Brilliance
Research of Artificial Intelligence

E-ISSN : 2807-9035
Volume 4, **Number** 2, November 2024
https://doi.org/10.47709/brilliance.v4i2.4496

Real Time Chicken Egg Size Classification Using Yolov4 Algorithm

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open access

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Article History:
Submitted: 09-08-2024
Accepted: 09-09-2024
Published: 01-11-2024

Keywords:
Yolov4; Real time; Chicken Egg.

ABSTRACT

The common problem currently faced by MSMEs producing chicken eggs is experiencing difficulties in grouping egg sizes every day. Currently, grouping egg sizes is still done manually, this is less than optimal and prone to errors so that many business owners often experience losses. Grouping egg sizes before being sold is very important to note because each size affects the selling price of eggs. The use of technology on a MSME scale in laying hen farmers has not been widely adopted, this is due to limited access and understanding of technology so that to improve and strengthen productivity, management, and marketing in this business, technological innovation is needed. One alternative solution to deal with this problem is to build a real-time computerized system that can group eggs according to their size. This study aims to evaluate the performance of the Yolov4 algorithm in grouping egg sizes based on their size in real time. Based on the results of the tests carried out, the Yolov4 algorithm is able to group chicken eggs in real time with an F1-Score value: 0.89 where the F1-Score value approaching 1 indicates that the system performance has been running well. The results of this classification can be used to create a real-time egg size grouping application that can help MSMEs to monitor the productivity of chicken eggs every day.

INTRODUCTION

The egg-laying chicken farming business is a very important business to pay attention to because this business has the potential to create jobs in rural and urban areas. In order for this business to be stable and develop, where egg-laying chicken farmers need to make improvements in various aspects starting with production, management, and marketing (Ishak et al., 2024). In UMKM scale farms, egg size grouping is still done conventionally. This is due to limited access and understanding of technology (van Veen et al., 2023). With increasingly advanced technological advances, innovation in UMKM egg-laying chicken farming is very necessary to be able to group egg sizes in real time. (Ruhnke et al., 2019). The importance of a system that provides real-time information to business owners allows them to predict egg production according to size to meet customer orders. (Sandy et al., 2023). Where one alternative solution is to build a computerized system that can group egg sizes in real time. (Joe et al., 2024). In this study, the Yolov4 algorithm will be used to evaluate its real-time performance in grouping chicken egg sizes. This egg-size grouping system is included in the object recognition concept, where the system can recognize objects based on previously conducted training.(Arulalan et al., 2022). Object recognition is a field of research that can be applied in various sectors. For example, (Rizal et al., 2020) Conducted a study on classifying tuberculosis image datasets using the k-nearest neighbor (KNN) method and SURF feature extraction. In this study, KNN successfully achieved an average accuracy of 73.18% in classifying positive and negative tuberculosis (TB) images, with KNN using SURF extraction being 2% superior in classifying TB X-ray images. Similar research was conducted by (Kelik Nugroho et al., 2023), Which uses a combination of OpenCV and YOLOv4-Tiny for object recognition. OpenCV is an open-source computer vision library known for its extensive collection of functions and algorithms, while yolov4-Tiny is a compact variant of the yolo (You Only Look Once) object detection algorithm, designed to achieve real-time performance without compromising accuracy. (Chary, 2023) Proposed a deep learning method using the Yolov3 algorithm to detect armed and unarmed objects in real-time, with accuracy results reaching 80%, precision 0.788, recall 0.631, and F1 score 0.701. Furthermore, (Muwardi et al., 2023) developed an Android application for object detection using yolov4, which was tested under optimal lighting conditions with an accuracy of 98%. Similar research by (Li et al., 2022) Comparing the performance of the yolov4 algorithm using the Darknet Framework architecture, where the yolov4 model shows the best performance with the highest FPS value of 171 and mAP of 96.75%. (Lavanya & Pande, 2024) Also proposed the use of the yolov4 algorithm for real-time object detection by implementing the OpenCV library, and the experimental results showed that yolov4 is an effective and efficient method for dataset recognition and localization. In this study, the yolov4 algorithm will be used because this algorithm is one of the well-known deep learning models for performing real-time object recognition with high accuracy (Geethanjali, 2023). YOLO's performance in real-time object detection involves dividing the input image into several SxS grids, where each grid predicts a bounding box and its probability. The size of the grid cells depends on the input size used in a particular architecture. (Imanuel et al., 2024)(Haq et al., 2024). Based on previous studies, chicken egg detection research focuses more on chicken egg detection through still

E-ISSN : 2807-9035
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images, so it is important to conduct research using moving images or videos in real-time. Therefore, this study will focus on chicken egg detection by grouping egg sizes using the YOLO algorithm, which is expected to be a reference for further studies focusing on the digital economy for MSME chicken egg entrepreneurs.

LITERATURE REVIEW

Object detection is one of the important tasks in computer image processing and computer vision. One very popular approach to object detection is using a model based on the YOLO (You Only Look Once) architecture. YOLO is known for its ability to perform real-time object detection with high accuracy. The latest versions of YOLO, namely YOLOv3 and YOLOv4, offer various improvements over the previous versions(Maleh et al., 2023). YOLOv3, introduced by (Redmon & Farhad, 2018), is the third version of the YOLO architecture that incorporates several innovations to improve object detection performance. Architecture: YOLOv3 uses Darknet-53 as the backbone, which consists of 53 convolutional layers with residual connections. This architecture helps in training very deep networks by enhancing gradient flow. Detection Features: YOLOv3 implements multi-scale detection by using three different resolution levels in object detection, which allows for more effective detection of objects of different sizes. Output: The model generates three predictions per grid cell using anchor boxes, which are adjusted for different object sizes. YOLOv4, introduced by Bochkovskiy, Wang, and Liao (2020), introduces several improvements in architecture and training techniques that improve performance over YOLOv3. Architecture: YOLOv4 uses CSPDarknet-53 as the backbone, which integrates Cross-Stage Partial connections to improve efficiency and accuracy(Wang & Liao, 2020). In addition, YOLOv4 utilizes PANet (Path Aggregation Network) to enhance feature fusion from different resolutions. Feature Detection: YOLOv4 implements augmentation and regularization techniques such as mosaic augmentation, DropBlock regularization, and Self-adversarial training to improve robustness and accuracy. Output: This model integrates FPN (Feature Pyramid Networks) and PAN for better multi-scale object detection.

METHOD

Research stage

The stages of this research are the steps that will be taken in solving the problem. In general, the overall stages of the research are shown in Figure 1.

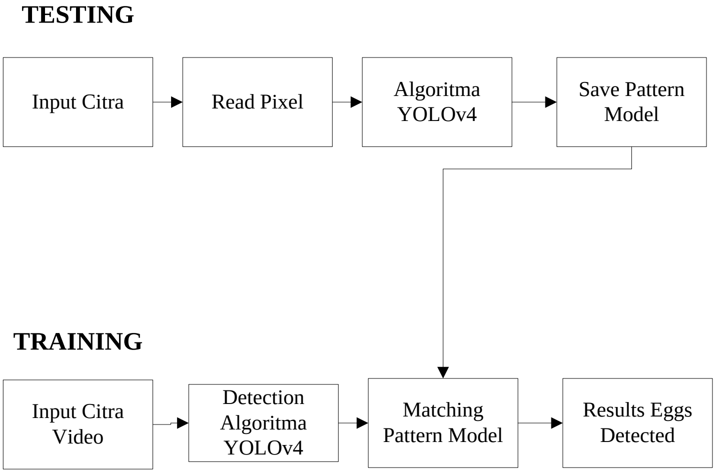

Figure 1. Research Flow

In Figure 1. It can be seen that the research flow that will be carried out begins with the first process, namely the system will read the image pixels for further modeling using the YOLOv4 Algorithms. Furthermore, the input image is modeled using the YOLOv4 Algorithms and the pattern model will be extracted and stored to be used as a reference pattern in the training process. While in the testing stage, the input video image is preprocessed using the YOLOv4 Algorithms then continued with pattern model matching, if the pattern is similar or close to the training pattern, the classification output is the result of the chicken egg classification. The final result of the system will provide the total number of eggs that can be detected using the YOLOv4 algorithms.

Classification model

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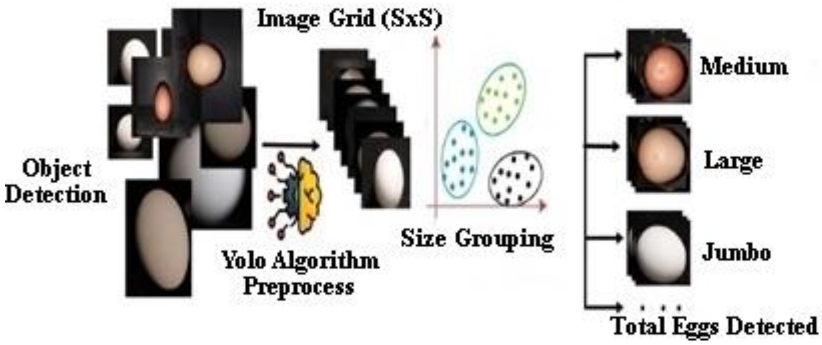

Figure 2. Classification Model

Figure 2 shows the process of detecting the recognition of the number of eggs and classifying the size of the eggs that will be carried out. It begins with the object detection stage using a camera, then the image will be pre-processed using the Yolov4 algorithm. Where the initial stage will form an image grid (SxS) then predict the bounding box and probability for each grid of all attributes in the bounding box through the normalization process, so that it will produce a value between 0 and 1, the second stage the image will be grouped into three groups, namely medium size, large size and jumbo size. The final stage of the system will provide the output of the number of egg detections according to their size.

RESULT

Model training

In the image pre-processing stage, the first step taken is to change the size of the egg image. At this stage, the image is resized to 255 x 255 pixels because the egg image data has varying sizes, where the dataset pre-processing stage is illustrated in Figure 3

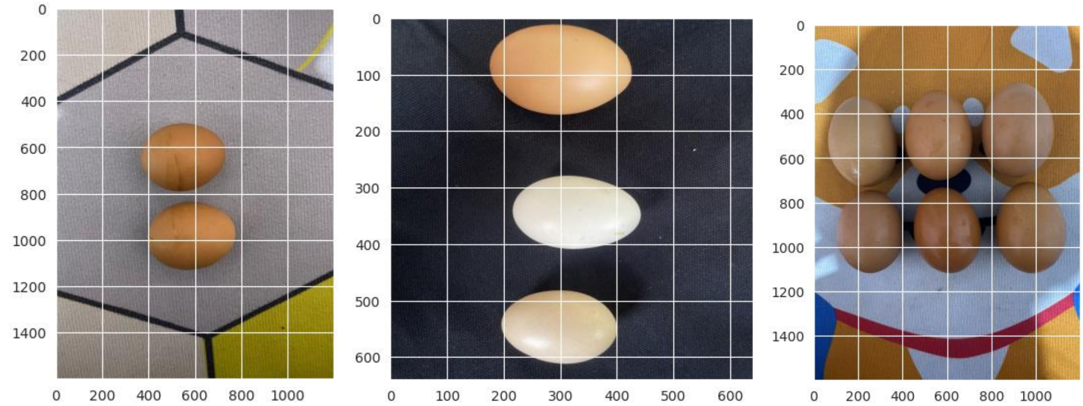
Figure 3. Pre-processing process of chicken egg image

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Dataset description

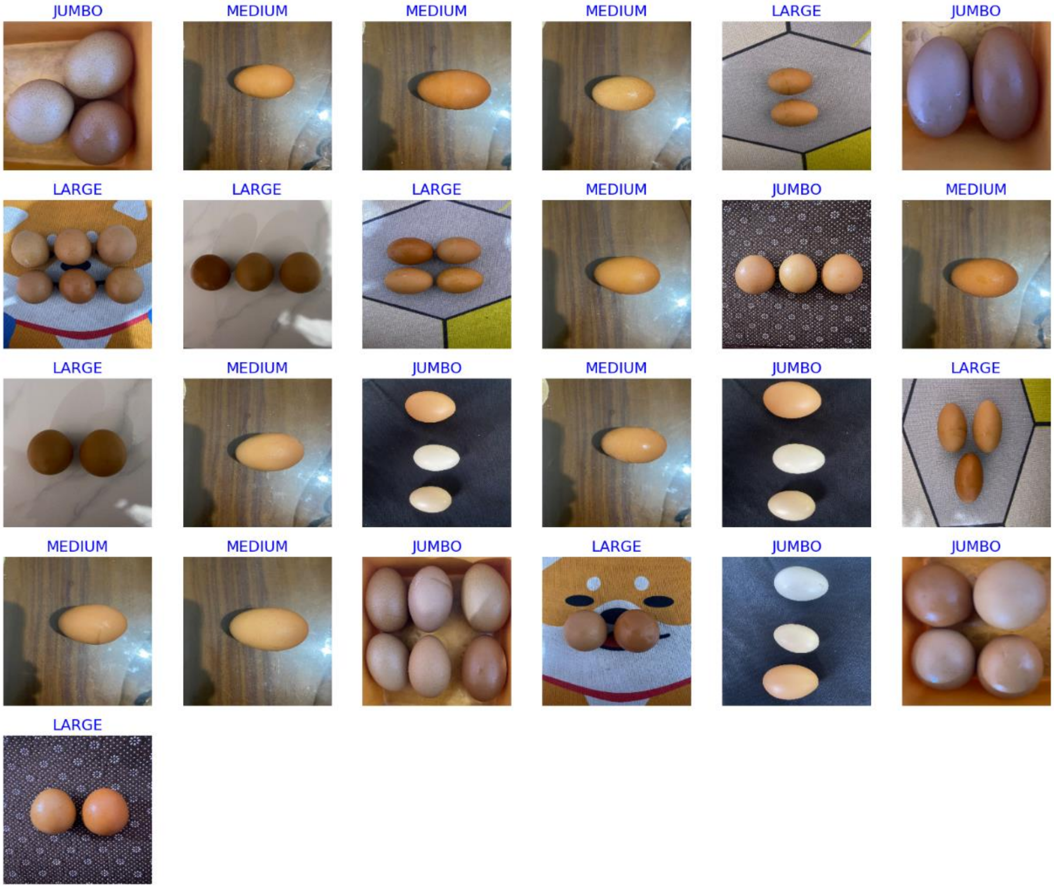
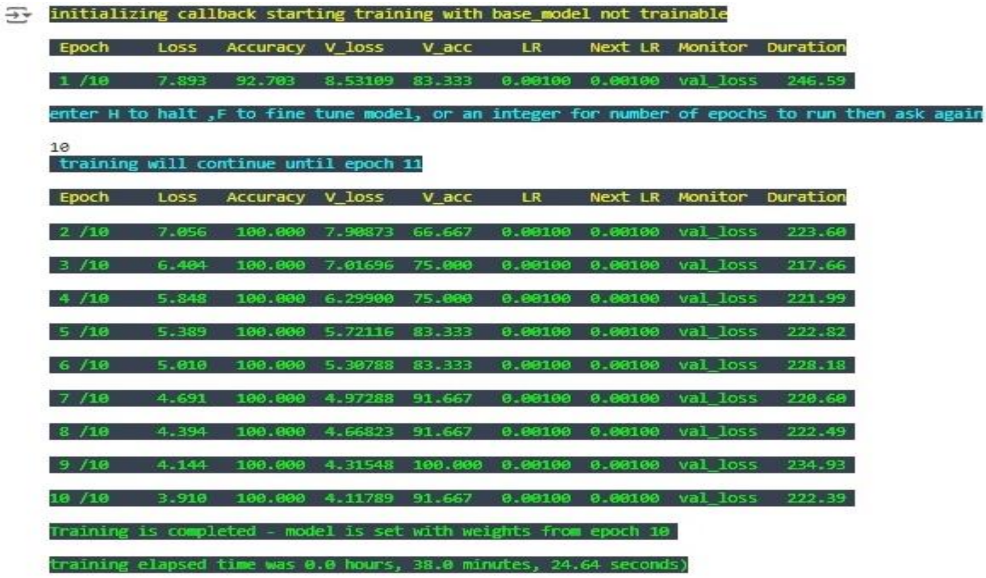


Figure 4. Training dataset of egg images.

Figure 4 is an illustration of the dataset training process aimed at obtaining image characteristics to distinguish the size of medium-sized chicken eggs, large-sized chicken eggs and jumbo-sized chicken eggs. The results of model training using epoch 10 using the yolov4 algorithm can be seen in Figure 5.



```
initializing callback starting training with base_model not trainable
 Epoch     Loss   Accuracy  V_loss    V_acc      LR      Next LR  Monitor  Duration
 1 /10     7.893   92.703   8.53109  83.333   0.00100  0.00100  val_loss   246.59
enter H to halt ,F to fine tune model, or an integer for number of epochs to run then ask again
10
 training will continue until epoch 11
 Epoch     Loss   Accuracy  V_loss    V_acc      LR      Next LR  Monitor  Duration
 2 /10     7.056  100.000   7.90873  66.667   0.00100  0.00100  val_loss   223.60
 3 /10     6.404  100.000   7.01696  75.000   0.00100  0.00100  val_loss   217.66
 4 /10     5.848  100.000   6.29900  75.000   0.00100  0.00100  val_loss   221.99
 5 /10     5.389  100.000   5.72116  83.333   0.00100  0.00100  val_loss   222.82
 6 /10     5.010  100.000   5.30788  83.333   0.00100  0.00100  val_loss   228.18
 7 /10     4.691  100.000   4.97288  91.667   0.00100  0.00100  val_loss   220.60
 8 /10     4.394  100.000   4.66823  91.667   0.00100  0.00100  val_loss   222.49
 9 /10     4.144  100.000   4.31548 100.000   0.00100  0.00100  val_loss   234.93
10 /10     3.910  100.000   4.11789  91.667   0.00100  0.00100  val_loss   222.39
Training is completed - model is set with weights from epoch 10
training elapsed time was 0.0 hours, 38.0 minutes, 24.64 seconds)
```

Figure 5. Model training process using the yolov4 algorithm

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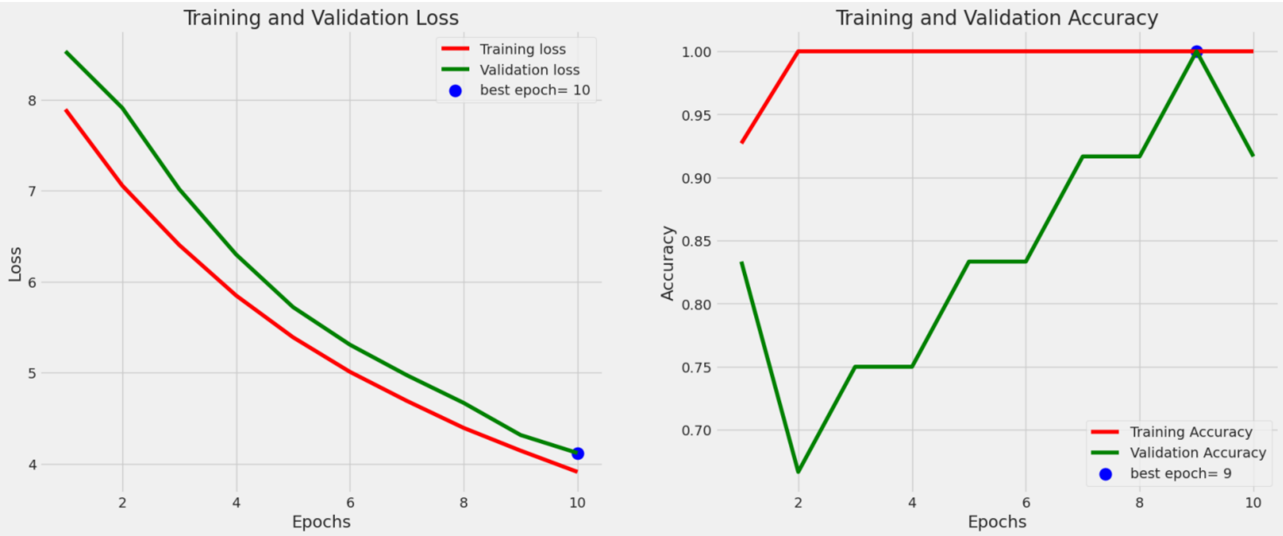

Figure 6. Model training result graph using yolov4 algorithm

In Figure 6, the training results of the Yolov4 algorithm model can be seen using epoch 10. Training carried out using the Yolov4 Algorithm shows the best epoch 9 value with an accuracy value of 0.8343, loss: 4.4567 and time 71s. The results of the evaluation of the training model carried out in this study can be seen in Table 1.

Table 1. Results of the Yolov4 Algorithm Accuracy Test with an Epoch Value of 10

Epoch	Loss	Accuracy	Validation Loss	Validation Accuracy
1/10	7.893	100.000	8.53109	83.333
2/10	7.056	100.000	7.90873	66.667
3/10	6.404	100.000	7.01696	75.000
4/10	5.548	100.000	6.29900	75.000
5/10	5.389	100.000	5.72116	83.333
6/10	5.010	100.000	5.30788	83.333
7/10	4.691	100.000	4.97288	91.667
8/10	4.394	100.000	4.66823	91.667
9/10	4.144	100.000	4.31548	100.000
10/10	3.910	100.000	4.11789	91.667

In table 1, the results of the performance test of the Yolov4 algorithm can be seen, the model testing was carried out with 794 images and 10 epochs, Learning Rate: 0.001. After carrying out the training and model evaluation process, the testing stage is carried out, namely real-time system testing using the Yolov4 algorithm, as can be seen in Figures 7 to 12 below.

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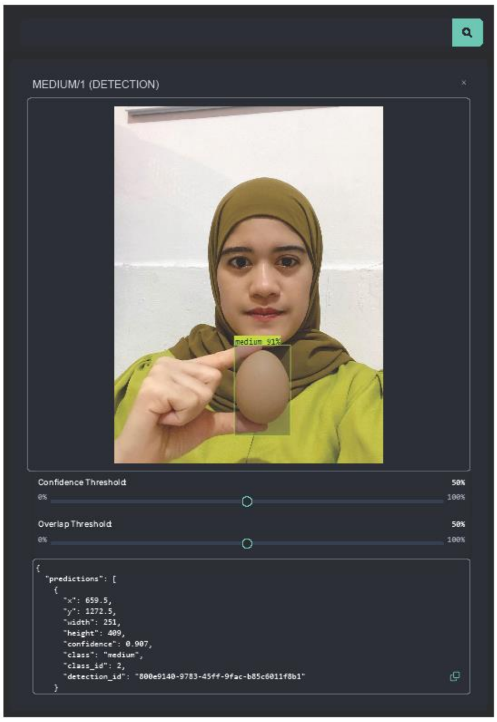

Figure 7. Testing Using the Yolov4 Algorithm with 1 Egg Objects

In Figure 7, the results of the system test can be seen using a trial with 1 egg objects. Where the results of the system test can detect all egg objects with a yellow color (medium size label). Furthermore, real-time testing is carried out using 2 egg objects as shown in Figure 8.

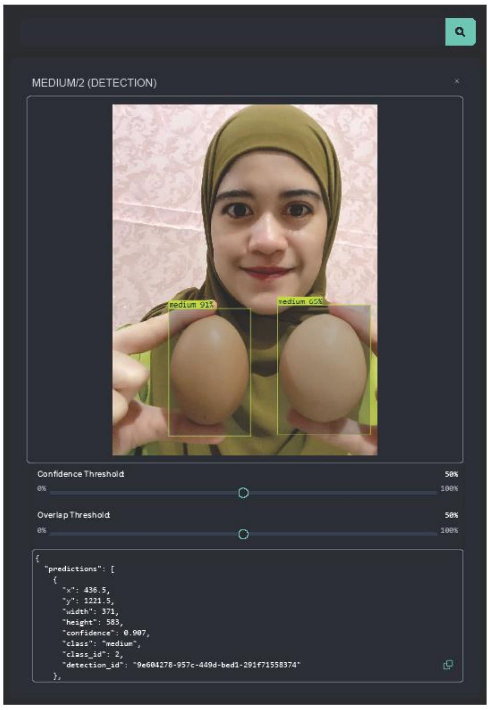

Figure 8. Testing Using the Yolov4 Algorithm with 2 Egg Objects

In Figure 8, the results of the system test can be seen using a trial with 2 egg objects. Where the results of the system test can detect all egg objects with a yellow color (medium size label). Furthermore, real-time testing is carried out using 3 egg objects as shown in Figure 9.

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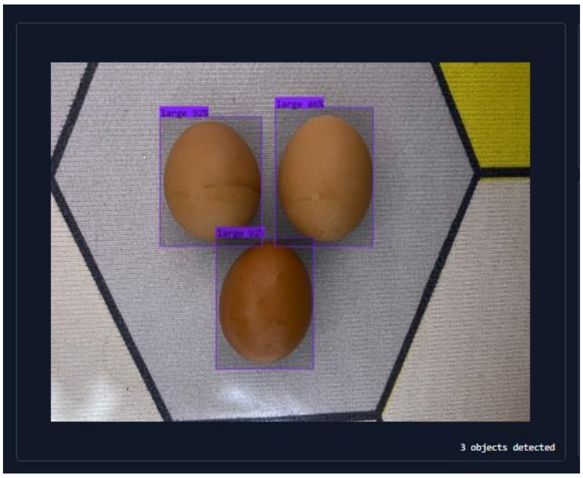

Figure 9. Testing Using the Yolov4 Algorithm with 3 Egg Objects

In Figure 8, the results of the system test can be seen using a trial with 3 egg objects. Where the results of the system test can detect all egg objects with blue color (large size label).

Figure 10. large size label

In Figure 10, the results of the system test can be seen using a trial with 3 egg objects. Where the results of the system test can detect all egg objects with purple color (jumbo size label).

DISCUSSION

The trials that have been conducted can be a reference for further research on the application of the Yolov4 algorithm in grouping the number of egg production in real time. The selection of the algorithm depends on the specific needs of the application to be built, such as speed, accuracy, complexity, and infrastructure factors. Through an in-depth evaluation that has been carried out on these factors, it can be used as a reference for the development of further research on the recognition of the number of egg production based on its size in real time.

CONCLUSION

The results of the research that has been conducted show that the Yolov4 algorithm can detect chicken eggs in real time and can recognize them without having to be based on light conditions, object angles, and attributes used properly. The level of accuracy or confidence value obtained from all trials conducted by the Yolov4 algorithm in grouping eggs based on an accuracy level of 84%. The use of the Yolov4 algorithm is highly recommended for use because the accuracy results are very good for grouping chicken egg sizes in real time. To get even better results in the future, it is highly recommended to increase the number of chicken egg samples to improve the best accuracy which

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will then be tested using deep learning with architectures such as MobileNetV2, VGG16 ADAM, ADAGRAD, and SGD, etc.

ACKNOWLEDGMENT

1. Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi who have provided assistance in the form of financial support.
2. University Islam Kebangsaan Indonesia who have provided motivational support and facilities

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