

PAPER NAME

**betta\_fish\_2022.pdf**

AUTHOR

**Zaenal Abidin**

WORD COUNT

**4446 Words**

CHARACTER COUNT

**21962 Characters**

PAGE COUNT

**6 Pages**

FILE SIZE

**273.6KB**

SUBMISSION DATE

**Feb 17, 2023 2:42 PM GMT+7**

REPORT DATE

**Feb 17, 2023 2:43 PM GMT+7**

### ● 13% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 9% Internet database
- 11% Publications database
- Crossref database
- Crossref Posted Content database
- 4% Submitted Works database

### ● Excluded from Similarity Report

- Bibliographic material
- Quoted material
- Cited material
- Small Matches (Less than 10 words)
- Manually excluded sources
- Manually excluded text blocks

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

Zaenal Abidin

Faculty of Engineering and Computer Science

Universitas Teknokrat Indonesia  
Bandarlampung, Indonesia  
zabin@teknokrat.ac.id

Rusliyawati

Faculty of Engineering and Computer Science

Universitas Teknokrat Indonesia  
Bandarlampung, Indonesia  
rusliyawati@teknokrat.ac.id

Permata

Faculty of Engineering and Computer Science

Universitas Teknokrat Indonesia  
Bandarlampung, Indonesia  
permata@teknokrat.ac.id

Fenty Ariany

Faculty of Engineering and Computer Science

Universitas Teknokrat Indonesia  
Bandarlampung, Indonesia  
fenty@teknokrat.ac.id

Ilham Solehudin

Faculty of Engineering and Computer Science

Universitas Teknokrat Indonesia  
Bandarlampung, Indonesia  
harloom.developer@gmail.com

Akmal Junaidi

Department of Computer Science

Universitas Lampung  
Bandarlampung, Indonesia  
akmal.junaidi@fmipa.unila.ac.id

**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-occurrence 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:

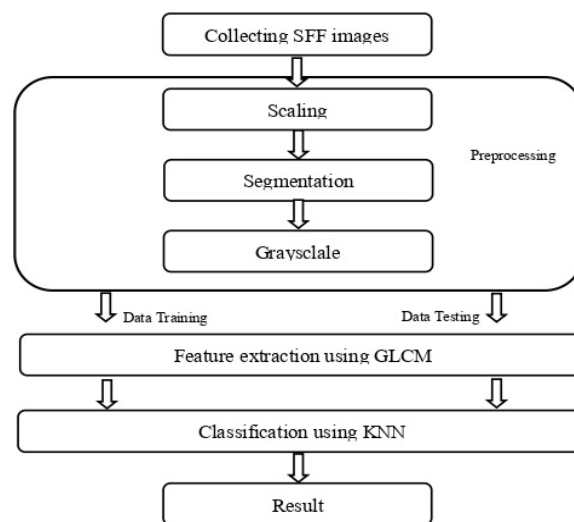


Fig. 1. The stages of conducting research

### 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.

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

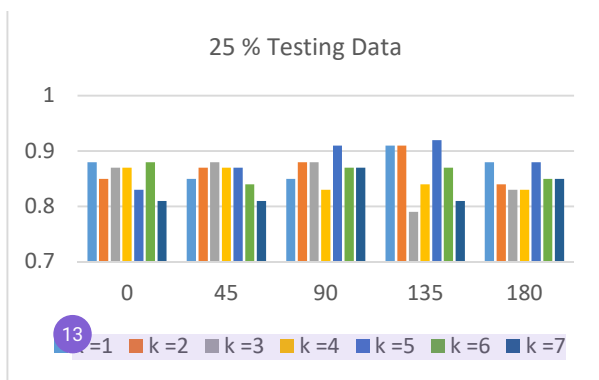


Fig. 7. Distribution of accuracy values on all angle orientation values

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.

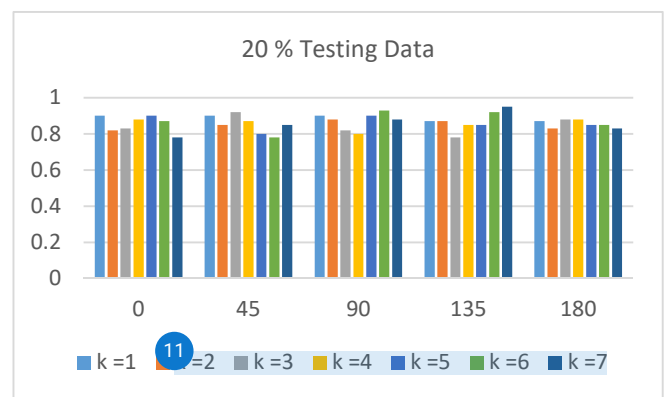


Fig. 8. Distribution of accuracy values on all angle orientation values

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.

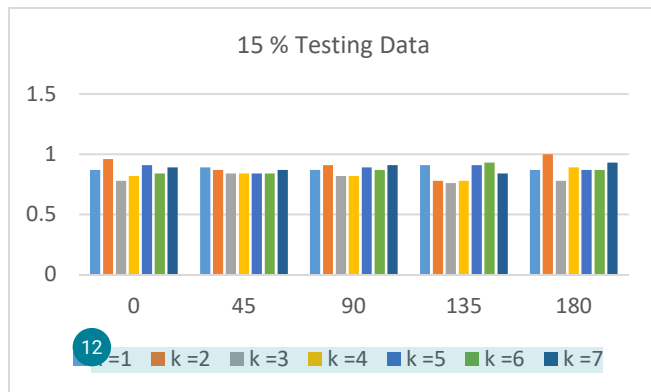


Fig. 9. Distribution of accuracy values on all angle orientation values

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.

## ACKNOWLEDGMENT

Thanks to Universitas Teknokrat Indonesia and the Rector of Universitas Teknokrat Indonesia for the Scopus indexed international publication grant as part of efforts to build the capacity of lecturers in researching and publishing research.

## REFERENCES

- [1] F. Waisapy, A. W. Soumokil, and B. M. Laimeheriwa, "Masculinization of Betta Fish (*Betta splendens*) Larva Using Different types of Honey," *J. Perikan.*, vol. 11, no. 1, pp. 50–55, 2021, doi: <https://doi.org/10.29303/jp.v11i1.238>.
- [2] D. M. Hibban and W. F. Al Maki, "Classification of Ornamental Betta Fish Using Convolutional Neural Network Method and Grabcut Segmentation," *2021 Int. Conf. Data Sci. Its Appl. ICoDSA 2021*, pp. 102–109, 2021, doi: [10.1109/ICoDSA53588.2021.9617213](https://doi.org/10.1109/ICoDSA53588.2021.9617213).
- [3] S. Hidayat and A. Y. Rahman, "Betta Fish Image Classification Using Artificial Neural Networks With Gabor Extraction Features," pp. 270–273, 2022.
- [4] R. Andrian, D. Maharani, M. A. Muhammad, and A. Junaidi, "Butterfly identification using gray level co-occurrence matrix (GlcM) extraction feature and k-nearest neighbor (knn) classification," *Regist. J. Ilm. Teknol. Sist. Inf.*, vol. 6, no. 1, pp. 11–21, 2020, doi: [10.26594/register.v6i1.1602](https://doi.org/10.26594/register.v6i1.1602).
- [5] D. P. Pamungkas, "Ekstraksi Citra menggunakan Metode GLCM dan KNN untuk Identifikasi Jenis Anggrek (Orchidaceae)," *Innov. Res. Informatics*, vol. 1, no. 2, pp. 51–56, 2019, doi: [10.37058/innovatics.v1i2.872](https://doi.org/10.37058/innovatics.v1i2.872).
- [6] N. Neneng, A. S. Puspaningrum, and A. A. Aldino, "Perbandingan Hasil Klasifikasi Jenis Daging Menggunakan Ekstraksi Ciri Tekstur Gray Level Co-occurrence Matrices (GLCM) Dan Local Binary Pattern (LBP)," *Smatika J.*, vol. 11, no. 01, pp. 48–52, 2021, doi: [10.32664/smatika.v11i01.572](https://doi.org/10.32664/smatika.v11i01.572).
- [7] A. R. Hakim, Y. Handayani, G. F. Shidiq, and A. Z. Fanani, "Classification Types of Wood Furnitures Using Gray Level Co-Occurrence Matrix and K-Nearest Neighbor," *Proc. - 2021 Int. Semin. Appl. Technol. Inf. Commun. IT Oppor. Creat. Digit. Innov. Commun. within Glob. Pandemic, iSemantic 2021*, pp. 300–306, 2021, doi: [10.1109/iSemantic52711.2021.9573247](https://doi.org/10.1109/iSemantic52711.2021.9573247).
- [8] L. Safira, B. Irawan, and C. Setianingsih, "GLCM for Identification of Terry 's Nail," pp. 98–104, 2019.
- [9] O. R. Indriani, E. J. Kusuma, C. A. Sari, E. H. Rachmawanto, and D. R. I. M. Setiadi, "Tomatoes classification using K-NN based on GLCM and HSV color space," *Proc. - 2017 Int. Conf. Innov. Creat. Inf. Technol. Comput. Intell. IoT, ICITech 2017*, vol. 2018-Janua, pp. 1–6, 2018, doi: [10.1109/INNOCIT.2017.8319133](https://doi.org/10.1109/INNOCIT.2017.8319133).
- [10] C. Irawan, E. N. Ardyastiti, D. R. I. M. Setiadi, E. H. Rachmawanto, and C. A. Sari, "A survey: Effect of the number of GLCM features on classification accuracy of lasem batik images using K-nearest neighbor," *2018 Int. Semin. Res. Inf. Technol. Intell. Syst. ISRITI 2018*, pp. 33–38, 2018, doi: [10.1109/ISRITI.2018.8864443](https://doi.org/10.1109/ISRITI.2018.8864443).
- [11] N. Rusli, H. Md Yusof, S. N. Sidek, and N. I. Ishak, "GLCM correlation approach for blood vessel identification in thermal image," *2018 IEEE EMBS Conf. Biomed. Eng. Sci. IECBES 2018 - Proc.*, pp. 112–116, 2019, doi: [10.1109/IECBES.2018.8626697](https://doi.org/10.1109/IECBES.2018.8626697).
- [12] W. Lumchanow and S. Udomsiri, "Combination of GLCM and KNN classification for chicken embryo development recognition," *ECTI DAMT-NCON 2019 - 4th Int. Conf. Digit. Arts, Media Technol. 2nd ECTI North. Sect. Conf. Electr. Electron. Comput. Telecommun. Eng.*, pp. 322–325, 2019, doi: [10.1109/ECTI-NCON.2019.8692272](https://doi.org/10.1109/ECTI-NCON.2019.8692272).
- [13] T. T. Htay and S. S. Maung, "Early Stage Breast Cancer Detection System using GLCM feature extraction and K-Nearest Neighbor (k-NN) on Mammography image," *Isc. 2018 - 18th Int. Symp. Commun. Inf. Technol.*, no. Iscit, pp. 345–348, 2018, doi: [10.1109/ISCIT.2018.8587920](https://doi.org/10.1109/ISCIT.2018.8587920).
- [14] K. S. F. Azam, F. F. Riya, S. Al Mamun, and M. S. Kaiser, "A Novel Approach of Detecting Image Forgery Using GLCM and KNN," *2021 Int. Conf. Inf. Commun. Technol. Sustain. Dev. ICICT4SD 2021 - Proc.*, pp. 125–129, 2021, doi: [10.1109/ICICT4SD50815.2021.9397057](https://doi.org/10.1109/ICICT4SD50815.2021.9397057).
- [15] S. S. Ashwini, M. Z. Kurain, and M. Nagaraja, "Performance Analysis of Lung Cancer Classification using Multiple Feature Extraction with SVM and KNN Classifiers," *2021 IEEE Int. Conf. Mob. Networks Wirel. Commun. ICMNWC 2021*, pp. 4–7, 2021, doi: [10.1109/ICMNWC52512.2021.9688404](https://doi.org/10.1109/ICMNWC52512.2021.9688404).

- [16] A. Krishna Jothi and P. Mohan, "A comparison between KNN and SVM for breast cancer diagnosis using GLCM shape and LBP Features," *Proc. 3rd Int. Conf. Smart Syst. Inven. Technol. ICSSIT 2020*, no. IcSSIT, pp. 1058–1062, 2020, doi: 10.1109/ICSSIT48917.2020.9214235.
- [17] S. Aygun and E. O. Gunes, "A benchmarking: Feature extraction and classification of agricultural textures using LBP, GLCM, RBO, Neural Networks, k-NN, and random forest," *2017 6th Int. Conf. Agro-Geoinformatics, Agro-Geoinformatics 2017*, 2017, doi: 10.1109/Agro-Geoinformatics.2017.8047000.
- [18] R. Andrian, M. A. Naufal, B. Hermanto, A. Junaidi, and F. R. Lumbanraja, "K-Nearest Neighbor (k-NN) Classification for Recognition of the Batik Lampung Motifs," *J. Phys. Conf. Ser.*, vol. 1338, no. 1, 2019, doi: 10.1088/1742-6596/1338/1/012061.
- [19] R. I. Borman, R. Napianto, N. Nugroho, D. Pasha, Y. Rahmanto, and Y. E. P. Yudoutomo, "Implementation of PCA and KNN Algorithms in the Classification of Indonesian Medicinal Plants," *2021 Int. Conf. Comput. Sci. Inf. Technol. Electr. Eng. ICOMITEE 2021*, pp. 46–50, 2021, doi: 10.1109/ICOMITEE53461.2021.9650176.

## ● 13% Overall Similarity

Top sources found in the following databases:

- 9% Internet database
- Crossref database
- 4% Submitted Works database
- 11% Publications database
- Crossref Posted Content database

### TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	<b>Universiti Putra Malaysia on 2012-07-09</b>	2%
	Submitted works	
2	<b>Neza Aemal Fadilla, Mohamad Lathif Puja Sakti, Nita Setyaningsih, Na...</b>	1%
	Crossref	
3	<b>complextoreal.com</b>	1%
	Internet	
4	<b>journal.uinjkt.ac.id</b>	1%
	Internet	
5	<b>ijece.iaescore.com</b>	<1%
	Internet	
6	<b>journal.unipdu.ac.id</b>	<1%
	Internet	
7	<b>frieyadie.web.id</b>	<1%
	Internet	
8	<b>Dedi Darwis, Adhie Thyo Priandika, Ade Surahman, A. Ferico Octavians...</b>	<1%
	Crossref	



- 9 **Marwadi University on 2019-05-01** <1%  
Submitted works

---
- 10 **"Table of Contents", 2022 International Conference on Information Tec...** <1%  
Crossref

---
- 11 **coek.info** <1%  
Internet

---
- 12 **hal.archives-ouvertes.fr** <1%  
Internet

---
- 13 **mafiadoc.com** <1%  
Internet

---
- 14 **Elisafina Siswanto, Masayu Leylia Khodra, Luh Joni Erawati Dewi. "Pre...** <1%  
Crossref

---
- 15 **Firas H. Almkhtar. "Facial emotions recognition using local monotoni...** <1%  
Crossref

---
- 16 **Rakhmat Dedi Gunawan, Imam Ahmad, Parjito, Harry Anggono, Ego He...** <1%  
Crossref

---
- 17 **Communications in Computer and Information Science, 2011.** <1%  
Crossref

---
- 18 **Universitas Amikom on 2022-12-09** <1%  
Submitted works

---
- 19 **Dwiza Riana, Sri Rahayu, Muhamad Hasan, Anton. "Comparison of seg...** <1%  
Crossref

---
- 20 **searchworks.stanford.edu** <1%  
Internet

## ● Excluded from Similarity Report

- Bibliographic material
- Cited material
- Manually excluded sources
- Quoted material
- Small Matches (Less than 10 words)
- Manually excluded text blocks

---

### EXCLUDED SOURCES

**Zaenal Abidin, Rusliyawati, Permata, Fenty Ariany, Ilham Solehudin, Akmal J...** 71%  
Crossref

---

**repository.lppm.unila.ac.id** <1%  
Internet

### EXCLUDED TEXT BLOCKS

**2022 International Conference on Information Technology Research and Innovatio...**  
www.semanticscholar.org

---

**ScienceUniversitas Teknokrat IndonesiaBandarlampung, Indonesia**  
Zaenal Abidin, Permata, Rohmat Indra Borman, Utoro Ardiyatno, Farli Rossi, Yessi Jusman. "Computer-aide...

---

**akmal.junaidi@fmipa.unila.ac.idare generally divided into three groups, namely orn...**  
Zaenal Abidin, Rusliyawati, Permata, Fenty Ariany, Ilham Solehudin, Akmal Junaidi. "Betta Fish Image Identi...

---

**Authorized licensed use limited to: UNIVERSITAS GADJAH MADA. Downloaded on...**  
Konsorsium Perguruan Tinggi Swasta Indonesia II on 2022-03-14

---

**2022 International Conference on Information Technology Research and Innovatio...**  
www.semanticscholar.org