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MESSAGE FROM GENERAL CHAIR

Assalamualaikum Warahmatullahi Wabarakatuh

I would like to extend a warm welcome to all of the keynote speakers, distinguished guests, and committee members of the 2022 International Conference on Information Technology Research and Innovation (ICITRI).

First of all, I would like to send my sincere greetings and warmest welcome to all attendees of ICITRI 2022, which is being conducted by Universitas Nusa Mandiri. Due to the COVID-19 epidemic, ICITRI 2022 will be the first conference in the history of Universitas Nusa Mandiri to be conducted entirely online. In conjunction with the theme chosen for this conference, "**Empowering Community with Advanced Technologies to Support Digital Transformation in The Post-Pandemic Era**," we transform our session through this advanced technology supported during the conference.

ICITRI 2022 seeks to offer a venue for researchers, academics, practitioners, and application developers to communicate and promote knowledge and information regarding computer and information science. All involved persons, institutions, and organisations, including sponsors, presenters, and participants, will gain from these knowledge-based sharing activities. May this conference provide opportunities and inspirations to thoroughly investigate the field of computer and information science.

The entire scope of the IEEE Computational Intelligence Society Indonesia Chapter is covered by the ICITRI 2022. Its scope includes the development of computational intelligence, fuzzy systems, artificial intelligence, and human-machine systems on a theoretical, practical, and multidisciplinary level. The following are the main areas of interest: informatics, computer networks, image processing and computer vision, and software engineering.

ICITRI 2022 presents 1 (one) speaker and 3 (three) invited speakers from highly qualified researchers in the region. In addition, authors and reviewers from 11 countries have supported the conference through their papers and dedicated efforts in the review process of 128 submissions received from 12 countries, and 33 papers from 10 countries accepted as a result of the review.

I want to extend my sincere gratitude to all notable keynote speakers, industrial speakers, and invited speakers for their attendance at the conference and their efforts. The members of the programme committee deserve congratulations for their tireless work to make this conference a success. I really hope that the keynote speakers and presented papers of this joint conference will be useful and informative to all participants and attendees, and I intend for the conference to be a great success.

In the end, I hope to discover that some new insights into the enormous influence of computer and information technology are revealed. Please utilise this wonderful opportunity to expand your network and share your significant excerpt of research work.All members of the ICITRI 2022 organising committee are sincerely appreciated on behalf of Universitas Nusa Mandiri for their efforts in making this event a success. Thank you especially to all of our partners and sponsors for working with us and for their support.

Thank you.

Best regards,
Prof. Dr. Dwiza Riana, S.Si., M.M, M.Kom

2022 International Conference on Information Technology Research and Innovation (ICITRI)

Informatics 1

Informatics 2

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Computer Network

Image Processing and Computer Vision

Betta Fish Image Identification using Feature Extraction GLCM and K-Nearest Neighbour Classification

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***Abstract*— Freshwater fish known as bettas have their natural habitats in a number of Southeast Asian nations, including Thailand, Malaysia, Brunei Darussalam, Singapore, Vietnam, and Indonesia. In addition to having a distinctive appearance and personality, this fish is aggressive while defending its area. The Betta Fish is distinctive in its size, pattern, and body color. It is known that there are 73 species of Betta Fish. The main reasons for carrying out this study were due to the limitations in recognizing Betta Fish with the human eye and to build an initial model for the Betta Fish pattern recognition application. The fish data set consists of 300 with limited species: 60 Halfmoon Fancy, 60 Hell boy, 60 Red Koi Galaxy, 60 Solid Blue, and 60 Yellow Koi Galaxy. This study uses three schemes between training data and testing data: scheme 1 consist of training data 75% and testing data 25%, scheme 2 training data 80% and testing data 20%, scheme 3 training data 85% and testing data 15%. In the pre-processing stage, the scaling, segmentation and gray scale methods are carried out. Characteristics of fish features were obtained through the gray level co-occurence matrix (GLCM) method with angular direction and the K-NN method was used for classification with values of k = 1, 2, 3, 4, 5, 6, 7. The results of this study show in Scheme 1 the highest accuracy is 92% with k = 5 and angular direction is 135 and error rate = 8%, scheme 2 has the highest accuracy 95% with k = 7 and angular direction is 135 and error rate = 5%, scheme 3 has the highest accuracy 100% with k = 2 and the angular direction is 180 and error rate is 0%.**

Keywords—GLCM, K-NN, Betta Fish, Classification, Accuracy

I. INTRODUCTION

Freshwater fish known as betta fish (Betta sp.) are found in a number of nations in their natural habitat. This fish has a distinct personality and shape, and it is more aggressive in guarding its habitat. Betta fish consists of 73 species and betta fishes are divided into 13 groups, while among betta fish fans are generally divided into three groups, namely ornamental betta fish, fighting betta fish and wild betta fish. Betta fish is a type of freshwater ornamental fish that is in demand by the public because it has beautiful morphological variations. Betta fish have a higher economic value than females because they are more attractive and aggressive and have more beautiful morphological variations [1]. It proves that there are certain characteristics in each species of betta fish. Betta fishes come in many sizes, patterns, and colors on their bodies. This makes it difficult for us to recognize the diversity of these fish species if we do not have knowledge or hobbies. In fact, by classifying the types of betta fish, we can get to know more about the diversity of betta ornamental fish species.

Classification is one of the real problems, including in the world of education in the field of Biology. So far, we have recognized ornamental fish by direct observation with eyes, books, and educational videos. This takes quite a bit of time. Especially in recognizing the type of betta fish in large quantities. The next problem is in the ornamental fish market, in the market there are many buying and selling processes between sellers and customers. Customers who are very expert in general already recognize many types of ornamental fish that are good and unique. Meanwhile, new customers who want to have ornamental fish will have difficulty knowing the type of ornamental fish that is good according to the price offered. So we need a way that can recognize and classify the diversity of betta fish species effectively, quickly, and automatically, especially in the diversity of ornamental fish species, namely betta fish.

Recent research related to the identification of betta fish computationally has been carried out by Daffa, Wikky in 2021 [2] and by Satria, Aviv and Istiadi in 2022 [3]. Daffa and Wikky use the Convolutional Neural Network approach, with the ResNet-50 architectural model and the RGB colorspace type and Adam optimization algorithm. Data augmentation

technique is used in research and conducted by Daffa and Wikky [2]. Satria, Aviv and Istiadi used the Gabor feature approach and Artificial Neural Networks in classifying Betta Fish images. Gabor features with CMYK, HSV and RGB precision colors. Research results from Satria, Aviv and Istiadi show that the Gabor feature with RGB precision color gives the best results in classifying Betta Fish [3].

II. Related Research

The use of GLCM features and K-NN methods have been widely used by researchers in various objects. Rico and colleagues used the GLCM feature and the K-NN method to identify butterfly using various angular directions and various *k* values [4]. Research on the identification of a butterfly obtained the highest accuracy is 91.1% [4]. The GLCM feature and the K-NN method to identify the type of orchid and the success rate obtained reached 80% [5]. Meanwhile, Neneng and friends use the GLCM or Local Binary Pattern (LBP) feature and the K-NN or Support vector machine (SVM) method to identify the type of meat [6].

Research using GLCM features and K-NN methods were found in various international conferences that written by various researchers from Indonesia [7]-[10], Malaysia [11], Thailand [12], Myanmar [13], Bangladesh [14], India [15][16] even Turkey [17].

Classification of wood furniture types using GLCM features and K-NN methods. The results showed that the lowest accuracy was obtained at 50% and the highest was 77.5% in classifying the types of wood furniture [7]. Human nail identification research was also carried out using GLCM features and K-NN methods and the highest accuracy result was 70.93% [8]. Furthermore, tomato classification and Lasem batik classification were also carried out using GLCM features and K-NN methods [9][10]. Research on identification of blood vessels using images from thermal cameras was also carried out using GLCM features and K-NN methods [11]. Even the combination of GLCM and K-NN was used to identify embryonic development from chicken eggs. Observation of chicken embryos was carried out for 18 days of egg incubation with 4 stages. Accuracy in stages 1, 2, 3 and 4 obtained values of 73.33%, 60%, 66.67% and 93.33%, respectively [12].

In the world of health, GLCM features and K-NN methods are used to identify or detect first-stage breast cancer. The results of the classification are divided into two, namely breasts in normal conditions or breasts in abnormal conditions [13]. Detection of an image forgery can be done using GLCM features and K-NN methods, the accuracy of the results obtained reaches a value of 85.42% [14]. Lung cancer classification was carried out using various feature extractions, GLCM, LBP and HOG while the methods used were K-NN and SVM [15]. Breast cancer, diagnostic research was conducted using GLCM, LBP feature extraction, while the methods used were K-NN and SVM. The results of the accuracy of breast cancer diagnosis with the SVM method are 96% while K-NN is 100% [16]. Classification of agricultural textures such as seeds and leaves using various feature extractions, GLCM, LBP and HOG while the methods used are K-NN, Neural Network and Random Forest [17]. Research using the K-NN method is also used to identify Lampung Batik Motifs [18], then the K-NN method along with a Principal component analysis (PCA) method is used to identify herbal plants [19].

III. Methodology

The research methodology section discussed the stages of conducting research betta fish or siamese fighting fish (SFF). The stage includes image collection, scaling, segmentation, grayscale, GLCM Feature extraction, KNN classification, calculation accuracy level. This study in identifying images of betta fish or SFF using the GLCM feature and K-NN classification are shown in Fig. 1 below:

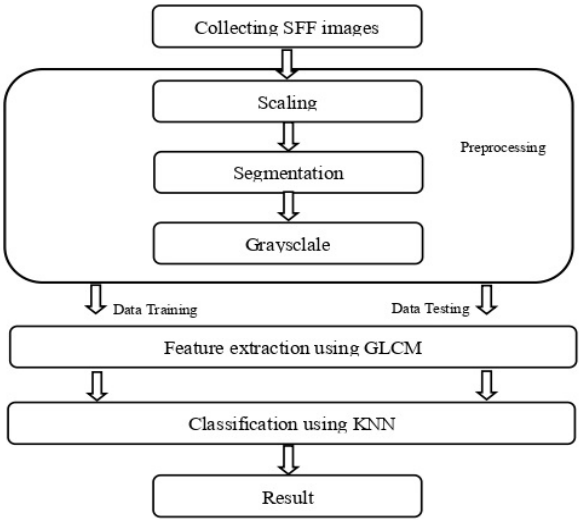

Fig. 1. The stages of conducting research

A. Betta Fish Image Collection Data Training and Testing

The betta fish images were obtained from fish farmers located in Metro City, Lampung province. The location is located on Jalan Kebun Cengkeh Metro City. The fish data set consists of 300 with limited species: 60 images HalfMoon Fancy in JPG (Fig. 2), 60 images Hellboy in JPG (Fig. 3), 60 images Red Koi Galaxy in JPG (figure 4), 60 images Solid Blue in JPG (Fig. 5), and 60 images Yellow Koi Galaxy in JPG (Fig. 5).

In this study, the distribution of training data and testing data are carried out using 3 schemes, namely scheme 1 consisting of 75% training data and 25% testing data, scheme 2 consisting of 80% training data and 20% testing data and scheme 3 consisting of 85% training data and 15% of testing data. The test scenarios consist of schemes one, two and three, respectively 25%, 20% and 15% of 300 images of betta fish.

Fig. 2. The sample of Halfmoon Fancy image

Fig. 3. The sample of Hellboy image

Fig. 4. The sample of Red Koi Galaxy image

Fig. 5. The sample of Solid Blue image

Fig. 6. The sample of Yellow Koi Galaxy image

B. *Preprocessing*

In the preprocessing section, the betta fish image was changed to another form. The results of preprocessing helped at the feature extraction stage using GLCM. Preprocessing included scaling, segmentation and gray scale.

a) *Scaling :* The size of the fish image obtained is 4160 x 3120 pixels, when the fish is photographed as an image. The image is cropped to 256 x 256 pixels so that the characteristics of the image appear.

b) *Segmentation :*.Separating the foreground from the background is the goal of segmentation, which is a step in the preprocessing stage.

c) *Grayscale :* When an image is converted to grayscale, all of the RGB (Red, Green, and Blue) colour information from its three image composition matrices is combined into a single matrix..

C. *Feature Extraction using GLCM*

Using GLCM to get feature textures: dissimilarity, correlation, homogeneity, contrast, ASM, energy. Visually we can distinguish the texture of an image by observing the repetition of patterns, spatial distribution, color arrangement and intensity. Statistical calculations such as mean, median, or standard deviation will not be able to distinguish three images above. The three images above have the same color arrangement and pixel intensity, but have different spatial patterns and distributions that cannot be recognized by statistical calculations such as the mean, median, or standard deviation so that a Gray-Level Co-occurrence matrix (GLCM) appears to solve this problem. Gray-Level Co-occurrence matrix (GLCM) is an image texture analysis technique. GLCM represents the relationship between 2 neighboring pixels that have grayscale intensity, distance and angle. There are 8 angles that can be used in GLCM, including 0°, 45°, 90°, 135° or 180° angles.

The normalized glcm matrix can get texture metrics such as correlation, homogeneity, contrast, energy. Here are the formulas for each metric :

Contrast is used for Measures local variations in the gray-level co-occurrence matrix.

$$\sum_{i,j=0}^{levels-1} P_{i,j}(i-j)^2 \quad (1)$$

Correlation is used for Measures the joint probability occurrence of the specified pixel pairs.

$$\sum_{i,j=0}^{levels-1} P_{i,j}\left[\frac{(i-\mu_i)(j-\mu_j)}{\sqrt{\sigma_i^2\sigma_j^2}}\right] \quad (2)$$

Energy is used for Provides the sum of squared elements in the GLCM. Also known as uniformity or the angular second moment.

$$\sum_{i,j=0}^{levels-1} P_{i,j}^2 \quad (3)$$

Homogeneity is used for measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal.

$$\sum_{i,j=0}^{levels-1} \frac{P_{i,j}}{1+(i-j)} \quad (4)$$

For *i,j* are pixel coordinates in the GLCM matrix level is the range of gray tones, in digital images 0–255 (level=256) and $P_{i,j}$ is the pixel value at coordinates *i,j* GLCM matrix.

D. *K-Nearest Neighbour*

The k-Nearest Neighbor algorithm is a supervised algorithm learning technique in which the outcomes of a new instance are categorised in accordance with the vast majority of the k-Nearest Neighbor categories. This algorithm's goal is to categorise new objects using their characteristics and training data samples. The Neighborhood Classification serves as the new instance value's prediction value in the k-Nearest Neighbor method.

The k-Nearest Neighbor algorithm is a classification algorithm based on the nearest neighbor. The example above is just a very simple example of implementing this algorithm. If in other cases, there are more than 2 independent variables, to calculate the distance we can use the Euclidean Distance formula. Similar to Pythagoras, only Euclidean Distance has more than 2 dimensions.

$$d(i,j) = \sqrt{\sum_{k=1}^{n}(i_k - j_k)^2} \quad (5)$$

IV. Results and Discussion

The experiment of research of betta fish image identification was carried out by doing only one of treatments. The angles used in feature extraction using GLCM are 0°, 45°, 90°, 135°, 180°. The *k* values used are 1, 2, 3, 4, 5, 6 and 7. The composition of the training data and testing data is made

in three schemes, namely scheme one which is 75% : 25%, scheme two is 80% : 20% and scheme three is 85% : 15%.

A. Scheme One

Scheme one uses a comparison between training data and testing data, which is 75% : 25%. So, the amount of training data used is 225 pictures of betta fish and the amount of testing data used is 75 pictures of betta fish. The test uses five of angle orientation, namely 0°, 45°, 90°, 135°, 180°and the test results are presented in Table I below.

TABLE I. RESULT FROM SCHEME ONE

Angles	Betta fish classification accuracy with 25 % testing data						
	k =1	k =2	k =3	k =4	k =5	k =6	k =7
0°	0.88	0.85	0.87	0.87	0.83	0.88	0.81
45°	0.85	0.87	0.88	0.87	0.87	0.84	0.81
90°	0.85	0.88	0.88	0.83	0.91	0.87	0.87
135°	0.91	0.91	0.79	0.84	0.92	0.87	0.81
180°	0.88	0.84	0.83	0.83	0.88	0.85	0.85

Table I shows the results of accuracy in each experiment on each k value. From table 1, it can be seen that the highest accuracy value is 92% with a value of k = 5 and the smallest accuracy value is 81% with a value of k = 7 at the orientation of the 0°, 45°, 135° angles. Visualization of Table I can be presented with the figure 7 below by looking at the orientation of the 0°, 45°, 90°, 135°, 180° angles.

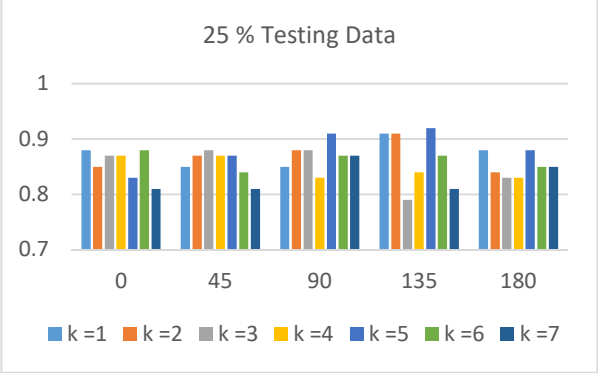

Fig. 7. Distribution of accuracy values on all angle orientation values

It can be seen from the figure 7 that the accuracy value at the orientation of the 0°, 45°, 90°, 180° angles and above 80% with the highest value of 92% except at the 135° angle with the value of k = 3 being below 80%.

B. Scheme Two

Scheme two uses a comparison between training data and testing data, which is 80% : 20%. So, the amount of training data used is 240 pictures of betta fish and the amount of testing data used is 60 pictures of betta fish. The test uses five of angle orientation, namely 0°, 45°, 90°, 135°, 180°and the test results are presented in table 2 below.

TABLE II. RESULT FROM TWO SCHEMES

Angles	Betta fish classification accuracy with 20 % testing data						
	k =1	k =2	k =3	k =4	k =5	k =6	k =7
0°	0.90	0.82	0.83	0.88	0.90	0.87	0.78
45°	0.90	0.85	0.92	0.87	0.80	0.78	0.85
90°	0.90	0.88	0.82	0.80	0.90	0.93	0.88
135°	0.87	0.87	0.78	0.85	0.85	0.92	0.95
180°	0.87	0.83	0.88	0.88	0.85	0.85	0.83

Table II shows the results of accuracy in each experiment on each k value. From table 2 it can be seen that the highest accuracy value is 95% with a value of k = 7 and the smallest accuracy value is 78% with a value of k = 3, 6, 7 at the orientation of the 0°, 45°, 135° angles. Visualization of table 2 can be presented with the figure 8 below by looking at the orientation of the 0°, 45°, 90°, 135°, 180° angles.

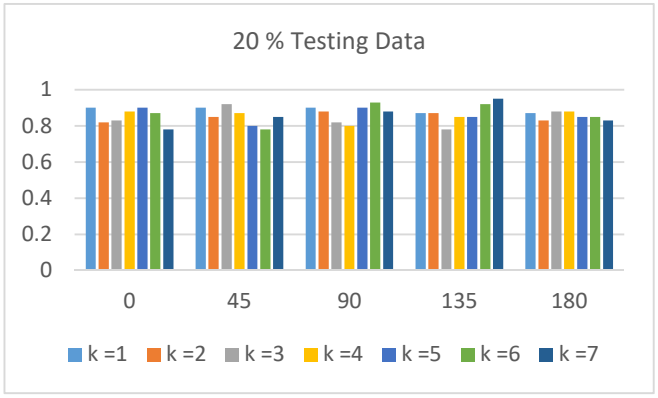

Fig. 8. Distribution of accuracy values on all angle orientation values

It can be seen from the figure 8 that the accuracy value at the orientation of the 0°, 45°, 90°, 180° angles and above 80% with the highest value of 95%.

C. Scheme Three

Scheme three uses a comparison between training data and testing data, which is 85% : 15%. So, the amount of training data used is 255 pictures of betta fish and the amount of testing data used is 45 pictures of betta fish. The test uses five of angle orientation, namely 0°, 45°, 90°, 135°, 180°and the test results are presented in Table III below.

TABLE III. RESULT FROM THREE SCHEMES

Angles	Betta fish classification accuracy with 15 % testing data						
	k =1	k =2	k =3	k =4	k =5	k =6	k =7
0°	0.87	0.96	0.78	0.82	0.91	0.84	0.89
45°	0.89	0.87	0.84	0.84	0.84	0.84	0.87
90°	0.87	0.91	0.82	0.82	0.89	0.87	0.91
135°	0.91	0.78	0.76	0.78	0.91	0.93	0.84
180°	0.87	1	0.78	0.89	0.87	0.87	0.93

Table III shows the results of accuracy in each experiment on each *k* value. From Table III, it can be seen that the highest accuracy value is 100% with a value of $k = 2$ and the smallest accuracy value is 76% with a value of $k = 3$ at the orientation of the 180° and 135° angles. Visualization of Table III can be presented with the figure 9 below by looking at the orientation of the 0°, 45°, 90°, 135°, 180° angles.

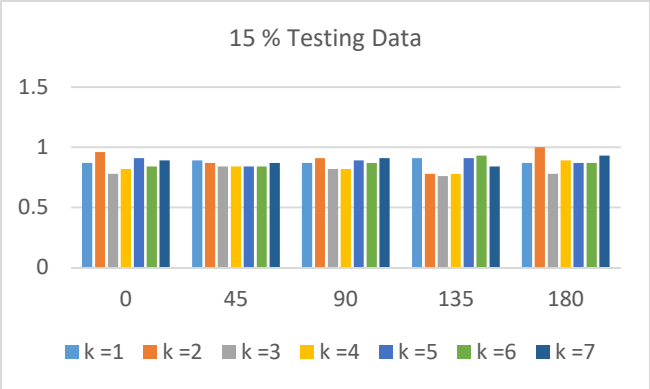

Fig. 9. Distribution of accuracy values on all angle orientation values

It can be seen from the Fig. 9 that the accuracy value at the orientation of the 0°, 45°, 90°, 180° angles, the average almost 90% with the highest value is 100%. Based on the results of scheme one, scheme two and scheme three, it can be concluded or summarized in Table IV below. It can be seen that the addition of training data has the effect of increasing accuracy in the identification of betta fish.

TABLE IV. COMPARISON RESULT FROM SCHEME ONE TWO THREE

Training Data : Testing Data	Angle	Value of k	Accuracy
75 % : 25 %	135°	5	92 %
80 % : 20 %	135°	7	95 %
85 % : 15 %	180°	2	100 %

Betta fish research using K-NN and GLCM feature extraction is proven to provide quite competitive results, when compared to using CNN [2] or Artificial Neural Networks [3]. The addition of the amount of training data is proven to have an effect on increasing accuracy with the amount of data as much as 300 images.

V. CONCLUSIONS

The conclusion of this study is based on research that has been carried out and GLCM feature extraction and the K-NN method have proven successful in classifying betta fish images with the highest accuracy value at 100% with a value of k = 2 and an angle orientation value of 180° . The effect of adding training data provides evidence of an increase in the value of classification accuracy.

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