Indonesian Journal of Electrical Engineering and Computer Science
Vol. 38, No. 3, June 2025, pp. 1851~1861
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v38.i3.pp1851-1861

Development of character extraction techniques to detect chicken gender based on egg shape

Adil Setiawan[1], Yuhandri[2], Muhammad Tajuddin[3]
[1]Information Technology, Faculty of Computer Science, Universitas Putra Indonesia YPTK Padang, Indonesia
[2]Department of Information Technology Doctor, Computer Science Faculty, Universitas Putra Indonesia YPTK, Padang, Indonesia
[3]Departement of Information Technology, Faculty of Computer Science, Bumigora University, NTB, Indonesia

Article Info

Article history:

Received Jun 14, 2024
Revised Dec 2, 2024
Accepted Feb 27, 2025

Keywords:

Eccentricity
Eggs
Feature extraction
Feature selection
Shape features

ABSTRACT

This research investigates the differentiation of chicken sex based on egg shape images by developing an innovative eccentricity shape feature extraction method. The goal is to determine the sex of chickens before hatching, by identifying the sex of the egg prior to incubation. Images of eggs are captured using a smartphone camera, creating a dataset of 150 images each of male and female eggs, with expert assistance. The research aims to accurately identify male and female eggs, aiding breeders in sorting them. The research introduces a unique method to expand the eccentricity value range, enhancing the precision of egg shape analysis. Characteristic extraction results include: area = 1290194, eccentricity = 6.56, contrast = 0.03, correlation = 0.99, energy = 0.44, and homogeneity = 0.98, with a previous value of 0.72. For Feature Selection, the values obtained are: eccentricity = 0.901188049, Area = 0.73, Energy = 0.03, Contrast = 0.01, Homogeneity = 0.01, and Correlation = 0.01. These findings demonstrate significant improvements in differentiating chicken sex from egg images, showcasing the effectiveness of the newly developed eccentricity shape feature extraction method.

Corresponding Author:

Adil Setiawan
Information Technology, Faculty of Computer Science, Universitas Putra Indonesia YPTK Padang
Padang, West Sumatera, 25221, Indonesia
Email: adio165@gmail.com

1. INTRODUCTION

Research to detect the sex of chickens still in the egg using digital image extraction methods, especially through eccentricity parameters, has significant importance in the poultry industry. Early detection of chicken sex allows farmers to optimize the rearing process by separating eggs that will produce males from females early on. This is very important because males are often less economical to raise than females that can lay eggs. Digital image extraction methods on chicken eggs allow non-invasive and accurate analysis to determine the sex of embryos. Eccentricity, which measures the imperfections of the shape of objects in the image, can be used as a parameter to detect small but significant differences between eggs containing male and female embryos. The use of eccentricity in this image analysis offers a more efficient and rapid approach compared to conventional methods such as vent sexing or DNA analysis, which are more expensive and time-consuming. The benefits of this research include increased operational efficiency, reduced production costs, and improved animal welfare. By eliminating the need to hatch and raise uneconomical males, resources can be allocated more appropriately to support the growth of productive females. Overall, the development of a digital image extraction method for detecting the sex of chickens in eggs based on eccentricity offers an innovative and sustainable technological solution to challenges in the poultry industry, with the potential to increase efficiency, reduce costs, and improve animal welfare.

The aim of this research was to automatically predict the sex of fertilized duck eggs using image processing. Feature extraction utilized egg eccentricity, and the classifier employed a segregator sensor, achieving an accuracy of 75.22% [1]. In Diocesan's research, the focus was on determining the performance of a classification model for Japanese quail eggs. Segmentation was performed using canny edge detection, feature extraction employed egg morphology, and the classifier was a support vector machine (SVM), resulting in an accuracy of 82.88% [2]. Waranusast's research aimed to detect the sex of chicken eggs based on size classification using image processing and machine learning. Segmentation was done using edge detection, feature extraction with GrabCut, and classification using SVM, achieving an accuracy of 80.4% [3]. Diantoro's research focused on developing an egg fertility detection system for images of free-range chicken eggs using the naive bayes classifier algorithm. The best accuracy from training data trials was 80% [4].

Zhao's research aimed to detect first-order feature extraction and principal component analysis (PCA) to identify types of free-range and Arabic chicken eggs, achieving an accuracy of 95% with PCA [5]. Pan's research targeted the early determination of the sex of chicken embryos during incubation using hyperspectral images. Predictions with an artificial neural network (ANN) model showed an increase in accuracy from 80.00% to 82.86%, indicating that removing interference information improves model accuracy [6]. Saifullah's research sought to identify the fertility of chicken eggs using FOS and BP-neural networks in image processing [7]. The results indicated that FOS feature extraction and BP-neural networks could effectively detect embryonic chicken eggs, although some egg images exhibited similar patterns in FOS [8]. Budiarto's research aims to detect egg fertility using image processing and fuzzy logic. The proposed system achieved sensitivity, specificity, and average accuracy results of 94.6%, 94.07%, and 94.68%, respectively [9]. In Saifullah's research, the goal was to segment images of embryonated eggs using the K-means algorithm. Experimental results indicated that the process runs effectively, with a mean structural similarity index (MSSIM) value of 0.9995, suggesting that the processed image retains most of the original image information. Additionally, the segmentation process provided a clear depiction of the embryo within the egg, demonstrating the efficacy of K-means segmentation for detecting embryos [10]. Mahdi's research, titled “Machine vision system for detecting fertile eggs in the incubation industry,” aimed to ensure that eggs placed in incubators are fertile. A fertility detection machine system was developed and evaluated, employing mechatronic machines to obtain accurate digital images of eggs without causing damage. Comparisons with existing methods showed that the proposed system achieved superior performance, proving highly reliable for application in the incubation industry [11].

Jeerapa's research, titled “Egg weight prediction and egg size classification using image processing and machine learning,” aimed to measure egg weight and assess size for grading purposes. The study used image processing and machine learning techniques to predict chicken egg weight and classify egg size from a single egg image. A brown chicken egg was photographed, and thirteen geometric features were extracted from the segmented egg image. Weight prediction using linear regression yielded a correlation coefficient of 0.9915, and size classification using a SVM achieved an accuracy of 87.58% [12]. Morphological feature extraction is a method for deriving and processing scientific information from image data related to the shape of observed features [13]-[15]. This method is used for pattern recognition to obtain critical information for accuracy classification techniques [17]-[19], serving as essential input for classification, prediction, and data analysis. Edge detection is vital in analyzing various images, including those in medical fields [20].

Determining egg sex before hatching is commonly performed to sort eggs prior to incubation. This study uses smartphone cameras for image acquisition, capturing egg images at a distance of 13 cm to ensure clarity and uniform shape. The research aims to accurately identify male and female eggs, facilitating breeders' sorting processes. The novelty lies in the development of an eccentricity shape feature extraction method, which compares the distance between the minor ellipse focus (b) and the major ellipse focus (a) of an object's area/shape. Typically, the resulting value ranges from 0 to 1, but this study expands the scale to 0-9 for a broader interval. An elongated area yields an E value near 0, while a circular/spherical area yields an E value near 9, aiding in measuring egg ovality. Additionally, the disc method measures egg volume, with larger volumes indicating male eggs and smaller volumes indicating female eggs. The findings in this study are that the method we proposed successfully detected the gender of chicken eggs, namely eggs of male chicken or eggs of female chicken based on chicken egg images by developing a feature extraction method. The feature extraction formula developed in this feature extraction method is the eccentricity value. The value we developed is named the eccentricity plus formula.

2. METHOD

The model developed in this research is the development of a model for the extraction of shape features combined with SVM in detecting sex in poultry eggs. The result is an architectural model, a feature extraction technique for shape features to detect sex in eggs. Figure 1 shows the research framework of this study.

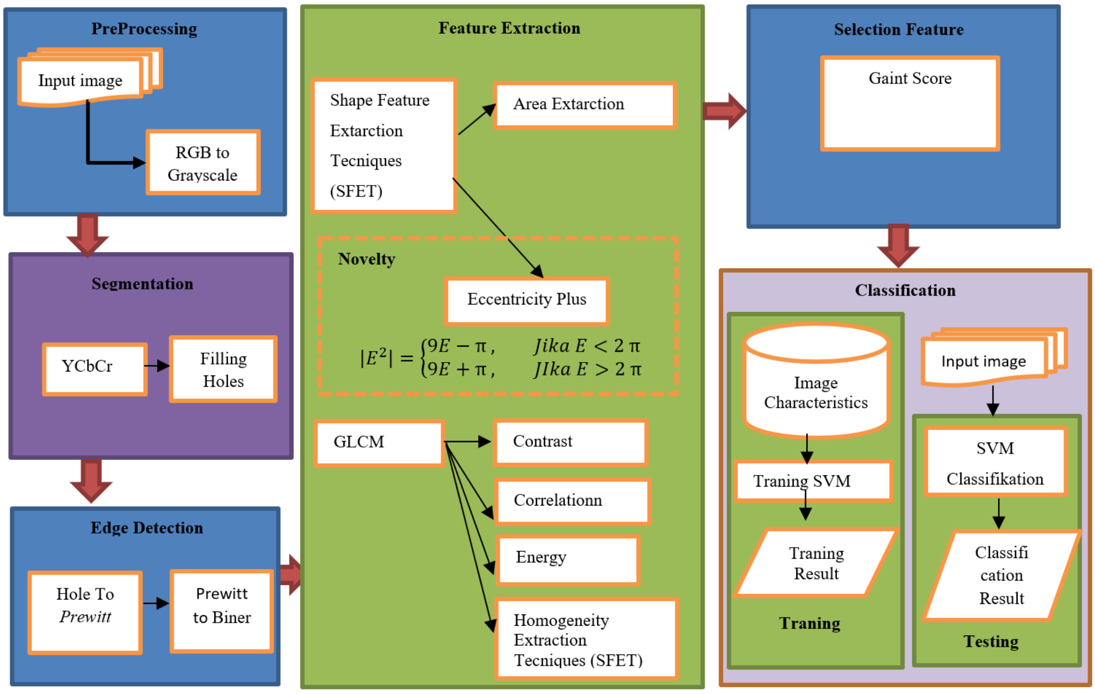


Figure 1. Research framework

2.1. Pre-processing

Image preprocessing is the initial step in processing an egg image, involving the conversion of an RGB image to a grayscale image to simplify subsequent processes. The preprocessing stage aims to enhance the image quality, making it easier to process and analyze in the subsequent steps. The preprocessing stages include cropping and filtering processes. Before initiating the preprocessing stage, the input image is acquired from the source.

a) Input image: Input images should be selected carefully with attention to format, color, quality and source. The image is read using the imread function and stored in the pre_a variable. Processing the input image includes calculating image dimensions and storing them in the size variable, obtaining image size information in the “width x height” format and storing it in the text_size variable, as well as identifying the image format, such as *.jpg. All this information will be displayed in the MATLAB GUI, and the input image will be displayed.
b) Image cropping: The cropping process involves cutting parts of the image to simplify the size and focus on the object of interest. The purpose of cropping is to remove unnecessary noise outside the research object by trimming each side of the image. This results in an area of interest, allowing the removal of unneeded regions outside the object’s region of interest (ROI) [21], [22].
c) RGB image to gray scale: The initial process involves converting the red green blue (RGB) image to a grayscale image to simplify the recognition of the egg image [23]. At this stage, preprocessing is performed by converting the RGB image to grayscale. In the RGB to grayscale stage, the input image is transformed into grayscale form. Converting the input image to grayscale is a common step in digital image processing, which converts a color image into a grayscale image.

2.2. Segmentation

Image segmentation is the intricate process of disassembling or categorizing an image based on the intrinsic characteristics of its pixels [24]. This segmentation can manifest as the isolation of the foreground from the background or the amalgamation of pixel regions based on similarities in color or shape. The primary objective of segmentation is to streamline image analysis by concentrating on specific areas or objects.

a) YCbCr color space transformation. The YCbCr color space transformation involves separating RGB colors into luminance and chrominance components [25]. The RGB color space in the original image contains lighting effects that alter color characteristics, necessitating conversion into a chromatic color space to mitigate these effects, using the YCbCr color model. In this model, Y represents luminance (brightness level), Cb represents chrominance blue (blueness level), and Cr represents chrominance red (redness level).
b) Filling holes. Filling Holes is an image segmentation method that distinguishes objects from the background in an image based on variations in brightness or darkness [26], [27]. Darker image regions are rendered even darker (pure black with an intensity value of 0), while lighter regions are rendered brighter (pure white with an intensity value of 1). Consequently, the output of the segmentation process using the thresholding method is a binary image with pixel intensity values of either 0 or 1. Once the image has been segmented, or the object has been successfully separated from the background, the resultant binary image can be utilized as a mask for further processing, ensuring the original image is displayed without its background.
c) Edge detection. The edge detection stage is a crucial step in the image processing pipeline, aimed at identifying and emphasizing the edges within an image [28]. This process utilizes specialized algorithms to distinguish between regions with significant intensity changes and those without. By accentuating the edges of objects in an image, edge detection enhances the clarity and structural detail of the image. The ultimate objective of this stage is to improve the sharpness and detail of images that may have experienced blurring or detail loss due to errors or artifacts introduced during the image acquisition process.
d) Prewitt edge detection. Prewitt edge detection is a critical stage in the image processing workflow, aimed at reducing or eliminating noise before executing the edge detection step [29]. This step is essential to ensure accurate and sharper edge detection results. To evaluate the edge detection performance using the Prewitt method, a trial will be conducted by developing a program using MATLAB software. The program will implement edge detection using the Prewitt method, along with other relevant edge detection techniques.
e) Binary transformation. Binary transformation is a pivotal stage in image processing, aiming to produce an image representation with black and white gradations, where each pixel is assigned a binary value: 0 for black and 1 for white [30]. This process typically involves assigning a value of 1 to pixels that are part of the object of interest, while pixels in the background are assigned a value of 0. Consequently, a binary image is generated with pixels colored white or black according to their assigned label. In thresholding, selecting the appropriate threshold value is a crucial parameter that influences the final binary image result.

2.3. New feature extraction method

Feature extraction is a process of taking features where the obtained values will later be analyzed for further processes [31], [32]. The novelty of this research lies in the stage of developing an extraction and feature selection algorithm called eccentricity feature development. This stage is a research contribution, where eccentricity is developed based on the ratio between the distance of the minor ellipse foci b and the major ellipse foci a of a region/shape on the object, which can be seen in the basic formula below.

$$E = \sqrt{1 - \frac{b^2}{a^2}} * 9 \quad (1)$$

The value of E ranges from 0 to 1. A region approaching a straight line (elongated) will have E close to 1, whereas a circular region will have E close to 0. Here, a is the major ellipse foci and b is the minor ellipse foci. This eccentricity ranges from 0 to 1, so it requires further development to achieve a wider result value, making the interval broader. A region approaching a straight line (elongated) will have E approaching a larger value, while a circular region will have E approaching a smaller value. This is needed to measure the elongation of an egg. The novelty of eccentricity Plus can be described as follows:

Step 1: Eccentricity and multiplication by 9.

Assume: $\boldsymbol{E = \sqrt{1 - \frac{b^2}{a^2}} * 9}$

E is the original eccentricity value. We multiply this eccentricity value by 9, resulting in $\boldsymbol{E = \sqrt{1 - \frac{b^2}{a^2}} * 9}$

Step 2: Application of conditions.

Next, we apply the following conditions to the result E1:

– If $E1 < 6.2721$, then subtract 3.139 from the result.
– If $E1 < 6.2721$, then $E2 = E1 - 3.139$.

– If $E1 > 6.2721$, then add 3.139 to the result.
– If $E1 > 6.2721$, then $E2 = E1 + 3.139$.

Step 3: Formulating the equation based on conditions.

We then formulate the equation E2 based on these conditions:

1. For $E^1 = 9E$, Jika $E^1 < 6{,}2721$:
   $E^2 = 9E - 3{,}139$
   $E^2 = \pi$
2. Untuk E^1=9E, Jika $E^1 > 6{,}2721$:
   $E^2 = 9E + 3.139$
   $E^2 = \pi$

Step 4: Determining the boundaries of E

Batas E ketika E^1 berubah dari kurang dari 6,2721/2 π menjadi lebih besar dari atau sama dengan 6,2721 adalah:

E = 6,2721/2 π Maka,

$M = (\frac{6{,}2721}{1}) = 2\ \pi$

The boundary of E when E1 changes from less than $6.2721/2\pi$ to greater than or equal to 6.2721 is:

E = 6,2721/2 π

Thus,

$M = (\frac{6{,}2721}{1}) = 2\ \pi$

Step 5: Final equation with conditions.

Combine both conditions into one equation to produce the final formula:

$$|E^2| = \begin{cases} 9E - \pi\ ,\ Jika\ E < 2\ \pi \\ 9E + \pi\ ,\ JIka\ E > 2\ \pi \end{cases}$$

As well as feature extraction on area features as well as contrast, energy, homogeneity and entropy. The shape features used are eccentricity and area. Where the object used can be extracted into 6 characteristics. The algorithm for the feature extraction stages used in this research can be seen in algorithm 1.

Algorithm 1. New feature extraction method

```
1. Read the edge detection image
2. Convert image to double.
3. Carry out the Feature Extraction process by determining the Area, Eccentricity, Contras,
   Correlation, Energy and Homogeneity values.
4. Eccentricity Modified = arrayfun(@(E) ...
    (9 * E - 3.139) * (9 * E < 6.2721) + ...
    (9 * E + 3.139) * (9 * E >= 6.2721), ... Eccentricity);
5. Obtain the average value results from Feature Extraction.
6. Determine the classification target
The values will be saved in svm.mat
```

2.4. Feature selection

Feature selection is a crucial stage in preprocessing for detection, aiming to select the most relevant subset of features from the available set. This research employs the Gaint Score technique, which combines attribute ranking with the assessment of each feature's significance based on data characteristics. The Gaint Score prioritizes the most important or relevant features for the data being processed. In practice, the Gaint Score generates a ranking of features based on their significance. Using six predetermined features, the technique is expected to produce a dominant subset, with higher Gaint Score values indicating higher priority in the selection process.

$$Gaint\ Score\ =\ First\ Class\ Average\ Value\ -\ Second\ Class\ Average\ Value \tag{2}$$

2.5. Classification

In the image classification stage, the SVM method is employed to classify egg images into two categories: male eggs and female eggs [33], [34]. The images subjected to this classification stage are new and have not been previously processed. The image grouping process is conducted in two main steps:

a) Training: Data obtained from the feature extraction stage is stored in a specialized database containing the image characteristics. This data is then used to train the SVM model. The training process utilizes the SVM method, where the processed and stored data serves as samples to train the classification model. Consequently, the SVM model learns to differentiate the characteristics of male and female egg images based on the provided training data.

b) Testing: At the testing stage, the images in the testing folder are used as input for the SVM classification process. This classification process aims to evaluate the accuracy of the previously trained SVM model. The result of this classification process is the grouping of images into two categories: male eggs and female eggs. This testing stage assesses the SVM model's ability to classify new images that have not been processed before.

3. RESULTS AND DISCUSSION

In this section, we will discuss in detail the results obtained from each procedural stage conducted in this research and provide a comprehensive discussion of the previously described results. The outcomes of this research include a variety of images produced through different phases of the research process. These images encompass the initial input images used in the research, images obtained after the initial preprocessing, images that have undergone the main processing stages, and the final images that reflect the output of the entire analysis and processing procedure.

3.1. Pre-processing result

3.1.1. Image input result

The first preprocessing stage in this research is image input. The input image is an RGB-colored egg image in JPG format, entered into the data processing system to be processed in the subsequent stage. The input images meet the standards for data processing, including good lighting and accurate data collection. A total of 300 chicken egg images will be used as research objects. As a sample, 8 images are displayed, as shown in Table 1.

3.1.2. RGB image to grayscale image result

The steps to convert a color image to a grayscale image begin with examining the input image to determine the number of color channels. If the image has three color channels (RGB), the next step is to convert the image to grayscale using the `rgb2gray` function. The conversion results are then saved for further use. If the color channel size is not equal to 3, it indicates that the image is not in RGB format, so the image is directly copied to the pre_b image without changes. After conversion, the grayscale image is displayed in the specified axes. The results of the RGB to grayscale conversion can be seen in Table 2.

Table 1. Egg input image

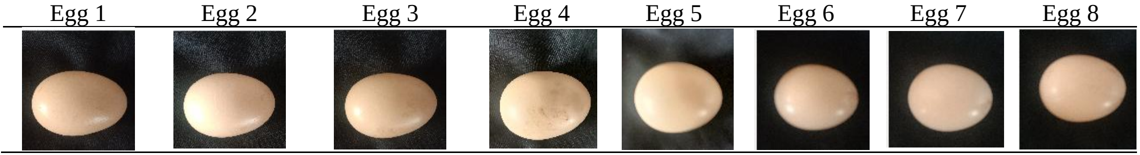
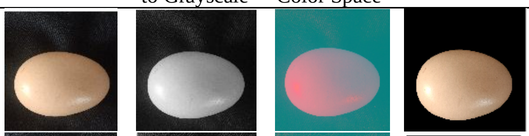
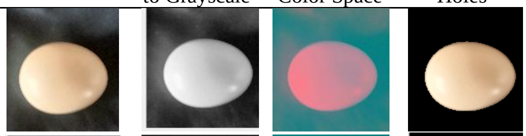
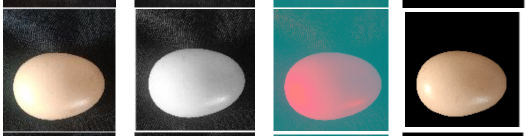
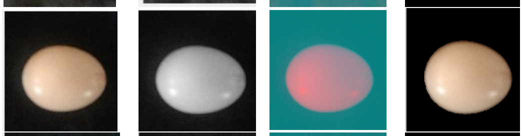
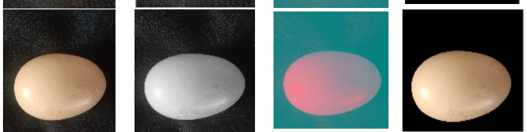
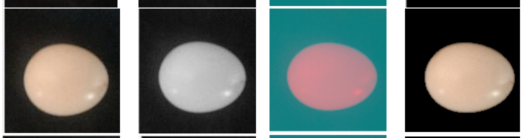
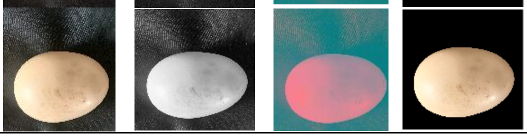
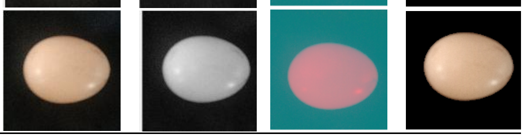
Egg 1	Egg 2	Egg 3	Egg 4	Egg 5	Egg 6	Egg 7	Egg 8
							

Table 2. RGB to grayscale, YCbCr color space transformation and filling holes result

No	Input Image	RGB Image to Grayscale	YCbCr Color Space	Filling Holes	No	Input Image	RGB Image to Grayscale	YCbCr Color Space	Filling Holes
1					5				
2					6				
3					7				
4					8				

3.2. Segmentation result
3.2.1. YCbCr color space transformation result

The YCbCr color space transformation is a process where colors in RGB format are separated into luminance (brightness) and chrominance (color) information. Colors in the RGB color space of the original image often retain lighting effects that can alter color characteristics. To mitigate this issue, it is necessary to convert the image into a chromatic color space, which better reduces the influence of lighting effects. The YCbCr color model is commonly used for this purpose because it separates the color component (chrominance) from the brightness component (luminance), facilitating further image processing. The results of the YCbCr color space transformation can be seen in Table 2.

3.2.2. Filling holes result

The steps to convert a YCbCr image to a Holes image begin with verifying that the input image has three color channels (RGB). This is crucial because proper conversion of a YCbCr image to a Holes image requires an image with intact RGB color channels. Once the image meets these criteria, the conversion process is executed by considering the changes in each color channel. This ensures that the conversion from the YCbCr image to the Holes image is performed accurately and efficiently, resulting in an image representation suitable for subsequent analysis and processing. The results of the Filling Holes process can be seen in Table 2.

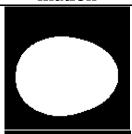
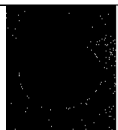
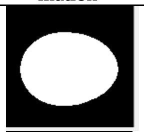
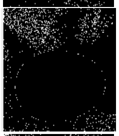
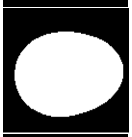
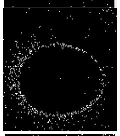
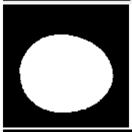
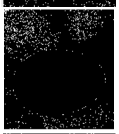
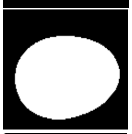
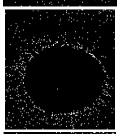
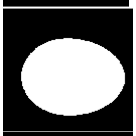
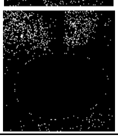
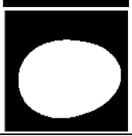
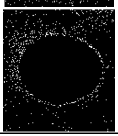
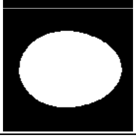
3.3. Edge detection result
3.3.1. Prewitt edge detection result

The Prewitt method is a technique used in the image edge detection stage, aimed at reducing noise interference before performing edge detection calculations. In this context, the Prewitt method identifies the edges of objects in images by utilizing the Prewitt operator. To test the effectiveness of the Prewitt method in detecting edges, a program was created using MATLAB software. This stage is crucial for verifying the edge detection results produced by the Prewitt method, allowing its quality to be measured and evaluated for accuracy. The results of the Prewitt edge detection can be seen in Table 3.

3.3.2. Binary transformation result

This stage involves producing a gradation of black (bit 0) and white (bit 1). Typically, the object pixel is assigned a value of 1, while the background pixel is assigned a value of 0. Consequently, a binary image is formed by coloring each pixel as white or black, depending on its label. The key parameter in the thresholding process is the selection of the threshold value. There are several methods available for choosing an appropriate threshold value. The results of the binary transformation can be seen in Table 3.

Table 3. Prewitt edge detection and binary transformation result

No	Filling Holes	Prewitt Edge Detection	Binary Transfor-mation	No	Filling Holes	Prewitt Edge Detection	Binary Transfor-mation
1				5			
2				6			
3				7			
4				8			

3.4. Feature extraction result
3.4.1. Old feature extraction method result

Feature extraction is a process that extracts important information or characteristics from data, with the obtained values being analyzed further in subsequent research or applications. In this research, there is a novel aspect highlighted at the feature extraction stage, focusing on the development of feature extraction and selection algorithms known as eccentricity feature development. The parameters used to track features in the image include eccentricity ratio, area, contrast, energy, homogeneity, and entropy. The shape features of particular concern in this research are eccentricity and area, which are crucial indicators in describing the characteristics of an object in an image. By analyzing these features, objects in the image can be extracted and represented more comprehensively using six different characteristics, facilitating further analysis of these objects. The results of the old feature extraction method result can be seen in Table 4.

3.4.2. New feature extraction method result

Feature selection is a critical step in the preprocessing process for detection, where this research adopts the attribute frequent selection (ASF) technique to optimize the process. ASF is used to prioritize attributes and assess their importance based on the specific needs of the data being processed. In this stage, after applying the ASF technique to the six selected features, the goal is to obtain the most dominant feature subset. This is achieved by producing a sequence of feature ASF values from highest to lowest, making it easier to select the features to be used based on the specific needs of the data analysis being carried out. The results of the new feature extraction method result can be seen in Table 4.

3.5. Classification result

After the previous stage is completed, the next step is to determine the egg sample size based on previous results. In this context, the SVM classification method is applied to process the egg size measurements, using six features generated from the most relevant geometric properties of the ellipse. These features include various parameters calculated from the geometric characteristics of the ellipse, which are then used in the classification process to accurately determine egg size.

In Table 4, the results of the male egg image test data can be shown. You can see the feature extraction results in the image as follows: area = 1290194, eccentricity = 6.56, contrast = 0.03, correlation = 0.99, energy = 0.44, homogeneity = 0.98 The process that occurs at the classification stage is that the test image stored in the testing folder is selected according to the image you want to test. If the egg image is selected then the pre-processing process for the test data will work. The results of the selected test data can group the images according to the specified results as in the image above. The results identified male eggs Table 4. Classification results of test data for male egg types.

Table 4. Old feature, new feature extraction method No and classification result

No	Area	Eccentricity	Contrast	Correlation	Energy	Homogeneity	Classification
			Old feature extraction method				
1	1290194	6,5	0,03	0,99	0,45	0,98	Male
2	1298501	6,7	0,02	0,99	0,46	0,98	Male
3	1302802	6,7	0,02	0,99	0,45	0,99	Male
4	1325509	6,8	0,03	0,99	0,45	0,99	Male
5	1324072	6,8	0,03	0,99	0,45	0,99	Female
6	1320380	6,8	0,03	0,99	0,45	0,98	Female
7	1297005	6,8	0,02	0,99	0,45	0,99	Female
8	1340056	6,8	0,03	0,99	0,44	0,98	Female
			New feature extraction method				
1	59,1	95,9	92,79	100	5,75	483,0	Male
2	77,6	98,0	43,06	-40,31	7,02	4,4	Male
3	79,6	98,6	-31,58	-19,83	10,06	61,7	Male
4	100	99,8	59,95	59,33	10,14	-5,9	Male
5	98,5	99,5	68,34	90,09	7,76	-118,5	Female
6	91,9	99,7	100	49,86	9,17	-274,3	Female
7	43,3	99,9	-52,6	-38,86	5,74	100	Female
8	125,5	95,9	62,099	41,85	9,56	-197,8	Female

4. CONCLUSION

Obtaining relevant data for different types of chickens presents significant challenges due to limited imagery. To address this, researchers developed an innovative eccentricity parameter technique for detecting gender in chicken eggs. This study introduced models for feature extraction and selection using the extraction and selection-total of features (ES-TF) method. The ES-TF method tracks feature ratios of eccentricity, Area, Energy, Contrast, Homogeneity, and Correlation to identify key characteristics. The dataset included 300 images, equally divided into 150 male and 150 female egg images, and was further expanded to incorporate 150 training data points with 300 male and female egg object data and 80 test data points with 300 male and female image data. The study focused on feature selection by measuring the distance between the values of male and female egg image extracts. The results demonstrated significant differences between male and female egg images, with the following feature values: eccentricity = 98.95, area = 84.48, energy = 43.25, contrast = 30.64, homogeneity = 7.31, and correlation = 0.01. These values highlight the effectiveness of the feature extraction and selection process. This study showcases the novelty of the developed eccentricity parameter technique and the ES-TF method in effectively differentiating gender in chicken eggs. The significant values obtained for each feature underscore the robustness of the approach, offering a reliable foundation for further research and application in poultry science and industry.

FUNDING INFORMATION

This research was not supported by any grants from funding bodies in the public, private, or not-for-profit sectors.

AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Adil Setiawan	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓
Yuhandri		✓				✓	✓	✓	✓	✓	✓	✓		
Muhammad Tajuddin	✓		✓	✓		✓	✓		✓		✓		✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to animal use has been complied with all the relevant national regulations and institutional policies for the care and use of animals.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [AS], upon reasonable request.

REFERENCES

[1] I. Sema and A. Gülsen, "An investigation on the determination of factors influencing chick sex prediction in hatching eggs," *African Journal of Agricultural Research*, vol. 9, no. 6, pp. 603–606, Feb. 2019, doi: 10.5897/ajar2013.8230.
[2] K. Bharodiya and A. M. Gonsai, "An improved edge detection algorithm for X-Ray images based on the statistical range," *Heliyon*, vol. 5, no. 10, p. e02743, Oct. 2019, doi: 10.1016/j.heliyon.2019.e02743.
[3] M. A. Ansari, D. Kurchaniya, and M. Dixit, "A comprehensive analysis of image edge detection techniques," *International Journal of Optics and Laser Technology*, vol. 98, pp. 157-168, 2017, doi: 10.1016/j.ijleo.2017.09.202.
[4] K. Shah, V. Kedia, R. Raut, S. Ansari, and A. Shroff, "Evaluation and comparative study of edge detection techniques," *IOSR Journal of Computer Engineering*, vol. 22, no. 5, pp. 6–15, Oct. 2020, doi: 10.9790/0661-2205030615.
[5] Dhruv, N. Mittal, and M. Modi, "Comparative analysis of edge detection techniques for medical images of different body parts," in *Data Science and Analytics*, Springer Singapore, 2018, pp. 164–176, doi: 10.1007/978-981-10-8527-7_15.

[6] I. N. Mohapatra, "Image edge detection techniques," *Transactions on Image Processing and Computer Vision*, vol. 5, no. 15, pp. 15–19, Dec. 2019, doi: 10.19101/tipcv.2019.515008.
[7] I. Vankova *et al.*, "Morphological features useful in the differential diagnosis between undifferentiated carcinoma and gastrointestinal stromal tumor," *Annals of Diagnostic Pathology*, vol. 46, p. 151527, 2020, doi: 10.1016/j.anndiagpath.2020.151527.
[8] Bai, "Morphological feature extraction for detail-maintained image enhancement by using two types of alternating filters and threshold constrained strategy," *Optik - International Journal for Light and Electron Optics*, vol. 126, no. 24, pp. 5038–5043, 2015, doi: 10.1016/j.ijleo.2015.09.202.
[9] S. Chidambaranathan, A. Radhika, V. V. Priya, S. K. Mohan, and M. G. Gireeshan, "Optimal SVM based brain tumor MRI image classification in cloud Internet of Medical Things," in *Cognitive Internet of Medical Things for Smart Healthcare*, Springer, Cham, 2021, pp. 87–103, doi: 10.22146/ijitee.62663.
[10] I. V. Mutneja, "Methods of image edge detection: A review," *Journal of Electrical and Electronic Systems*, vol. 4, no. 2, 2015, doi: 10.4172/2332-0796.1000150.
[11] J. L. Dioses, R. P. Medina, A. C. Fajardo, and A. A. Hernandez, "Performance of classification models in Japanese quail egg sexing," in *Proceedings of the 2021 IEEE 17th International Colloquium on Signal Processing & Its Applications (CSPA)*, Mar. 2021, pp. 29–34, doi: 10.1109/CSPA52141.2021.9377275.
[12] N. A. Fadchar and J. C. D. Cruz, "Prediction model for chicken egg fertility using artificial neural network," in *Proceedings of the 2020 IEEE 7th International Conference on Industrial Engineering and Applications (ICIEA)*, Bangkok, Thailand, 2020, pp. 916–920, doi: 10.1109/ICIEA49774.2020.9101966.
[13] M. Hashemzadeh and N. Farajzadeh, "A machine vision system for detecting fertile eggs in the incubation industry," *International Journal of Computational Intelligence Systems*, vol. 9, no. 5, pp. 850–862, Sep. 2016, doi: 10.1080/18756891.2016.1237185.
[14] K. O. Idahor, L. A. F. Akinola, and S. S. Chia "Predetermination of quail chick sex using egg indices in north central Nigeria," *Journal of Animal Production Advances*, vol. 5, no. 1, p. 599, 2015, doi: 10.5455/japa.20141223074311.
[15] I. Indra, T. Hasanuddin, R. Satra, and N. R. Wibowo, "Eggs detection using Otsu thresholding method," in *Proceedings of the 2018 2nd East Indonesia Conference on Computer and Information Technology (EIConCIT)*, Makassar, Indonesia, 2018, pp. 10–13, doi: 10.1109/EIConCIT.2018.8878517.
[16] J. Thipakorn, R. Waranusast, and P. Riyamongkol, "Egg weight prediction and egg size classification using image processing and machine learning," in *Proceedings of the 2017 14th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)*, Jun. 2017, doi: 10.1109/ecticon.2017.8096278.
[17] J. Thipakorn, R. Waranusast, and P. Riyamongkol, "Egg weight prediction and egg size classification using image processing and machine learning," *presented at the 2017 14th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)*, Jun. 2017, doi: 10.1109/ecticon.2017.8096278.
[18] K. Bresilla *et al.*, "Single-shot convolution neural networks for real-time fruit detection within the tree," *Frontiers in Plant Science*, vol. 10, May 2019, doi: 10.3389/fpls.2019.00611.
[19] Kaur and D. Singh, "Geometric feature extraction of selected rice grains using image processing techniques," *Indonesian Journal of Chemical Analysis (IJCA)*, vol. 124, no. 8, pp. 41–46, Aug. 2015, doi: 10.5120/ijca2015905576.
[20] G. Kumar and P. K. Bhatia, P. K. "A detailed review of feature extraction in image processing systems," *International Conference on Advanced Computing and Communication Technologies, ACCT*, 5–12. 2014, doi: 10.1109/ACCT.2014.74.
[21] M. Kumar, S. Gupta, X.-Z. Gao, and A. Singh, "Plant species recognition using morphological features and adaptive boosting methodology," *IEEE Access*, vol. 7, pp. 163912–163918, 2019, doi: 10.1109/ACCESS.2019.2952176.
[22] M. A. T. Valdez, P. A. S. T. Watt, and G. P. Mappatao, "Automated fertilized duck egg sorting system using image processing," *Advanced Science Letters*, vol. 23, no. 6, pp. 5191–5194, Jun. 2017, doi: 10.1166/asl.2017.7339.
[23] M. Hashemzadeh, "A vision machine for detecting fertile eggs and performance evaluation of neural networks and support vector machines in this machine," *Journal of Soft Computing and Decision Support Systems*, vol. 14, no. 3, pp. 97–112, Dec. 2017, doi: 10.29252/jsdp.14.3.97.
[24] M. Krautwald-Junghanns *et al.*, "Current approaches to avoid the culling of day-old male chicks in the layer industry, with special reference to spectroscopic methods," *Poultry Science*, vol. 97, no. 3, pp. 749–757, 2018, doi: 10.3382/ps/pex389.
[25] M. S. Nixon and A. S. Aguado, "Low-level feature extraction (including edge detection)," in *Feature Extraction and Image Processing for Computer Vision*, Elsevier, 2020, pp. 141–222, doi: 10.1016/j.jplph.2016.03.009.
[26] M. San, M. M. Aung, and P. P. Khaing, "Fruit recognition using color and morphological features fusion," *International Journal of Image, Graphics and Signal Processing*, vol. 11, no. 10, pp. 8–15, Oct. 2019, doi: 10.5815/ijigsp.2019.10.02.
[27] M. Tamayo-Ordóñez *et al.*, "Morphological features of different polyploids for adaptation and molecular characterization of CC-NBS-LRR and LEA gene families in *Agave* L.," *Journal of Plant Physiology*, vol. 195, pp. 80–94, 2016, doi: 10.1016/j.jplph.2016.03.009.
[28] M. A. Ansari, D. Kurchaniya, and M. Dixit, "A comprehensive analysis of image edge detection techniques," *International Journal of Multimedia and Ubiquitous Engineering*, vol. 12, no. 11, pp. 1–12, Nov. 2017, doi: 10.14257/ijmue.2017.12.11.01.
[29] B. Narin, S. Buntan, N. Chumuang, and M. Ketcham, "Performance analysis of feature extraction techniques for image classification," in *Proceedings of the 2018 18th International Symposium on Communications and Information Technologies (ISCIT)*, Bangkok, Thailand, Sep. 2018, doi: 10.1109/ISCIT.2018.8587980.
[30] O. Nurhayati, "Image processing for identification of Leghorn and Omega-3 chicken eggs using K-mean clustering and principal component analysis," *Journal of Smart Informatics and Networked Business Information Systems*, vol. 10, no. 1, pp. 84–93, Jun. 2020, doi: 10.21456/vol10iss1pp84-93.
[31] J. Xu, "Image data visualization and communication system based on sensor network simulation and visual feature extraction," *Measurement and Sensors*, vol. 33, p. 101223, 2024, doi: 10.1016/j.measen.2024.101223.
[32] W. You, K. J. T. Noonan, and G. W. Coates, "Analysis of the off-focal source in transmission geometry X-ray systems," *Progress in Polymer Science*, p. 101177, 2019, doi: 10.1016/j.heliyon.2024.e35358.
[33] H. Hendri *et al.*, "A hybrid data mining for predicting scholarship recipient students by combining K-Means and C4.5 methods," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 33, no. 3, p. 1726, 2024, doi: 10.11591/ijeecs.v33.i3.pp1726-1735.
[34] H. Hendri, Masriadi, and Mardison, "A novel algorithm for monitoring field data collection officers of Indonesia's Central Statistics Agency (BPS) using web-based digital technology," *International Journal on Advanced Science, Engineering and Information Technology*, vol. 13, no. 3, p. 1154, 2023, doi: 10.18517/ijaseit.13.3.18302.

BIOGRAPHIES OF AUTHORS

Adil Setiawan is a tenured lecturer at Universitas Potensi Utama, specializing in the software engineering study program within the Faculty of Computer Science. He earned her undergraduate degree (S1) and Master's (S2) in the information systems and informatics engineering study programs, respectively, at University Potensi Utama and The Universitas Putra Indonesia YPTK Padang, West Sumatra, Indonesia. Currently, He is currently pursuing Doctoral Education (S3) in the Information Technology study program at the same institution. Providing a variety of courses in the artificial intelligence study program, including intelligent systems, mobile programming, and expert systems, it makes significant contributions to the academic environment. He can be contacted via email at: adio165@gmail.com.

Yuhandri holds the distinguished title of Professor at Universitas Putra Indonesia YPTK Padang, contributing as a lecturer in the information technology study program within the Faculty of Computer Science. He earned his undergraduate degree (S1) in the computer systems study program and completed his Master's (S2) in the informatics engineering study program at UPI YPTK Padang, West Sumatra, Indonesia. Additionally, he obtained his doctoral degree from Gunadharma University, Jakarta, Indonesia. Professor Yuhandri is recognized as a leading expert in the field of image processing at UPI YPTK Padang. His pedagogical repertoire encompasses courses in the image processing and artificial intelligence. He can be contacted via email at: yuyu@upiyptk.ac.id.

Muhammad Tajuddin is a dedicated lecturer and Professor in the Information Technology (S3) Study Program within the Faculty of Computer Science at Universitas Putra Indonesia YPTK Padang, Sumatera Barat, Indonesia. He earned his Bachelor's Degree from Universitas Mataram in the Information System program under the Faculty of Computer Science. Subsequently, he pursued a Master's Degree at Universitas Brawijaya, specializing in Computer Science. And he pursued a doctoral degree from Universitas Brawijaya. His research endeavors traverse diverse domains, with particular expertise in image processing, information system, and web design. Muhammad Tajuddin welcomes communication and collaboration. He can be contacted via email at: tajuddin@universitasbumigora.ac.id.