nardo, and S. Buratti, "Meat and fish freshness assessment by a portable and simplified electronic nose system (Mastersense)," *Sensors (Switzerland)*, vol. 19, no. 14, 2019, doi: 10.3390/s19143225.

[10] H. zhi Chen, M. Zhang, B. Bhandari, and C. hui Yang, "Novel pH-sensitive films containing curcumin and anthocyanins to monitor fish freshness," *Food Hydrocoll.*, vol. 100, no. October 2019, p. 105438, 2020, doi: 10.1016/j.foodhyd.2019.105438.

[11] A. Kalista, A. Redjo, and U. Rosidah, "Aplication of Image Processing to Determine The Freshness of Tilapia Fish (Oreochromis niloticus)," *J. Pengolah. Has. Perikan. Indones.*, vol. 22, no. 2, pp. 229–235, 2019, doi: 10.17844/jphpi.v22i2.27364.

[12] H. Fitriyah, D. Syauqy, and F. A. Susilo, "Automatic Detection of Tongkol Fish (Euthynnus Affinis) Freshness Level Based on Eye Image Using Binary Similarity," *J. Teknol. Inf. dan Ilmu Komput.*, vol. 7, no. 5, pp. 879–885, 2020, doi: 10.25126/jtiik.202073839.

[13] T. Arsatria, K. Munadi, and F. Arnia, "Thermal Image Processing for Region of Interest (ROI) Identification and Freshness Detection of Tilapia (Oreochromis Niloticus)," *J. Karya Ilm. Tek. Elektro*, vol. 5, no. 3, pp. 20–24, 2020.

[14] Dwiyanto, Saleh, Iksal, and S. Nugraha, "Fish Freshness Detector Using K-Nearest Neighbor Method Based on Eye Color Based on ATMega328," *J. PROSISKO*, vol. 5, no. 2, pp. 127–135, 2018.

[15] G. D. K. Sandi, D. Syauqy, and R. Maulana, "Milkfish Freshness Detection System Based on Odor and Color of Meat Based on Mq135 and Tcs3200 Sensors Using Naive Bayes Method," *J. Pengemb. Teknol. Inf. dan Ilmu Komput.*, vol. 2548, no. 10, p. 964X, 2020, [Online]. Available: http://j-ptiik.ub.ac.id.

[16] Adam, Agustiawan, and Marzuarman, "Neural Network Implementation to Determine the Freshness Level of Tuna Meat," *Inovtek Polbeng*, vol. 9, no. 1, pp. 1–7, 2019, doi: 10.35314/ip.v9i1.854.

[17] Indrabayu, M. Niswar, and A. Aman, "Milkfish Freshness Detection System Using Image," *J. Infotel*, vol. 8, no. 2, pp. 170–179, 2016.

[18] R. Umar, I. Riadi, and Purwono, "Classification of Programmer Performance on Social Media Activities with the Stochastic Gradient Descent Method," *Jointecs*, vol. 5, no. 2, pp. 55–60, 2020, doi: 10.29406/cbn.v4i01.2042.

[19] R. Umar, I. Riadi, A. Hanif, and S. Helmiyah, "Identification of speaker recognition for audio forensic using k-nearest neighbor," *Int. J. Sci. Technol. Res.*, vol. 8, no. 11, pp. 3846–3850, 2019.

[20] S. Saputra, T. D. Rahmawati, and N. Safrudin, "Development of puzzle square as interactive learning media using macromedia flash 8," *JINoP (Jurnal Inov. Pembelajaran)*, vol. 6, no. 2, pp. 124–135, 2020, doi: 10.22219/jinop.v6i2.12096.

[21] R. Umar, I. Riadi, and M. Miladiah, "Authenticity Identification System for Rupiah Banknotes Using the K-Means Clustering Method," *Techno.Com*, vol. 17, no. 2, pp. 179–185, 2018, doi: 10.33633/tc.v17i2.1681.

[22] A. Salman *et al.*, "Fish species classification in unconstrained underwater environments based on deep learning," *Limnol. Oceanogr. Methods*, vol. 14, no. 9, pp. 570–585, 2016, doi: 10.1002/lom3.10113.

[23] A. Yudhana, Sunardi, and S. Saifullah, "Segmentation comparing eggs watermarking image and original image," *Bull. Electr. Eng. Informatics*, vol. 6, no. 1, pp. 47–53, 2017, doi: 10.11591/eei.v6i1.595.

[24] S. Saputra, A. Yudhana, and R. Umar, "Fish Freshness Identification Using Digital Image-Based KNN Algorithm," vol. 10, no. 1, pp. 1–9, 2022, doi: 10.32832/kreatif.v10i1.6845.

[25] H. Azarmdel, S. S. Mohtasebi, A. Jafari, and A. Rosado Muñoz, "Developing an orientation and cutting point determination algorithm for a trout fish processing system using machine vision," *Comput. Electron. Agric.*, vol. 162, no. May, pp. 613–629, 2019, doi: 10.1016/j.compag.2019.05.005.

[26] R. A. Surya, A. Fadlil, and A. Yudhana, "Identification of Pekalongan Batik Images Using Backpropagation Method," *J. Phys. Conf. Ser.*, vol. 1373, no. 1, 2019, doi: 10.1088/1742-6596/1373/1/012049.

[27] A. Roihan, P. A. Sunarya, and A. S. Rafika, "Utilization of Machine Learning in Various Fields: Review paper," *IJCIT (Indonesian J. Comput. Inf. Technol.*, vol. 5, no. 1, pp. 75–82, 2020, doi: 10.31294/ijcit.v5i1.7951.

[28] Y. R. Prayogi, C. L. Wibisono, and A. H. Abror, "Freshness Detection of Milkfish Based on Digital Image Processing," *REMIK (Riset dan E-Jurnal Manaj. Inform. Komputer)*, vol. 4, no. 1, p. 53, 2019, doi: 10.33395/remik.v4i1.10228.

[29] F. Liantoni and H. Nugroho, "Classification of Herbal Leaves Using the Naïve Bayes Classifier and Knearest Neighbor Method," *J. Simantec*, vol. 5, no. 1, pp. 9–16, 2015, doi: https://doi.org/10.21107/simantec.v5i1.

[30] M. M. Maga and A. A. Pekuwali, "Comparison of the Naïve Bayes Classifier Method with K-Nearest Neighbors in Classifying Apples," *Bisnis dan Komput.*, vol. 1, no. 3, pp. 107–116, 2021, [Online]. Available: https://journal.unpak.ac.id/index.php/jubikom.

[31] H. Annur, "Classification of the Poor Using the Naive Bayes Method," *Ilk. J. Ilm.*, vol. 10, no. 2, pp. 160–165, 2018, doi: 10.33096/ilkom.v10i2.303.160-165.

[32] A. Yudhana, I. Riadi, and F. Ridho, "DDoS Classification Using Neural Network and Naïve Bayes Methods for Network Forensics," *Int. J. Adv. Comput. Sci. Appl.*, vol. 9, no. 11, pp. 177–183, 2018.

[33] Sunardi, A. Yudhana, and S. Saifullah, "Identity analysis of

DOI: https://doi.org/10.29207/resti.v6i3.4062

egg based on digital and thermal imaging: Image processing and counting object concept," *Int. J. Electr. Comput. Eng.*, vol. 7, no. 1, pp. 200–208, 2017, doi: 10.11591/ijece.v7i1.pp200-208.

[34] R. Umar, I. Riadi, and D. A. Faroek, "Classification Based on Machine Learning Methods for Identification of Image Matching Achievements," *J. RESTI (Rekayasa Sist. dan Teknol. Informasi)*, vol. 6, no. 2, pp. 198–206, 2022, doi: https://doi.org/10.29207/resti.v6i2.3826.

[35] A. Yudhana, Sunardi, and S. Saifullah, "Wavelet Compression For Egg Identification," *Ilk. J. Ilm.*, vol. 8, no. Desember, pp. 190–196, 2016.

[36] R. Umar, I. Riadi, and A. Hanif, "Sound Pattern Shape Analysis Using Mel-Frequencey Cepstral Coefficients (MFCC) Feature Extraction," *CogITo Smart J.*, vol. 4, no. 2, pp. 294–304, 2018, doi: 10.31154/cogito.v4i2.130.294-304.

[37] A. Yudhana, D. Sulistyo, and I. Mufandi, "GIS-based and Naïve Bayes for nitrogen soil mapping in Lendah, Indonesia," *Sens. Bio-Sensing Res.*, vol. 33, 2021, doi: 10.1016/j.sbsr.2021.100435.

[38] Z. Zhang, "Introduction to machine learning: K-nearest neighbors," *Ann. Transl. Med.*, vol. 4, no. 11, pp. 1–7, 2016, doi: 10.21037/atm.2016.03.37.

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