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Optimization of the YOLOv7 Object Detection Algorithm for Estimating the Amount of Apple Harvest

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ABSTRACT

The increasing population consumed in high production and food needs for survival. Apples are one of the crop harvest products in Indonesia whose needs are increasing, because they are not only needed for human vitamins but can be used as hand fruit or a form of gratitude to those who receive the fruit. In the process of harvesting apples in agricultural land, harvesting is often found which is not feasible in the hands of consumers because it takes too long for apples to not be harvested when the condition of the fruit is feasible in maturity. Therefore, the authors approach this problem by processing the image results obtained to form a detection model, whether the apples are said to be feasible to be harvested immediately and from the image results it can also be calculated the number of fruits captured by the image model, feature enhancements. If the MAP value is up to 0.95%, it can be interpreted that the architecture has a high level of accuracy. And object estimates on objects from this image model are expected to provide more timely harvest predictions in order to provide longer aging of apples and good fruit quality after reaching consumers.

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INTRODUCTION

The need for apples is not only for consuming vitamins, but can help children with special needs to maintain healthy teeth by chewing apples against Streptococcus bacteria attacks mutans in children. The need for apples is not only for consuming vitamins, but can help children with special needs to maintain healthy teeth by chewing apples against Streptococcus mutans in children (Wiyatini et al., 2016), can also be used to prevent asthma (Arifah & Aprilia, 2019). Business opportunities in SMEs can also be exploited by extracting apple cider for consumption by drinking (Dohitra et al., 2015). But as the population increases, the annual demand for agricultural food and agricultural products also increases. The experience of continuous rapid civilization in countries and cities around the world shows massive migration to cities, coupled with changes in the type of work most of the

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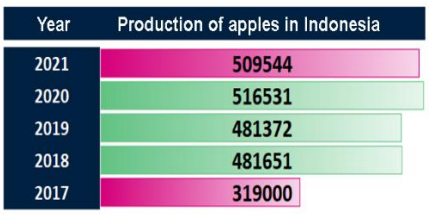
working people prefer to work in the non-agricultural sector. Therefore, high pressure is faced on production in the agricultural sector to meet food needs and industrial needs in the development of modern life. What often happens is that apples often have poor quality when they reach consumers, the impact can damage the image of producers due to bad delivery of apples. The results of the Central Bureau of Statistics also prove that the area of apple production is not evenly distributed throughout Indonesia, coupled with a decrease in the number of harvests, proving the need for evaluation and action so that apple production can increase again.

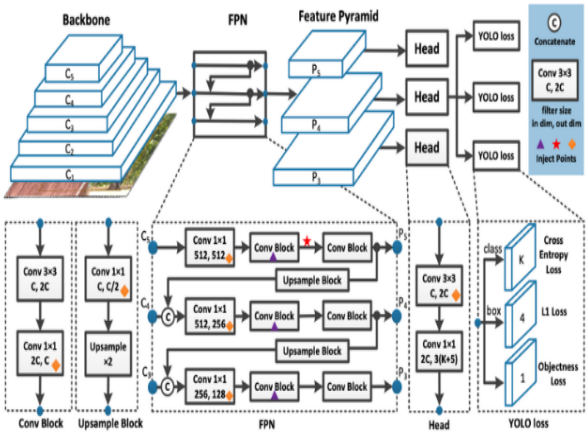
As the population increases, the annual demand for agricultural food and agricultural agricultural products also increases (Statistics, 2021.). The experience of continuous rapid civilization in countries and cities around the world shows massive migration to cities, coupled with changes in the type of work most of the working people prefer to work in the non-agricultural sector. Therefore, high pressure is faced on production in the agricultural sector to meet food needs and industrial needs in the development of modern life. What often happens is that apples often have poor quality when they reach the hands of consumers, the impact can damage the image of producers due to bad delivery of apples. Inefficient farming methods will further exacerbate the agricultural cycle which will lead to an increase in environmental burden and deviate from the concept of environmental protection. Generally apples can be harvested at the age of 4 to 5 months after the flowers bloom, but varietal and climatic factors affect harvest time. As in the rainy season and higher agricultural land can make apples last longer. Apples or in Latin Malus domestica is a type of fruit originating from western Asia that can live in subtropical climates. Apples can now be planted in Indonesia after this apple plant has been able to adapt to the Indonesian climate, namely the tropical climate. Apple cultivation in Indonesia began in 1934 and has grown rapidly since 1960 until now. Indonesian apples grow well in the highlands, especially the areas of Malang (Batu and Pongkoksumo) and Pasuruan (Nongkojajar) in East Java. Apples are classified in the Rosaceae family. The tree trunk grows to a height of 7-10 meters. Apple leaves are very similar to rose leaves. Oval with small spikes around the edges.



Source: (BPS, 2021)

Figure 1. Apple Production Graphic Info

Apples are best harvested when the plants reach a physiological maturity level (Ripening), which is the level at which apples have the ability to ripen normally after being harvested. The characteristics of the physiological maturity of apples include, the size of the apples looks maximal, the aroma of apples begins to be felt, and the color of the apples looks fresh and bright. Therefore, a technology related to object detection sensing is needed to predict harvest time for apples. uses an artificial intelligence system, especially deep learning and can be monitored early on with the *You only look once* (YOLO) algorithm, YOLO is one of the fastest object detection algorithms with good performance and high accuracy (Redmon et al., 2016).



Source: (Solawetz, 2022)

Figure 2. YOLO network architecture.

This method is very suitable for detecting objects in real time. That's why this method can be used to detect apples that are ready to be harvested before being sold to consumers. Until the release of the latest version where YOLOv7 outperformed all known object detectors in speed and accuracy in the range from 5 FPS to 160 FPS and had the highest accuracy of 56.8% AP among all known real time object detectors with 30 FPS or higher on GPU V100 (Wang et al., 2022).

RESEARCH METHOD

In this case, we started collecting datasets of apple image objects available on the site https://www.kaggle.com/datasets Kaggle is a site that supports various data publication formats, data formats that can be accessed on various platforms (Dataset Kaggle, 2022). with a total of 731 objects collected, then we filtered again manually and removed duplicate objects to produce 550 apple image objects, as can be seen in Figure 3. Testing of detected objects.

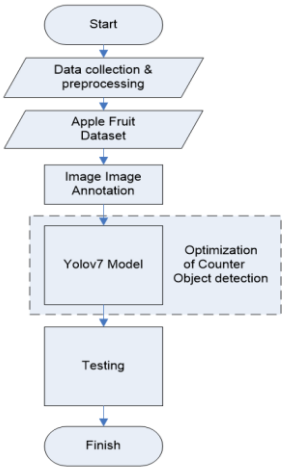


Figure 3. Apple Detect Object Optimization Flow

The image annotation stage or image object is labeled and the image size is resized. Image object labeling is the stage where each image in the dataset is labeled with the aim of storing image information. The label process is done by providing a bounding box along with the class name for each image object, roboflow service support makes the image annotation process more effective and efficient in data pre-processing so that a valid dataset can be built. Roboflow empowers developers to build applications for a user's computer regardless of skill or experience. This application provides all the necessary tools to convert raw images into specially trained computer vision models and deploy them for use in applications. Roboflow also supports object detection and classification models (Roboflow, 2022).

Source: (Roboflow, 2022)

Figure 4. Image object annotation process with roboflow

The next step is to resize the image to improve the performance of the YOLOv7 model in object recognition. Building a YOLOv7 Network configuration where network configuration is needed as a model to learn the data to be trained. The process of detecting objects by dividing the image into several grids, YOLO output feature maps produce bounding boxes, objective scores, and class scores (Riad et al., 2018). In this study, the authors used the Colab Pro application from Google with the specifications of the NVIDIA GPU CUDA A100-SXM4-40GB device with 40GB HBM2e memory as a medium for running the Yolov7 model algorithm.

RESULTS AND DISCUSSION

Based on the testing process that has been passed on a collection of apple image objects, then the image size is selected according to the size of 640x480 and a total of 550 image objects are obtained for pre-processing in the form of a bounding box, the prediction results obtained in the dataset process are formed using the Roboflow 2.0 Object Detection model, namely 94% mAP with a precision of 80.5%. The next stage is testing the two Datasets which have been tested by the Roboflow model through the YOLOv7 algorithm model which has been optimized with an object detection counter, the result is a 95% mAP with a precision level of up to 87%. This proves that the YOLOv7 model has an advantage in detecting apples.

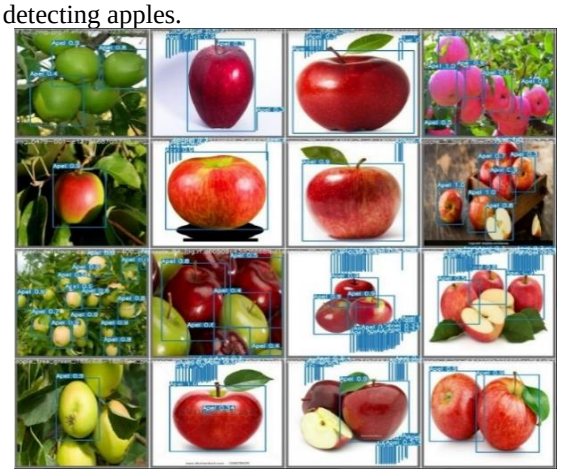


Figure 5. Data set detection results with the YOLOv7 model

Figure 6. Yolov7 Detection Object Optimization Results

From the results obtained, it can be interpreted that the architecture has a high level of accuracy in classifying and identifying test objects. A high mAP value indicates that the model is capable of producing accurate predictions for most of the objects in the dataset test.

CONCLUSION

The use of image objects on the kaggle.com website can help as a source of data processing for testing algorithm models, by using the R oboflow application in pre-processing with 95% maP results so from this data it can build and produce valid and feasible data sets for future development . Improvement of the YOLOv7 model by implementing a user Object Counter makes it easy to create an initial ranking system for harvesting apples.

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