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REAL-TIME EGGPLANT DISEASE DETECTION USING YOLO ALGORITHM AND TELEGRAM NOTIFICATIONS

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Article Info

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Abstract

The urgent need for enhancing agricultural production has been a critical focus due to agriculture's significance in providing food, supporting public health, and fostering the well-being of farmers. Among the crops cultivated year-round in Indonesia, eggplant stands out as a vital staple. However, persistent pest infestations, particularly by the Step nursery Pilchna sp., have hindered the full realization of eggplant's potential. Ideal eggplant growth conditions call for sandy loam soil with a pH range of 6.5-7, and a temperature range of 22-30˚C, making it suitable for cultivation during the dry season. Nevertheless, eggplant plants in Indonesia are under constant attack by polyphagous pests like the Beetle, which damages the lower epidermis of leaves, leaving them vulnerable to various pathogens from the Solanaceae family, causing diseases such as leaf spot, root neck rot, fruit rot, anthracnose, and bacterial wilt. To combat these issues effectively, an automatic classification system capable of recognizing leaves, fruit, and stems on eggplant plants based on recorded pest categories is essential. This research focuses on the implementation of a high-performance automatic classification system for pest-disease detection in eggplant plants. The system, executed on devices with graphical processing units, achieves real-time video stream processing with less than 25 ms latency per second and a significantly improved Mean Average Precision (MAP). The system's accuracy value for identification and calculation stands at an impressive 92.85%, with an inference time of 11.88 seconds for detecting one plant and 25.29 seconds for sending notifications. Further studies have shown an average classification accuracy of 99.25%, with an average bounding box detection of 74.57% and an average classification and detection speed of 0.911 seconds per image.

With this automated pest-disease detection system, eggplant farmers can promptly identify and address infestations, leading to faster and more accurate intervention measures, thereby ensuring better yields and reduced crop losses. The proposed system heralds a significant step towards sustainable and efficient agricultural practices, contributing to food security and economic prosperity.

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1. Introduction

Enhancement of production results in agriculture is an aspect which is very urgent because of effects agriculture is beneficial good as a source of food for support the health Public nor support income and well-being of Public farmers. Enhancement production agriculture in Indonesia, specifically eggplant, could materialize because eggplant is planted throughout the year; however, according to the government, eggplant, which could grow throughout the year, precisely beset pest Step nursery Pilchna sp. [1]. The ideal soil for growing eggplants is sandy loam with a pH of 6 .5 -7. Eggplant produces maximum at a temperature of 22-30˚C. This plant requires sufficient sunlight, so it is suitable for planting in the dry season [2]. Beetle Is one of the pests reported attacking eggplant plants in Indonesia. This insect is polyphagous and eats several plants from the Solanaceae family. Both larvae and maggots damage plants by eating the lower epidermis of the leaves and leaving the epidermis on the leaves [3]. Eggplant plants are very susceptible and can be infected with several pathogens that infect plants, for example, from the Solanaceae family. Several diseases that have been reported to attack eggplant in Indonesia include leaf spot, root neck rot, fruit rot, anthracnose, and bacterial wilt. Diseases in eggplant plants are generally caused by pests [4]. Classifying eggplant plants that are attacked by pests requires a system that can automatically recognize leaves, fruit, and stems on eggplant plants according to the pest categories that have been recorded. With automatic classification, pest disease detection is faster. In addition, it can be more accurate and efficient [5]. This method on devices that support graphical processing units can also process video streams in real-time with less than 25 ms per second latency and achieve more than double the Mean Average Precision (MAP) [6]. The results obtained in the previous study showed that the system was successfully implemented with an accuracy value of identification and calculation of 92.85%, and the inference time for detecting one plant was 11.88 seconds and for sending notifications was 25.29 seconds [7]. The results obtained from other studies show that the average classification accuracy value is 99.25%. The average bounding box detection is 74.57%, while the average classification and detection speed are 0.911 seconds per image.

2. Literature Review

Eggplant (Solanum Melongena L) bears fruit at the age of 55 days to 75 days after transplanting or 12 days to 15 days after the flowers bloom. Using a good system will produce a good harvest too. The system is a collection of elements that are interconnected to achieve certain goals. A system has parts that are connected to achieve a goal because the system cannot stand alone [9]. Android is a mobile operating system. The definition of the mobile itself is not staying in one place so that it is possible to move from place to place. Android is used for mobile devices which are currently popular on several smartphones in the world and Indonesia [10]. Application components are an important part of Android. Each component has a different function, and between components, one with the other is interconnected [11]. The hallmark of machine learning is that there is a process of training, learning, or training. Therefore, machine learning requires learning from data which is called training data. [12]. Artificial Neural Networks are made similar to the human brain, where neurons are connected to form a very complex network of neurons. Deep learning or deep structured learning or hierarchical learning or deep neural is a learning method that utilizes multiple non-linear transformations. Today, it is well known that deep learning can be viewed as a combination of machine learning and Artificial Intelligence (AI). [13].

You only look once is an algorithm designed to detect objects in real time. The detection system used is to use a reuse classifier or locator for detection. Models are applied to drawings in multiple locations and on a large scale. The areas with the highest scores in the image are considered detections. Before running the training process, you need to run the annotation process to form the dataset. All data has a class name, object x-coordinate, object y-coordinate, bounding box length, and bounding box width [14]. Globally informed predictions about the image. YOLO v4 implements a similar architecture to convolutional neural networks.

YOLO v4 uses only one convolution layer and one pooling layer. The final convolution layer is adjusted to the number of classes and prediction boxes needed [15]. For an illustration of object detection can be seen in Figure 1 below

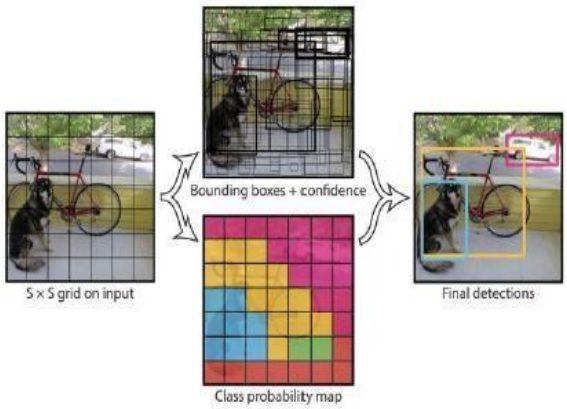

Fig 1. Illustrious YOLO

Raspberries pi is an SBC (single-board computer) the size of a credit card. Raspberries pi has been equipped with all the functions it deserves a computer complete, uses SOC (System-on-a-Chip) ARMS which is packed and integrated into PCBs (board circuits). Raspberries Pi this capable work like a computer generally with the ability for operating system operation Linux and applications such as Library Office, multimedia (audio and video), web browsers, or programming [16]. The process of taking pictures with a webcam is the same as the process of taking pictures with a regular digital camera. This is done by two types of optical sensors that operate differently: Charge Couple Device (CCD) and Complementary Metal Oxide Semiconductor (CMOS) [17]. Python is a general-purpose interpretation programming language with a design philosophy focused on code readability. Python aims to be a language that features a large and comprehensive standard library that combines skills and capabilities with very clear code syntax. Python is also supported by a large community. Python primarily supports multiple programming paradigms. However, it is not limited to object-oriented programming, imperative programming, or functional programming [18]. The Tensorflow framework was developed by the Google Brain Team in 2015 for numerical calculations and is now widely used by large companies for developing AI applications, such as image classification, word embedding, and chatbot development. Tensorflow provides an interface that can express ML algorithms and applications to execute algorithms. Tensorflow supports the modeling of Recurrent Neural Networks (RNN), Restricted Boltzmann Machine (RBM), Convolutional Neural Networks, and Dynamic Bayesian Networks (DBN), as well as parallel execution [19]. The name Tensorflow is based on how it tensors across the network. Tensorflow r is a multidimensional array type [20]. Python is a program created by a Dutch programmer named Guido Van Rossum [21]. Python is classified as a high-level programming language, but Python is designed in such a way that it is easy to learn and understand [22]. The advantages of this Python program are that it is easy to learn, can run programs with many complex functions in it easily, uses less code, and is even able to change programs. with a high level of complexity becomes easy[23]. However, python also has drawbacks, namely, it is quite slow to run, lacks support for Android and IOS, has limitations in database access, and is also not suitable for doing multi-core / multi-processor work [24].

3. Method

Making "Diagnosis of Diseases in Eggplant Plants Based on Telegram Notified Algorithm Yolo V4 " is to make a flowchart so that it can help make it easier to analyze and implement a system. The following is the shape of the flowchart that has been made shown in Figure 2 below :

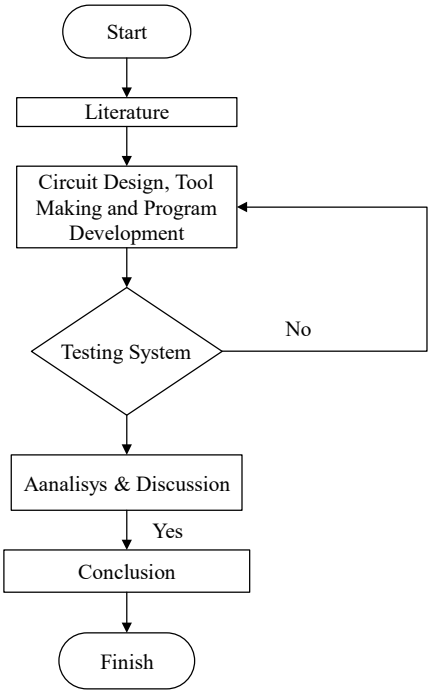

Fig 2. Research Flowchart

From the diagram flow could outline:

a. In the early stages of this research is a literature study, namely searching literature from the study before, that expected can share confidence if this research can be carried out and provide direction for reducing error in research.
b. The next stage is to design the circuit, namely the selection of components according to the design, and assembling of the components on the PCB.
c. After the design is complete, the next step is to design the software for the system needed with the Rasberry Pi. Compile the Python program, then design the tool after the circuit and software have been completed. The next step is to test the tool by testing the system with the Raspberry Pi module. System reading process. Data processing on Rasberry Pi. YOLO implementation. notifications to Telegram, and storing data into a database using internet media accessed via Telegram on an Android Smartphone. If the system cannot operate properly, it needs to be evaluated and analyzed what causes the failure of the system. Then after knowing the cause of the failure, improvements will be made to the Hardware and Software.
d. After the system operates properly, then we analyze the results of the system's work. Furthermore, data collection was carried out, namely, the method used by the author in this study, namely using You Only Look Once (YOLO), which is a method for object detection. An implementation of this idea is available on DARKNET (open-source neural network). The way YOLO works is by looking at the entire image once, then passing through the neural network once, it immediately detects an existing object. Therefore it is called YOLO (You Only Look Once). To detect objects besides YOLO, there are also other methods such as Faster RCNN and SSD, then data collection that will be measured later will be disease data on eggplant plants in the leaves, fruit, and stems. The data collection will be entered into the system to find out which parts of the plant are affected by diseases or pests. So that farmers can immediately take care of their plants.
e. After data collection has been carried out and the system detects it will operate properly, the research phase ends.

Disease Detection Tool System in Plants Before making a program, it is necessary to understand the working order of the tool which will make, so that the program can be sequentially by wants. The following are diagrams flow system on purpose.

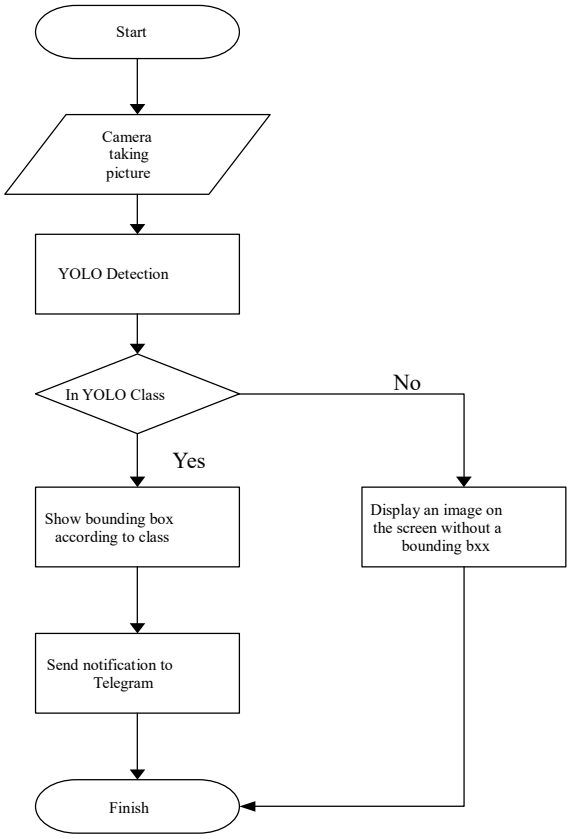

Fig 3. Flowchart of the YOLO v4 Work System

Flowchart of the working system of disease diagnostic tools in eggplant plants using the YOLOv4 algorithm above can be described as follows:

a. Open CV initiation functions as a real-time color image processing
b. Eggplant crop images are taken using a webcam. Furthermore, the captured images are entered into the RGB color image processing to find out which parts are affected by disease or pests.
c. YOLOv4 processing functions as a determinant of the results of color image processing. Where YOLO v4 processing determines whether a plant is diagnosed with a pest disease.

If the colors of the leaves, fruit, and stems are different from the color of the leaves, fruit, and stems in general which is healthy, the system will diagnose that the plant is affected by the disease and vice versa if the leaves, fruit, and stems are captured by the camera, the resulting color image will be given the result that the plants are healthy, whereas if the system gives the results the plants are affected by diseases or pests. Then the system will provide notifications on Smartphone Android using the Telegram application.

4. Result and Discussion

As explained at the time of data collection, the disease that often appears in the field is fruit rot caused by the attack of the fungus Phytophthora sp. There is a leaf beetle on each eggplant leaf. Not only 1 or even 3 beetles are found on 1 leaf, it's no wonder the beetles land because beetles like leaves so leaf beetles very often land on eggplant leaves and eat them. Then there are mealybug pests, mealybug pests that don't appear so often. And the vulnerable parts affected by mealybug pests on young leaves. This causes the fruit to germinate slowly. Due to the presence of obstacles from mealybug pests. The next step is to form a data set. This process is carried out by allocating the images that have been collected randomly into two groups, namely training data, and testing. To avoid an unbalanced dataset, each group contains the same number of images of diseased eggplant plants and healthy eggplant plants. The collection of datasets is the first step before YOLO is

implemented to identify the plant parts to be detected. The dataset collection can be done either by taking photos first or by downloading pictures from the internet. Here's the author's way of collecting datasets.

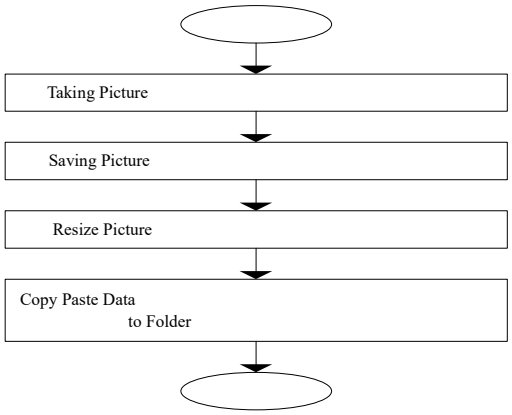

Fig 4. Flowchart for taking eggplant plant disease data

YOLOv4 can run and detect objects with 80 built-in classes that exist on the darknet. To be able to detect objects other than innate objects, training is carried out using a dataset consisting of image files of eggplant plant diseases in JPG form and three types a new class to distinguish types of eggplant plant diseases. For each type of disease, annotations rot fruit, beetle leaf, pestfleawhite, and spot leaf, Annotations are made on Python-based software, namely labeling. The training process is carried out on Google's cloud platform, namely Google Colab. Google Colab is Jupyter Notebook software that can be accessed online to run Python programs and the Linux kernel. At Google Colab, there is a GPU feature with specifications that need to be used in the training process, where the GPU is not on the Raspberry Pi 4. The training stage is cloning the darknet repository with git into the Google Colab virtual machine, creating a darknet build, configuring the YOLO-cf file for training, uploading the training dataset file to the VM via Google Drive, downloading the pretrained weight file, and finally perform YOLOv4 training with the dataset eggplant plant disease, which is called a custom object detector.

The results of the training are in the form of a custom. weight file which will be used to diagnose eggplant disease.

The results of eggplant disease testing using Yolo from functional testing and performance testing of the entire system that has been carried out and it can be seen to what extent the function and performance of the tool are running as expected.

The test was carried out by testing three eggplant conditions namely "healthy fruit", eggplant disease "leaf beetle", and "pod rot" conditions. Testing is carried out with the time parameter, calculating how long it takes the system to detect eggplant and display the output on the screen. Random testing was carried out to test the system response time when testing with Telegram output. When the command for detection is executed, the time needed by the system is calculated from the time the command is issued until the output appears on the Telegram notification.

Table 1 Fresh Fruit Testing

No.	Testing	Time	accuracy
1	1st test	65	76
2	2nd test	70	89
3	3rd test	75	90
4	4th test	82	91
5	5th test	73	92

6	6th test	72	88
7	7th test	69	87
8	Test 8	71	86
9	Test 9	72	85
10	10th test	74	84

The data above is a test with eggplant conditions, namely "healthy fruit". Testing is carried out with the time parameter, calculating how long it takes the system to detect eggplant and display the output on the screen. The following graph is generated on the conditions of the "Healthy Fruit" eggplant plant.

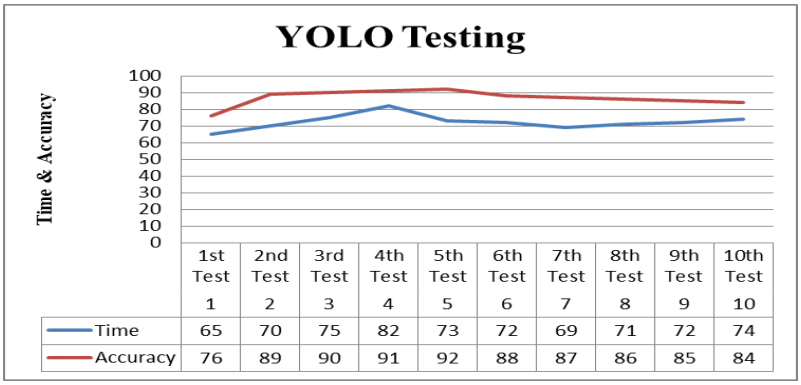

Fig 5. Graph of YOLO test for healthy fruit conditions

Conclusion

After conducting research on Diagnosing Diseases in Eggplant Plants Based on the Telegram Notified YOLO Algorithm, the following conclusions can be drawn:

1. The YOLO algorithm displays image detection results on eggplant plants according to the training data provided.
2. The data that has been trained will become a reference for the algorithm to decide whether the eggplant plant is affected by the disease or not.
3. The results of detection via the camera processed in the YOLO algorithm will be notified directly to the user's telegram.

References

E. Famati Saro Ndruru *et al.*, "Sistem Pakar Mendiagnosis Hama Dan Penyakit Tanaman Terong Berbasis Web," *Jurna Inf.*, vol. 5, no. 2, pp. 47–51, 2020.

D. A. N. Leunca, "IDENTIFIKASI DAN EVALUASI MUSUH ALAMI KUMBANG PEMAKAN DAUN (Henosepilachna sparsa) PADA TANAMAN TERUNG (Solanum melongena L .)," vol. 2, no. 1, pp. 10–20, 2015.

M. B. S. S.P, I. M. MP., and I. J. MP., "Respon Produktivitas Tanaman Terong Ungu (Solanum melongena L.) Terhadap Pemberian Pupuk Urea," *JINTAN J. Ilm. Pertan. Nas.*, vol. 1, no. 1, p. 1, 2021, doi: 10.30737/jintan.v1i1.1386.

W. Mey, S. J. Santoso, and K. Triyono, "ISSN (Print): 1693-0738 ISSN (Online): 2714-5549 Innofarm : Jurnal Inovasi Pertanian Vol . 23 (2), Oktober 2021 KAJIAN INSEKTISIDA NABATI TERHADAP HAMA KUTU PUTIH (Pseudococcus citriculus) PADA TANAMAN TERONG UNGU (Solanum melongena L .) ISSN (," vol. 23, no. 2, pp. 179–185, 2021.

A. R. Putri, "Pengolahan Citra Dengan Menggunakan Web Cam Pada Kendaraan Bergerak Di Jalan Raya," *JIPI (Jurnal Ilm. Penelit. dan Pembelajaran Inform.*, vol. 1, no. 01, pp. 1–6, 2016, doi: 10.29100/jipi.v1i01.18.

M. L. Nazilly, B. Rahmat, and E. Y. Puspaningrum, "Implementasi Algoritma Yolo (You Only Look Once) Untuk Deteksi Api," *J. Inform. dan Sist. Inf.*, vol. 1, no. 1, pp. 81–91, 2020, doi: 10.33087/jiubj.v22i3.2421.

F. Ramasari, F. Firdaus, S. Nita, and K. Kartika, "Penggunaan Metode You Only Look Once dalam Penentu Pindah Tanaman Cabai Besar Ternotifikasi Telegram," *Elektron J. Ilm.*, vol. 13, no. November, pp. 45–52, 2021, doi: 10.30630/eji.13.2.229.

H. K. Wicaksono, "Sistem Pakar Untuk Mendiagnosa Kerusakan Mesin Nissan Diesel MD92TB Dengan Implementasi Case Based Reasoning Berbasis Web," *J. Transit*, no. September, pp. 1–6, 2020.

L. Septiana, "Perancangan Sistem Pakar Diagnosa Penyakit Ispa Dengan Metode Certainty Factor Berbasis Android," *J. TECHNO Nusa Mandiri*, vol. XIII, no. 2, p. 89, 2016.

N. E. Raharjo and G. K. Pitaloka, "Pengembangan Media Pelajaran Berbasis Aplikasi Android Dengan Augmented Reality Untuk Mata Pelajaran Gambar Teknik Kelas X Kontruksi Gedung, Sanitasi Dan Perawatan Di Smk Negeri 1 Seyegan," *J. Pendidik. Tek. Sipil*, vol. 2, no. 1, pp. 65–77, 2020, doi: 10.21831/jpts.v2i1.31966.

A. Roihan, P. A. Sunarya, and A. S. Rafika, "Pemanfaatan Machine Learning dalam Berbagai Bidang: Review paper," *IJCIT (Indonesian J. Comput. Inf. Technol.*, vol. 5, no. 1, pp. 75–82, 2020, doi: 10.31294/ijcit.v5i1.7951.

A. Ahmad Hania, "Mengenal Artificial Intelligence, Machine Learning, & Deep Learning," *J. Teknol. Indones.*, vol. 1, no. June, pp. 1–6, 2017.

K. Kurniawan and L. Lina, "Pengenalan Produk Pada Rak Toko Menggunakan Metode You Only Look Once (Yolo) Dan Color Histogram," *J. Ilmu Komput. dan Sist. Inf.*, vol. 9, no. 2, p. 50, 2021, doi: 10.24912/jiksi.v9i2.13106.

A. N. Sugandi, B. Hartono, and K. Kunci, "Implementasi Pengolahan Citra pada Quadcopter untuk Deteksi Manusia Menggunakan Algoritma YOLO," pp. 13–14, 2022.

I. Maulana, "Implementasi Raspberry Pi 4 Sebagai Server," *J. Media Apl.*, vol. 13, 2021.

J. Ali, "SISTEM SECURITY WEBCAM DENGAN MENGGUNAKAN MICROSOFT VISUAL," vol. 1, no. 2, pp. 46–58, 2016.

D. N. Zuraidah, M. F. Apriyadi, A. R. Fatoni, M. Al Fatih, and Y. Amrozi, "Menelisik Platform Digital Dalam Teknologi Bahasa Pemrograman," *Teknois J. Ilm. Teknol. Inf. dan Sains*, vol. 11, no. 2, pp. 1–6, 2021, doi: 10.36350/jbs.v11i2.107.

N. Wiranda, H. S. Purba, and R. A. Sukmawati, "Survei Penggunaan Tensorflow pada Machine Learning untuk Identifikasi Ikan Kawasan Lahan Basah," *IJEIS (Indonesian J. Electron. Instrum. Syst.*, vol. 10, no. 2, p. 179, 2020, doi: 10.22146/ijeis.58315.

A. Parvat and S. Dev, “A Survey of Deep-learning Frameworks,” pp. 1–7, 2017.

M. Z. Andrekha and Y. Huda, “Deteksi Warna Manggis Menggunakan Pengolahan Citra dengan Opencv Python,” *Voteteknika (Vocational Tek. Elektron. dan Inform.*, vol. 9, no. 4, p. 27, 2021, doi: 10.24036/voteteknika.v9i4.114251.

Y. Rizkiya, “Bab II Landasan Teori,” *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2019.

M. Mahasin and I. A. Dewi, “Comparison of CSPDarkNet53, CSPResNeXt-50, and EfficientNet-B0 Backbones on YOLO V4 as Object Detector,” *Int. J. Eng. Sci. Inf. Technol.*, vol. 2, no. 3, pp. 64–72, 2022, doi: 10.52088/ijesty.v2i3.291.

R. Putri and R. Tiara, “Design and Development of a Coffee Bean Selector Using The Yolo Algorithm,” vol. 2, no. 4, pp. 84–89, 2022.