Smart Rice Disease Detection Based on Leaf Analysis Using the YOLO Algorithm with an Interactive User Interface

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Abstract—Rice is an important commodity for human life. The application of appropriate technology continues to be developed and researched as an effort to create food security. Indonesia is one of the largest rice producers but has not fully implemented agricultural technology. The lack of application of technology causes agricultural techniques to be still traditional. This causes the younger generation to be less interested in working as farmers. One of the challenges for novice farmers is how to handle plant diseases. This study aims to design a disease detection system so that it can be easier to handle. This plant detection uses a deep learning method with the YOLO V5 Algorithm. To obtain the best model, each YOLO V5 version was compared. The experimental results showed that the detection of healthy plants could be predicted better (0.99) than the other classes. Based on the predicted value, it means that the extra-large version is better (0.83) than the other versions. In addition, this study also designed the user interface with website application media. This website can be accessed via a laptop or smartphone so that its use is more effective and efficient. The user interface design is designed simply so that farmers and novices can easily learn and use it. With this research, it is hoped that rice production can be increased and one way to attract the interest of the younger generation.

Keywords— Disease, Rice, User Interface, YOLO

I. INTRODUCTION

Rice is one of the most important staple foods in the world [1], [2]. Rice is a source of energy and carbohydrates to carry out daily activities. In addition, rice also contains protein, vitamins, minerals, fat, and so forth [3], [4], [5]. This causes rice production to greatly affect the food security of a country. One of the world's largest rice producing countries is Indonesia. In 2022, based on the Indonesia Central Statistics Agency, rice production in Indonesia will reach 55.67 million tons of dry milled grain. This production increased by 2.31% from the previous year which reached 54.42 million tons of dry milled unhusked rice. Meanwhile, the total harvested area reached 10.61 million hectares. This harvested area increased 1.87% from the previous year which reached 10.41 million hectares [6]. Based on this data, rice production in Indonesia still has the potential to increase the area of harvested land and rice production.

But on the other hand, Indonesia is also one of the largest rice consuming country in the world [7], [8]. According to the Indonesia Ministry of Home Affairs, Indonesia's population in Semester I of 2022 will reach 275.77 million people. The total population is up 1.13% from 2021 [9]. This increase has caused rice production to become one of the government's focuses so that supply and demand can be met. As well as rice production is an important topic in development and research [10], [11]. A sustainable circular economic model is necessary to ensure a seamless integration of production and consumption. It also seeks to reduce waste and ensure a sustainable future for farmers, businesses, and households [12], [13].

One of the efforts to develop rice production is the application of appropriate technology that can be used from planting to distribution. The application of this technology aims to increase production and meet domestic rice needs and accelerate national food security [14]. The lack of use of technology makes agricultural techniques still traditional. This traditional farming is also one of the causes of the younger generation and woman being less interested in working as farmers [15], [16], [17]. This is because farming work becomes difficult because it requires a lot of energy, such as sowing, planting, plowing, irrigating and harvesting.

One of the beginner challenges in agriculture is how to control diseases in rice plants. Diseases in plants can cause crop failure of farmers. Identification of rice diseases traditionally can still cause subjective errors [18]. The application of technology that was being developed at that time used AI technology, Machine Learning, Computer vision, Deep Learning, and the Internet of things [19], [20], [21], [22]. Diseases in rice plants can be in the form of bacterial lead blight, false smut, rice hispa, blast, stemborer, sheath blight, brown spot, brown planthopper, and others [23], [24]. On the other side, the development of IoT technology also has an important role in the future of agriculture [25], [26], [27], [28]. With the presence of IoT technology in agriculture, it will make it easier for humans to monitor field conditions, collect data and predict future conditions.

In this study designed a technology that can overcome the problem of disease control in rice plants. The technology designed combines IoT and deep learning. This system will utilize a camera located on a laptop or smartphone electronic device. This camera is used to obtain input images from the user. The system can be used by farmers to detect and determine diseases in rice plants. The determination of disease in rice uses Deep Learning with the YOLO V5 Algorithm. This plant disease detection system is designed using a media website application as the user interface. This website application can be accessed via laptop or smartphone devices so that it can be used anywhere. After the system determines plant disease, the system will also provide recommendations for disease control or preventive measurements for the rice plant. With this system, it is hoped that the management of plant diseases will be more effective and efficient. The intended target users are farmers and people who are even beginners in using electronic devices. Therefore, the user interface is designed with a simple design. So that the user interface is easy to use, easy to learn, effective, efficient, and satisfying for the user.

II. RECENT STUDIES

Several studies have discussed the identification of diseases in rice plants. As in research [29] utilizing CNN and deep learning approaches to detect and classify diseases in rice. Diseases that are detected are Stem borer, Sheath Blight, Brow Spot and False Smut. This study uses a dataset of 1045 images as training data. This dataset was obtained using the KNN model. After conducting data training, the results obtained were 95% accuracy for healthy leaves, 89% for Stem Borer, 90% for Sheath Blight, 86% for Brown Spot, and 87% for False Smut.

On research [30] utilizing The You Only Look Once (YOLO) Algorithm to develop rice disease identification applications. Diseases detected are Blast and Brown Spot. This study uses a dataset of 200 images as training data. The application developed uses raspberry pi as the working environment of the system. When the application is run, the Raspberry pi provides image input via the camera and then images can be classified based on the results of the YOLO algorithm training. The results of this study are 90% accuracy for Blast, 70% for Brown Spot, 100% for unknown disease. The overall accuracy of the device is 73% and the error of commission is only 26%.

On research [31] build android application 'AgriCare' which is used to identify and detect rice plant diseases. Identification and detection of this disease using machine learning image processing techniques. Diseases detected are bacterial leaf blast, leaf scald, and false smut. Training uses the CNN model but there is no information regarding the number of datasets used. The test results show an accuracy of 99.48% and all diseases can be detected properly. The results page displays disease names, scientific names, and preventive measures.

Based on the literature study, the difference with research designed to identify diseases in rice is the deep learning method and the number of training datasets of 10,000 images. This research will try to compare YOLO V5 with the various versions provided. This data training is expected to increase the detection rate of rice diseases. In addition, the user interface is built using website applications so that it can be accessed via laptop or smartphone devices. The website page design is designed simply so that users can easily learn and use it.

III. METHODOLOGY

A. Methodology and Specification

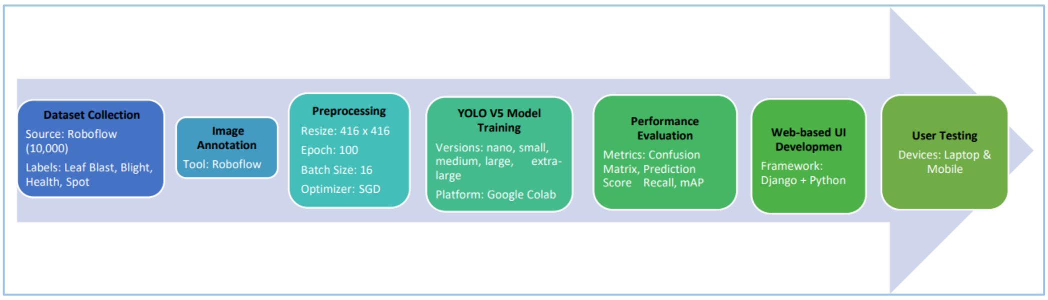


Figure 1. Research Methodology

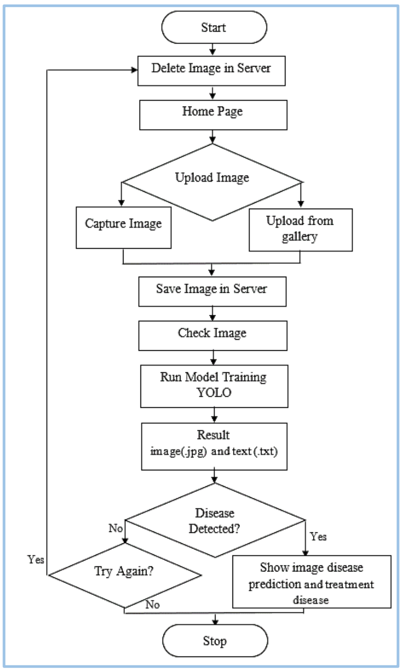
This methodology Figure 1, bridges deep learning and practical agricultural use, empowering farmers with a reliable and user-friendly tool for early rice disease detection. The integration of YOLO V5 with a web-based interface ensures the system is accurate, efficient, and accessible-helping enhance rice productivity and reduce crop loss due to diseases.

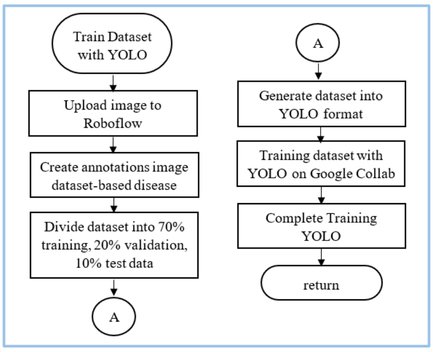
This study designed a disease detection method using the YOLO V5 Algorithm with several versions. This YOLO V5 version consists of nano, small, medium, large, and extra-large. Training data used to classify diseases into 4 categories namely Leaf Blast, Leaf Blight, Leaf Health, and Leaf Spot. User interface built using website applications.

The platform used for training uses Google Collab. The number of training datasets used is 10,000 images. The dataset is taken from [32] with some changes needed. In Roboflow it is also used as a medium for annotating images before dataset training. Input image size 416x416, epoch 100, batch size 16 and sigmoid optimizer.

B. System Flowchart

Figure 2 (b) explains the flowchart used to conduct data training using the YOLO V5 Algorithm and annotations using roboflow tools. Figure 2 (a) shows the main flow chart used in this study.





(b)

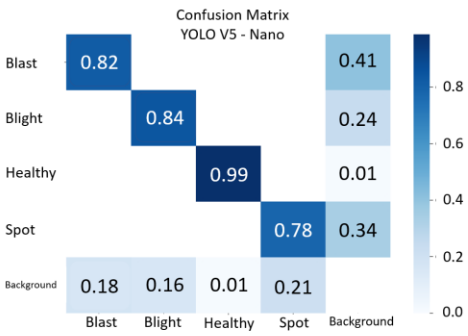
(a)

Figure 2. Flowchart: (a) Main and (b) Training Dataset

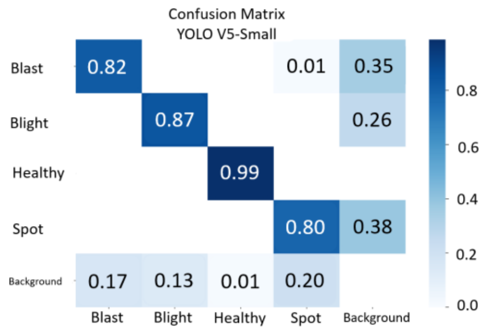
IV. RESULT AND ANALYSIS

A. Training Data

Figure 3 describes the results of the YOLO v5 training dataset based on each version to produce a confusion matrix. The use of the confusion matrix is a measurement of image classification performance for each disease class. In each column the confusion matrix represents the predicted value of each class. By comparing the YOLO V5 version, it can be concluded that the best predictive value is a leaf health image of 0.99 compared to the others.



(a)



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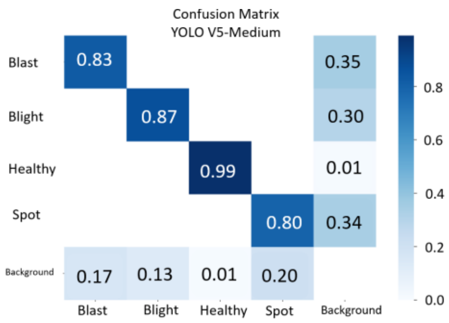

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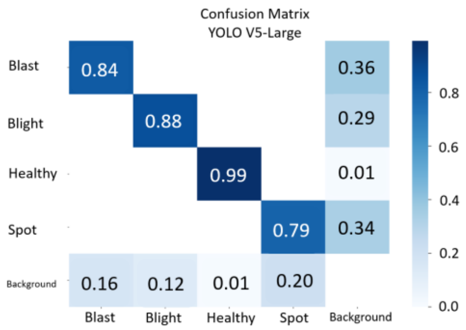

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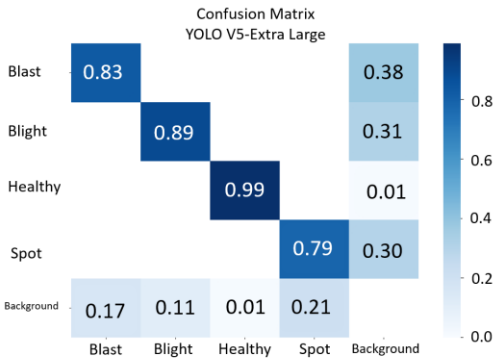


(e)

Figure 3. Confusion Matrix YOLO V5 (a). Nano, (b). Small, (c). Medium, (d). Large, (e). Extra Large

Figure 4 describes the disease class classification charts based on each version that has been done. Figure 4 (a) describes the prediction score graph, which illustrates the level of accuracy by comparing the testing data with the prediction results given by the model. Figure 4 (b) describes the recall (sensitivity) graph, which describes the model's success in retrieving information. So that recall is the ratio of true positive predictions compared to all data that is true positive. Figure 4 (c) describes the graph of the mean average prediction (mAP), which evaluates the robustness of object detection models.

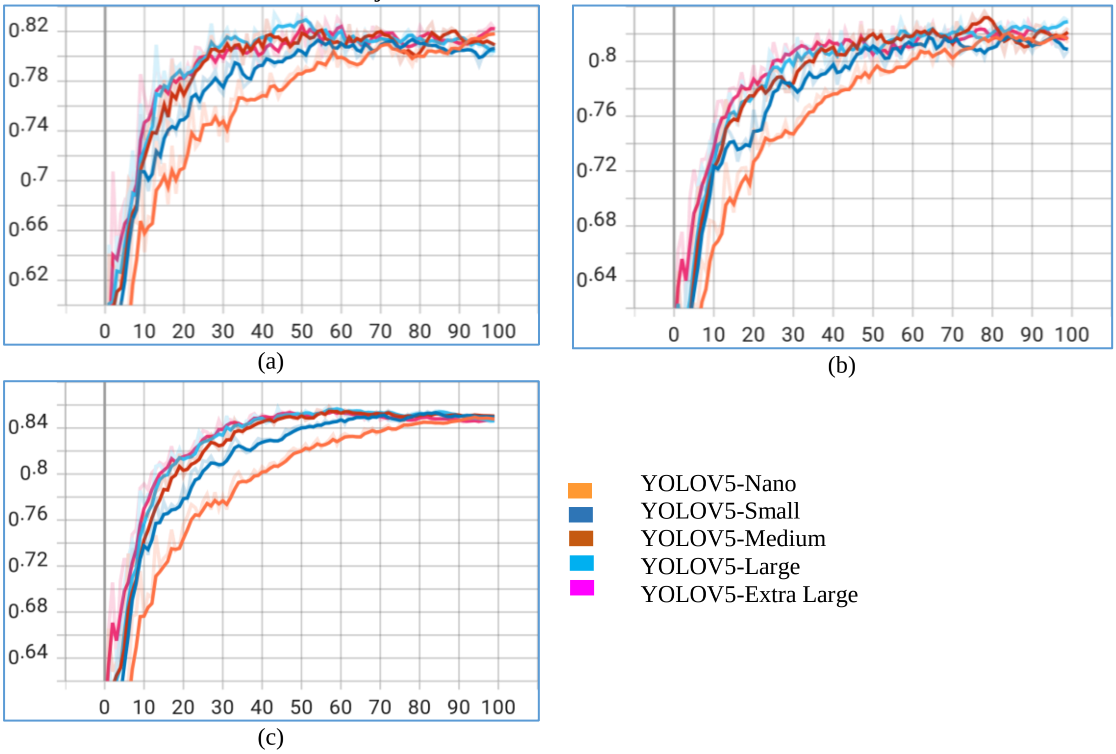


Figure 4. Result Graphic: (a) Prediction, (b) Recall, (c) mAP

To facilitate understanding regarding the results of the training dataset, the data is displayed in table form. Table 1 describes the YOLO V5 comparison results based on each version. From the comparison results it is known that based on the prediction value, the extra-large version is better (0.821) than the other versions. Based on the recall value, the large version is better (0.83) than the other versions. Based on the mAP value, the small and medium versions are better (0.85) than the other versions. The table also shows that the length of training and the model size are increasing from the nano version to the extra-large version. Figure 5 presents several examples of dataset testing results using the YOLO V5 model. The detection results show the model's ability to identify different conditions, including healthy leaves (confidence score: 0.94) and various rice diseases such as blight (0.81), brown spot (0.72 and 0.43), and blast (0.74, 0.30, and 0.29). These results demonstrate the model's effectiveness in detecting multiple diseases with varying confidence levels, highlighting its potential for automated plant disease recognition in rice.

Table 1. Result Comparison YOLO V5

Parameter	YOLO V 5				
	Nano	Small	Medium	Large	Extra Large
Prediction	0,82	0,807	0,806	0,804	0,821
Recall	0,819	0,808	0,824	0,83	0,816
mAP	0,849	0,85	0,85	0,846	0,847
Time Training	1,34 hours	1,349 hours	1,636 hours	1,943 hours	2,365 hours
Model Size (MP)	3,8	14,3	42,1	92,8	173,1

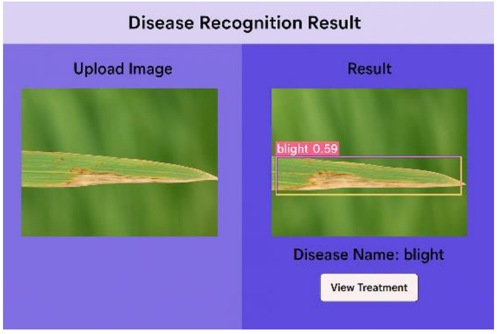
Figure 5. Example Testing model YOLO V5

B. User Interface

Figure 6 shows the results of implementation website application pages. This page is designed and developed using the Django framework with the Python programming language. Figure 6 (a) shows the implemented homepage of the Tani Pintar web-based plant disease detection system. It runs on a local server (192.168.0.166:5000) and features a simple interface with a welcome message, logo, and a "Start Detection" button. This interface allows users to begin the process of uploading and analyzing plant images for disease detection. The system is fully functional and accessible via web browsers, supporting practical use in the field. Figure 6 (b) shows the implementation result of a web-based system for plant image detection. The interface allows users to upload an image of a plant using the "Choose file" and "UPLOAD" buttons. After uploading, users can click the "DETECT" button to process the image. The interface is divided into two sections: one for uploading images and the other for displaying detection results, providing a simple and user-friendly layout for plant health analysis. Figure 6 (c) shows the implementation result of the disease recognition feature in the developed system. The interface displays the uploaded image of the plant on the left and the detection result on the right, highlighting the identified disease ("blight") with a confidence score of 0.59. The system also provides the disease name and a "View Treatment" button to guide users in accessing relevant treatment information. Figure 6 (d) shows the implementation result of the disease control information module. The interface provides the disease name (Bacterial Leaf Blight or Bacterial Leaf Streak Disease), along with key information on causes and conditions that promote its spread. It also presents recommended control measures, including the use of resistant varieties, proper fertilization, and water management. Additionally, the interface details symptoms for both leaf blight and leaf streak and lists direct control methods such as fertilizer application and targeted chemical treatments to help manage the disease effectively.

(a)

(b)



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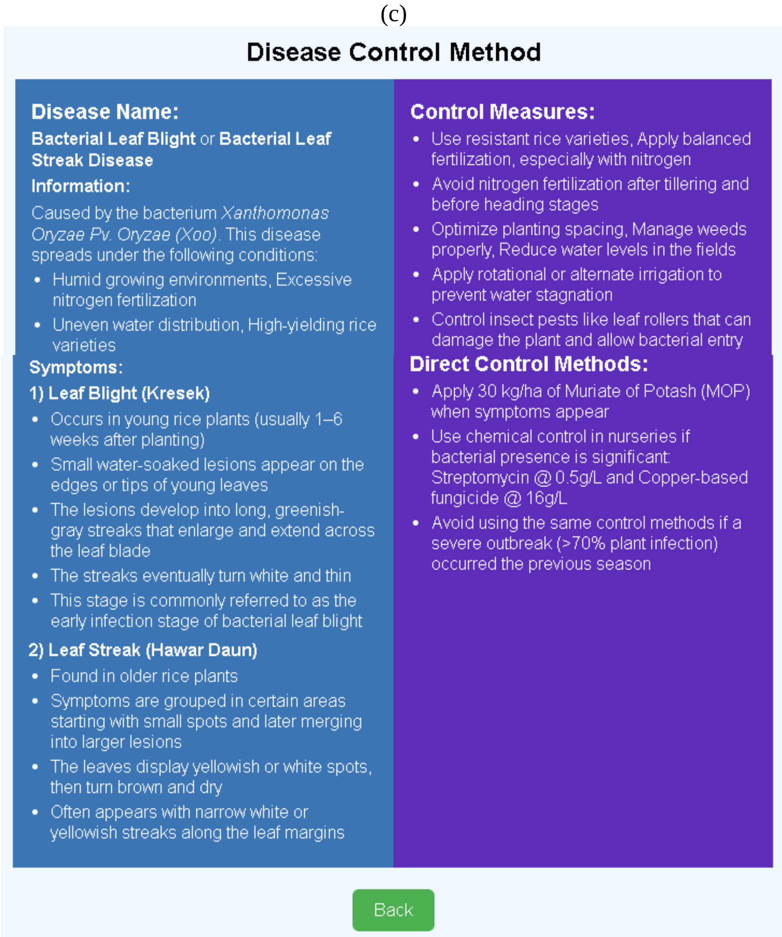

(d)

Figure 6. Implementation User Interface: (a). Homepage, (b) Upload Image Page, (c). Result Page, (d). Suggestion Page

V. CONCLUSION

From the research conducted, it can be concluded that the YOLO V5 are effective in predicting plant diseases in rice. Based on the confusion matrix, each version demonstrates superior performance in identifying healthy leaves with a prediction rate of 0.99 compared to other classes. In addition, YOLO V5 is capable of achieving more than 80% accuracy, with the extra-large version providing the best performance at 82% prediction accuracy. Furthermore, the YOLO V5 model can be seamlessly integrated with website applications, enabling users to conveniently interact with the rice disease prediction system through laptops and smartphones for more effective and efficient usage. The user interface of the website is designed to be simple and user-friendly, allowing farmers to quickly understand and utilize the system. This feature is expected to support farmers in managing rice diseases effectively, thereby contributing to improved agricultural productivity.

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