Classification of Perkutut Bird Using the KNN Algorithm with RGB Features

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ABSTRACT

Indonesia has 1,539 bird species, representing 17% of the world's total bird species, with 381 being endemic. Keeping birds, especially Perkutut birds (Geopelia striata), is popular in Indonesia due to their melodious voices and elegant appearance. However, the challenge of accurately identifying Perkutut species remains a problem for enthusiasts due to the similarity in feather colours and patterns among species. This study proposes a solution using the K-Nearest Neighbors (KNN) algorithm with RGB (Red, Green, Blue) feature extraction from Perkutut bird images. This study aims to help bird enthusiasts distinguish Perkutut species more efficiently and accurately. The research methodology involves collecting 315 Perkutut bird images, preprocessing data such as background removal and resizing, and extracting RGB colour features for classification using KNN. The KNN model is evaluated using accuracy metrics, and an accuracy rate of 85% was achieved in classifying Perkutut bird images. Despite some classification errors due to similar colour patterns among species, the model's performance demonstrates the potential of machine learning in bird species identification. Further development is recommended to increase the amount of training data, improve preprocessing techniques with data augmentation, and consider additional features such as texture or shape to enhance model accuracy. Exploring other algorithms, such as SVM or CNN, and developing practical applications for users are also suggested for further development

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1. INTRODUCTION

Indonesia has 1539 bird species or 17% of all bird species worldwide. Three hundred and eighty-one species are endemic to Indonesia and are naturally found in Indonesia [1]. Birds are found almost everywhere and have an essential position as one of Indonesia's animal wealth. The types are diverse, and each has its beauty value [2]. Keeping animals, especially birds, has become a popular hobby in Indonesia. Apart from being entertainment, keeping birds can also provide emotional satisfaction for their owners [3]. Various types of birds, ranging from those with melodious voices to those with an exotic appearance, are often kept as pets at home [4]. This activity strengthens the relationship between humans and animals and fosters a sense of responsibility in caring for living creatures. Besides, keeping birds can be an educational tool for children to learn about nature and animal life. However, keepers need to understand the needs and welfare of their pets in order to create a healthy and comfortable environment for these birds [5]. The turtle dove (Geopelia striata) is a member of the Columbidae family. This bird can generally be recognized by characteristics, among others, relatively small body size with a maximum length of around 22 cm and dark brownish body feathers [6], [7]. The turtle dove (Geopelia striata) is a bird famous in Indonesia, especially among bird lovers. The beauty of its melodious voice and elegant appearance makes this bird sought after by many people [8]. There are various breeds and colour variants of commonly found doves on the market, such as Local, Bangkok, Ordinary Cemani, Majapahit and Golden doves for race and mocha, silver, cotton white, striated white, cream, and black for colour variants [8].

The problem faced by ordinary people who love turtle doves is the difficulty of accurately identifying the type of turtle dove. Most people only know turtle doves in general without paying attention to the detailed differences that may exist between one type and another. This is caused by variations in feather colour and patterns, which are similar between one type and another, as well as the many types of doves. This can be an obstacle when you want to get a dove of a particular type according to your wishes. To overcome this problem, this research proposes a solution using the K-Nearest Neighbors (KNN) algorithm with RGB (Red, Green, Blue) features in images of doves. The KNN algorithm is a method in machine learning that can be used for classification based on specific features [9]. In this context, the RGB feature will be used to identify the distinctive feather colour patterns of each type of dove bird.

This research aims to contribute positively to public who love turtle doves by making it easier to recognize and differentiate types of turtle doves. With a classification system using the KNN algorithm and RGB features, the public can better understand the diversity of turtle dove species and choose turtle doves according to their preferences more efficiently and accurately. With the various benefits and potential offered, developing bird identification technology using the KNN algorithm and RGB features is expected to contribute significantly to Indonesia's ornithology and conservation field. This aligns with efforts to preserve Indonesia's abundant natural wealth and maintain the balance of the existing ecosystem

2. METHOD

The KNN algorithm is a non-parametric method that can be used to classify an object [10]. Algorithms or classification methods are diverse, including K-Nearest Neighbor (KNN). This research method uses the K-Nearest Neighbors (KNN) algorithm [11]. The K-Nearest Neighbor (KNN) algorithm is a method for classifying objects based on learning data closest to the tested object. KNN can be used to insert new data (test data) into a data group close to the training data, so this method can be used to classify the test sound data according to the sound data group it should be in. KNN will group the calculation results with training data with the most relatives within the specified range value [12]. The K-Nearst Neighbor (KNN) algorithm is a classification technique for objects based on the neighbor (K) values as shown in Figure 1.

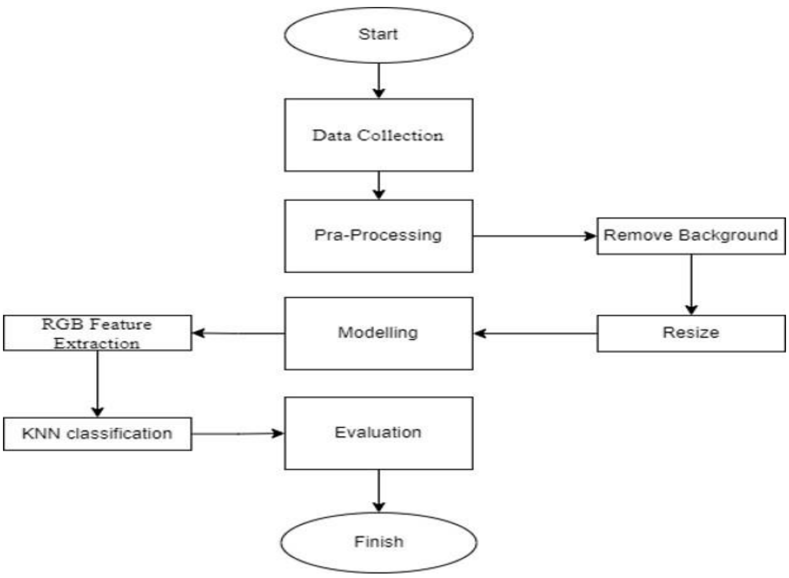

Figure 1. Research Scheme

2.1 Data Collection

The data used in this research are pictures of turtle doves, which will be collected directly from turtle dove breeders in the Jepara City, Central Java, Indonesia. The data collection process will be carried out by taking photos of doves from various angles and lighting conditions to obtain representative variations [13]. The total data that will be collected is 315 images in .jpg format. Table 1 shown examples of images from each class.

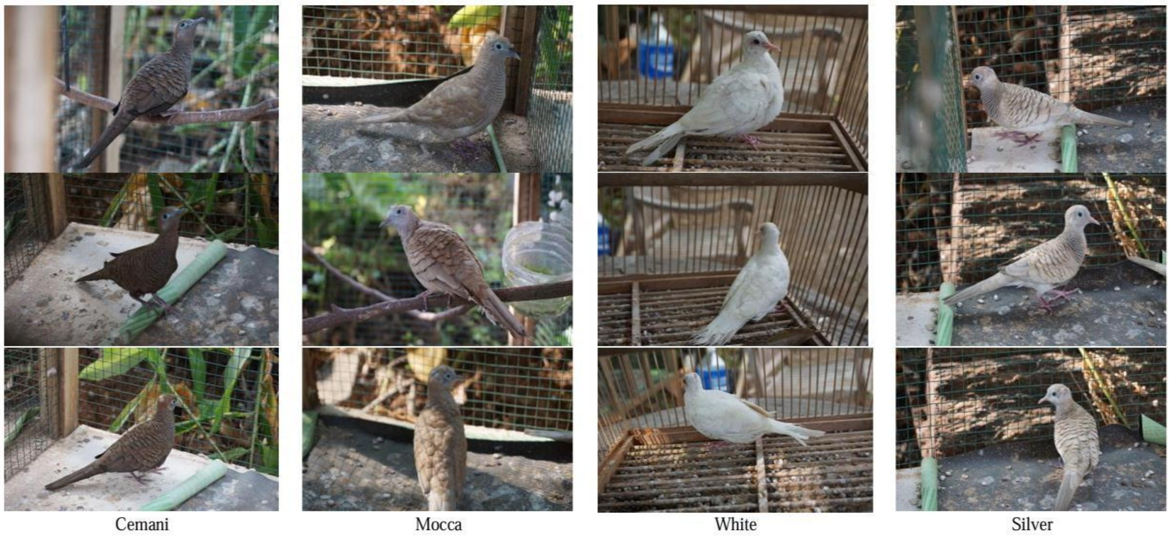

Figure 2. Dataset visualization

The following is a graph as shown in Figure 3 is visualized the dataset distribution.

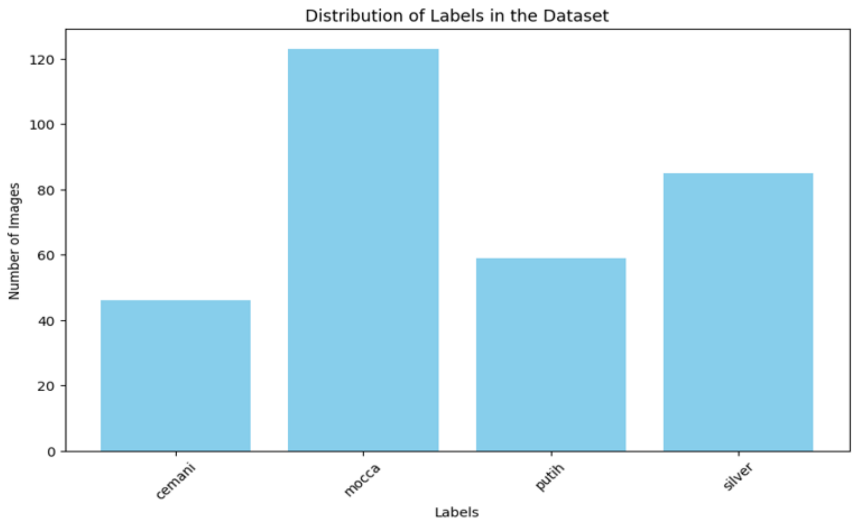

Figure 3. Distribution dataset

2.2 Data Pre-Processing

Before data can be used for further analysis, pre-processing steps are required to ensure data quality and consistency [14]. In this research, data processing was carried out in several stages.

2.2.1 Remove Background

The Background in the image of the dove is removed to focus on the features and characteristics of the bird more clearly [15]. This step helps reduce irrelevant visual noise in the analysis.

2.2.2 Resize

The image size is changed to have uniform dimensions [16], simplifying subsequent processing without sacrificing the visual information in the image.

2.3 RGB Feature Extraction

RGB is a colour space composed of three colour channels, namely the red channel (Red), the green channel (Green), and the blue channel (Blue). Each channel has a different colour intensity; the minimum colour intensity value is zero (0), and the maximum is 255 (8 bits). Each RGB image pixel has 16,777,216 color variations (256 x 256 x 256). Essential features from the dove bird image are extracted through an RGB (Red, Green, Blue) colour-based feature extraction technique. These features include colour information, which is critical to the classification process.

2.4 Classification KNN

K-Nearest Neighbors (KNN) is a classification method for objects based on the training data closest to the object. The K-Nearest Neighbors algorithm or what is usually called K-NN. K-NN is a classification method for data sets where the results of new instances are classified based on the proximity of their nearest neighbours [17]. KNN is included in supervised learning, which uses existing data, and the same goes for the output, which uses Neighborhood Classification to get new prediction values. The purpose of using KNN is to classify new objects from attributes and samples from training data.

Projects the training data into a Multidimensional space, where each Dimension represents a data characteristic. Algorithms or classification methods are very diverse. One of them is the K-Nearest Neighbor (KNN). KNN is a straightforward classification method for classifying an image based on the closest distance to its neighbours. The KNN algorithm aims to classify new objects based on attributes and training examples. After the RGB feature extraction, the K-Nearest Neighbors (KNN) classification model is applied to classify the turtle dove image based on the colour features that have been extracted previously. KNN is used because of its simple but effectual ability to classify data based on its closeness to the training data [18]. The following is the formula for K-Nearest Neighbor.

$$d = \sqrt{\sum_{i=1}^{k}(xi - yi)^2} \tag{1}$$

Where :
k = determines the data attribute
Xi = determines the training data
Yi = determines testing data or test data
K-Nearest Neighbor has calculation steps, namely:
1. Determine the set/parameter k = the closest number of data
2. Calculate the amount of new data with training data
3. Sort the closest data based on the minimum distance of the K value
4. Check the class data from the closest data
5. Determine the results from the closest data as the predicted value of the new data.

Calculating the distance between new data and old data can be calculated using several methods, one of which uses the Euclidean distance formula. The formula for calculating Euclidean distance can be seen as follows:

$$d = \sqrt{(a1 - b1)^2 + \cdots + (an - bn)^2} \tag{2}$$

Where :
D = distance
a = a1, a2, a3, …., an up to the n^{th} value
b = b1, b2, b3, …., bn up to the nth value

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{3}$$

$$Precision = \frac{TP}{TP + FP} \quad (4)$$

$$Recall = \frac{TP}{(TP + FN)} \quad (5)$$

2.5 Evaluation

Evaluation is a crucial stage in measuring the performance of the KNN classification model being developed. Evaluation uses test data that is not used in training for good results. To produce a convusion, the stage metrics used include accuracy, precision, recall and f1-score [19].

$$F1 - score = \frac{2 * (Precision\ * Recall)}{(Precision + Recall)} \quad (6)$$

3. RESULTS AND DISCUSSION

3.1 Data Description

The dataset consists of 315 images of doves collected from breeders in Jepara. These images were taken from various angles and lighting conditions to ensure a representative, high-resolution variety covering a wide range of colour patterns and shapes of doves. The dataset will be divided into two subsets:

- Training Data: 252 images (80%) were used to train the KNN model, helping the model recognize distinctive colour patterns.
- Test Data: 63 images (20%) were used to test the model performance and ensure the model's ability to classify new images not included in the training data.

The dataset is divided randomly to ensure a representative distribution so that the evaluation results are more reliable and the model is better generalized.

3.2 Pra-Processing Data

At this stage, the image data is processed before the knn classification. Researchers carried out several pre-processing stages, including:

3.2.1 Background removal

The image data background is removed using the background remove application, leaving only the bird image because the background can affect the RGB feature extraction results as in Figure 5.

Figure 4. Data before background removal

Figure 5. Data after background removal

3.2.2 Resize

Next, the image data will be resized, making all the data the same size to get more appropriate results. Resizing is done using the cv2.resize library. All data will be resized to 64x64 pixels.

3.3 Feature Extraction

After Pre-Processing, feature extraction is carried out from each image. The features extracted are the average value of each colour (R, G, B) from all pixels from each data, which consists of training data and test data. The following is a sample of the feature extraction results from the dataset in this research. In Figure 6, there is a graph of the average value based on plotting the RGB values from the training data. In Figure 7 is a graph of average values based on plotting RGB values from test data.

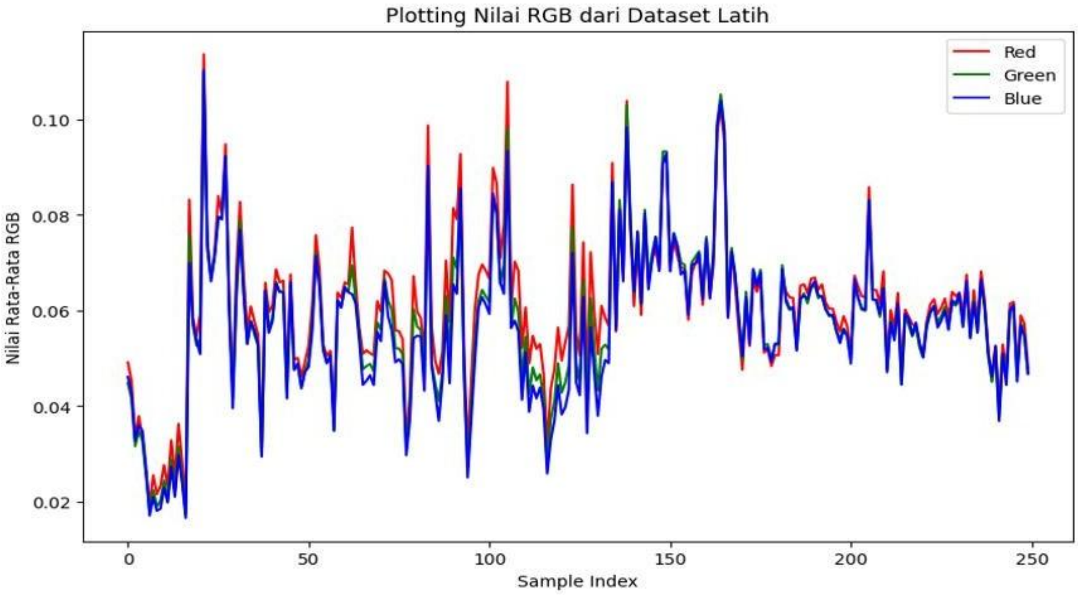

Figure 6. Plotting RGB Data Training

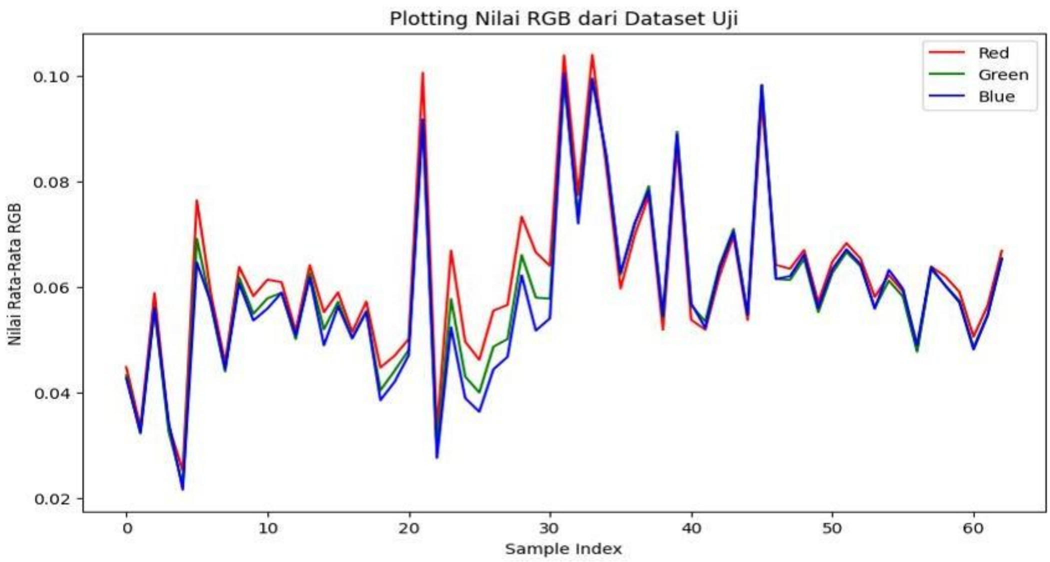

Figure 7. Plotting RGB Data Testing

3.4 KNN classification

The classification process uses the K-Nearest Neighbors (KNN) algorithm. This algorithm was chosen because of its simplicity and ability to classify data based on proximity to training data. In this study, the training data consisted of 252 images of doves, while 63 images were used as test data. The average value of each colour component (R, G, B) is used as a feature for each image. To implement KNN, the k value used needs to be determined first. In this research, various k values (for example, k=1, k=3, k=5) were tested to obtain the optimal k, namely the value k=3, which provides the highest accuracy on the test data. The KNN model was then implemented using the scikit-learn library in Python. Then, it produces a classification output based on the closest RGB value.

3.5. Evaluation

KNN model evaluation was carried out to measure classification performance using several metrics: accuracy, precision, recall, F1-score, and Confusion Matrix. The aim of this evaluation is to determine the optimal k value so that the KNN model can produce the best performance.

1. **Model Accuracy:** Accuracy is the comparison between correct predictions and the total number of predictions. The results of evaluating the accuracy of the KNN model in this research are as follows:
    - **k=3**: The KNN model provides an accuracy of 82.54%, where of the 63 images in the test data, 52 images are classified correctly.
    - **k=5**: The KNN model provides an accuracy of 68.25%, where of the 63 images in the test data, 43 images are classified correctly.
    - **k=7**: The KNN model provides an accuracy of 65.08%, where of the 63 images in the test data, 41 images are classified correctly.
2. **Model Precision:** Precision is the ratio of true positive predictions to the total number of positive predictions. The following are the precision results of the KNN model:
    - **k=3**: Precision of 88.30%.
    - **k=5**: Precision of 76.62%.
    - **k=7**: Precision of 72.90%.
3. **Recall**: Recall is the ratio of true positive predictions to the total amount of actual positive data. The following are the recall results of the KNN model:
    - **k=3**: Recall amount 82.54%.
    - **k=5**: Recall amount 68.25%.
    - **k=7**: Recall amount 65.08%.
4. **F1-Score**: F1-Score is the harmonic mean of precision and recall. Following are the F1-Score results of the KNN model:
    - **k=3**: F1-Score of 83.56%.
    - **k=5**: F1-Score of 68.06%.
    - **k=7**: F1-Score of 65.85%.
5. **Confusion Matrix**: Confusion Matrix provides more detailed information about correct model predictions (True Positives) and incorrect predictions (False Positives, False Negatives, True Negatives). The Confusion Matrix results from the KNN model with different k values are as follows in Figure 7.
    - k=3:

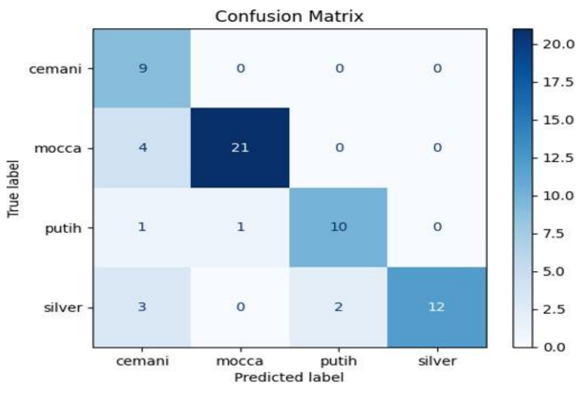

Figure 8. Confusion matrix k=3

- k=5:

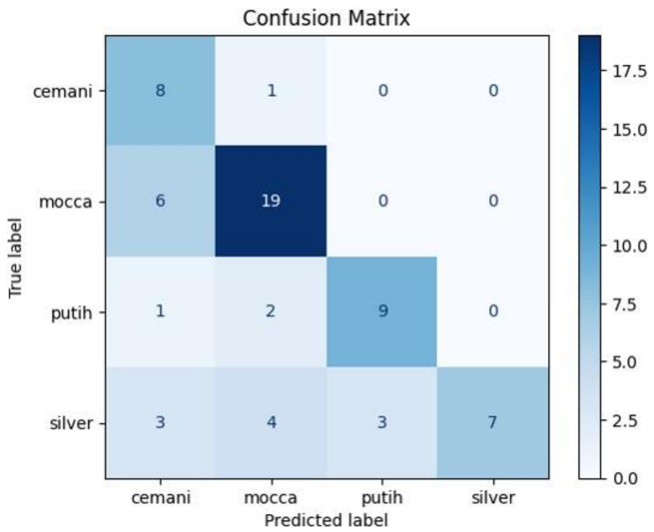

Figure 9. Confusion matrix k=5

- k=7:

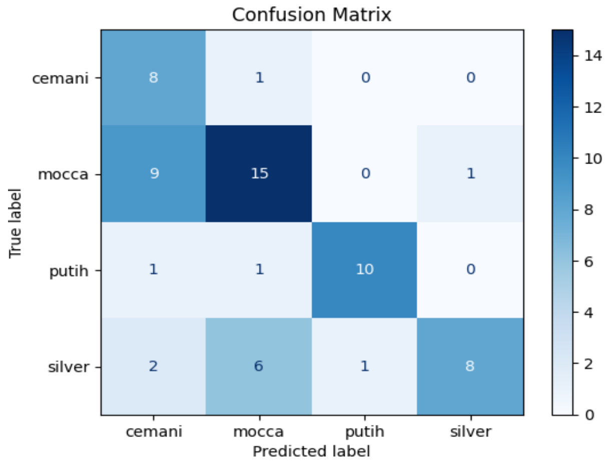

Figure 10. Confusion matrix k=7

In Figure 9, the model shows the best performance in the mocha class with 19 correct predictions, followed by putih (9), cemani (8), and silver (7). However, there are still classification errors between classes, especially between silver and other classes. In Figure 10, the model's accuracy relatively improved in the putih and silver classes with 10 and 8 correct predictions, respectively, although the number of correct predictions for mocca decreased slightly to 15. Overall, the model performed quite well, especially in recognizing the mocca and cemani classes, but still needs improvement in distinguishing between the putih and silver classes.

The Confusion Matrix table above shows that the KNN model is quite effective in classifying pigeon images, although there are still some classification errors. Selection of the optimal k value is very important to achieve the best performance in the KNN model.

4. CONCLUSION

This research succeeded in developing a classification model for doves using the K-Nearest Neighbors (KNN) algorithm with RGB features from bird images. With a dataset of 315 images divided into training and test data, the KNN model achieved 82.5% accuracy in classifying turtle dove species. However, several classification errors occur in bird species with similar colour patterns. For further development, it is recommended to increase the amount of training data, improve pre-processing techniques with data augmentation, and consider using additional features such as texture or shape to increase model accuracy. Apart from that, exploration of other algorithms, such as SVM or CNN, can also be carried out to compare model performance and implement this classification system as practical applications for users.

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