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Applications for Detecting Plant Diseases Based on Artificial Intelligence

Bita Parga Zen[1)*], Iqsyahiro Kresna A[2)], Diandra Chika Fransisca[3)]
[1)2)3)]Informatics Engineering Departement, Telkom Institute of Technology Purwokerto
[1)]bita@ittelkom-pwt.ac.id, [2)]hiro@ittelkom-pwt.ac.id, [3)]diandra@ittelkom-pwt.ac.id

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Abstract: Agriculture is an activity to manage biological natural resources with the help of technology and labor. The presence of diseases in plants that suddenly inhibit plant growth is alarming to farmers. So, farmers cannot determine what conditions these plants suffer. This study will discuss the implementation of Artificial Intelligence-based plant disease detection software. At this stage, deep learning models are created using cameras matched with objects. The application development is to detect diseases in plants. The fourth step is testing. This application includes the implementation of Convolutional Neural Network and Recurrent Neural Network, which provides Artificial Intelligence architecture to diagnose plant diseases, and offer solutions to those plants from the results of research with tomato plant sample tests obtained four categories of disease Early Blight disease with a prediction of 100%, Bacterial Spots 90%, Healthy 100%, Late Blight 100% a system that can recommend health care related to crops based on images so that it can help farmers identify types of plant diseases. This application can help farmers to reduce crop failure for farmers caused by plant diseases to improve the quality of agricultural and plantation products

Keywords: Software, Plant diseases, Artificial Intelligence (AI), Detection systems

INTRODUCTION

The agricultural industry is one of the biggest economic factors that have the most influence on economic growth in Indonesia. (Halim 2020) The urgency of research in this study is the lack of new and old generations who are farmers and are technology literate. In Indonesia, more than 20% of farmers are over 60 years old, and only less than 10% of farmers are from the younger generation under 25 years old (Bappenas RI 2020) As a result, in 2016/2017, there were crop failures based on plant-disturbing organisms by 12% for stem borers, 27% for blasts, and 4% for BLB and increasing by an average of 6% annually (BPPOT 2018) With very fertile soil conditions, Sijeruk Village also has potential for fruit crops with a plantation area of 119 827 hectares. One of them is the salak fruit, with an average production of 150 tons per year, while the type of banana produces an average of 5 tons per year. (BPS 2020) However, when farming rice and salak, which are the main commodities of the village community there, sometimes they cannot know what type of disease the plant suffers from, so farmers experience losses which of course have an impact on the economy.

From the existing problems, not only can disease reduce agricultural productivity, but the lack of new generations to serve as successors also has an impact on agricultural productivity in Indonesia. (Effendy, Widyaastuti, and Lastri 2022). Therefore, a disease detection application in plants is needed to overcome the problem of detecting disease in plants. (Harahap et al. 2021), pada aplikasi ini sudah memuat implementasi Convolutional Neural Network dan Recurrent Neural Network dengan memanfaatkan library yang ada pada Tensorflow js (Park and Lee 2020). The specific purpose of this application is to diagnose plant diseases, provide solutions for diseased plants, and provide a healthcare recommendation system related to plants based on images on leaves. The target users for this application are farmers in Sijeruk Village, Banjarnegara Regency, whose plants are affected by the disease.

LITERATURE REVIEW

Currently, the risk to the global economy has shifted from a food crisis and a pandemic to potential energy and financial crisis. The Indonesian government will continue to maintain that domestic economic performance continues to strengthen even in the midst of various global challenges (Fawzi and Husna 2021) In the development of website applications, there is a framework that is used as the basic structure of program code. A

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framework is a program structure that makes it easier for programmers to create an application so that it will be easier for programmers to make changes (Utami, Zen, and Rauna 2021)

To support research on the application of researchers using the Laravel framework, Laravel is a PHP based web-framework for building high-end web applications using its significant and graceful syntaxes (Kausar Bagwan and Swati Ghule 2019) In laravel there is a routing that bridges between requests from users and controllers (Sinha 2019) that the Laravel framework is preferable for large-scale Web projects that require faster delivery with fewer resources (Laaziri et al. 2019) Use case is a model for the behavior of the actor to the information system to be made (Pritoni et al. 2021) Use case describes an interaction between one or more actors and the information system that will be created, so that it can be seen how the influence of an actor on the system being developed (Loucopoulos, Kavakli, and Mascolo 2022) Database Management System (DBMS) is a software that is used to help maintain and utilize large collections of data and information (Alvarez and Ayala 2022) MySQL is a DBMS software that is fast and easy to use so that it can be used for various needs (Ongo and Kusuma 2018) This software can be used to manage data quickly and flexibly (Ariandi, Hadi, and Lusinia 2022)

MobileNetV2 is a development model of MobileNetV1, in the image classification experiment using ImageNet, MobileNetV2 shows better accuracy results than MobileNetV1 with fewer parameters (Xiang et al. 2019) In MobileNetV2, there are two types of blocks, residual obstructions with stride one and with stride 2; the two blocks are arranged to form the MobileNetV2 architecture. Based on the MobileNetV2 hardware library, consists of 155 layers which are divided into 16 blocks (Sandler et al. 2018). Furthermore, Python is an interpretive programming language with object-oriented and dynamic semantics using Python. Python has high-level data structures, dynamic typing, and dynamic binding Furthermore, Python is an interpretive programming language with object-oriented and dynamic semantics using Python. Python has high-level data structures, dynamic typing, and dynamic binding (Nagpal and Gabrani 2019)

Smalltalk is an object-oriented programming language developed by Xerox PARC. The basic idea of Smalltalk includes all are objects, objects can communicate with each other through messages or news (Broman 2021). Tensorflow.js is a library built on top of deeplearn.js to create deep learning modules right from the web browser! Deep learning is a branch of machine learning and artificial intelligence. With Tensorflow.js, we can implement Convolutional Neural networks, Recurrent Neural networks, and so on (Arvanitis 2021).

METHOD

In this architectural drawing, there are several stages of research carried out on the application consisting of the Client being able to register, changing passwords, logging in, and also predicting diseases in plants. Login Users can log in by entering their email and user password. Change Password can change the password; the system will send a token to the user an email to confirm the user wants to change the password. When the appropriate token is, then the user can change the password. After the user successfully enters the application, the user will be faced with a dashboard; on this page, the user can see a list of plants and diseases that this application can diagnose later. This application can also predict disease by uploading photos of plants affected by the disease and getting predictions or diagnosis results in real-time.

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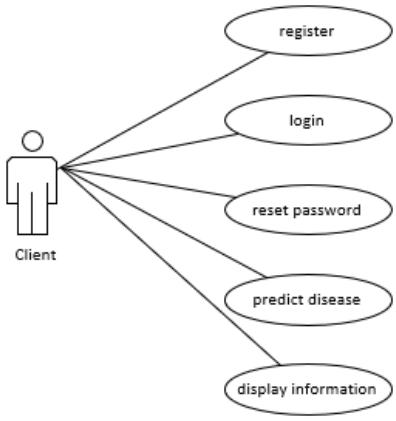

Figure 1. Usecase Diagram for Client

Figure 2 depicts the specifics of architectural design. The user's input data may be accepted by the input module. The user enters data using a webcam image, but the input data can either be saved as files or take the form of live images produced by a camera device. The type of plant that contracts the illness is then determined by data input, which is subsequently modified and stored on the server. Pre-processing of the input data can be done by the input module to make it suitable for teaching the learning JavaScript code.

By selecting one of the system's suggestions, which include well-known models like the Convolutional Neural Network (CNN) and the Recurrent Neural Network, a user can select a neural network model for the learning module (RNN). The JavaScript Tensorflow.js library provides a number of useful methods that a user can use to create their own neural network. The Learning Module begins learning from the labeled input data placed in the Data Storage Module of the Web once the neural network model to be used has been chosen.

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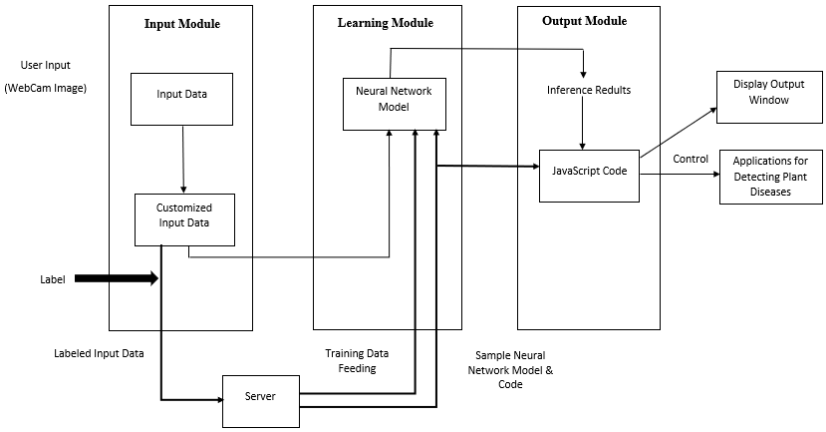

Figure 2. Functional Architecture

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In this section, each researcher expected to be able to make the most recent contribution related to the solution to the existing problems. Researchers can also use images, diagrams, and flowcharts to explain the solutions to these problems.

RESULT

In this study, researchers used tomato leaves as a test for types of diseases such as Bacterial Spot, Early Blight, Healthy, Late Blight, Septoria Leaf Spot, Spider mites, Target Spot, Tomato Mosaic Virus, Tomato Yellow Leaf Curl Virus, by including examples of plant species included in the application, for more details can be seen in the picture.

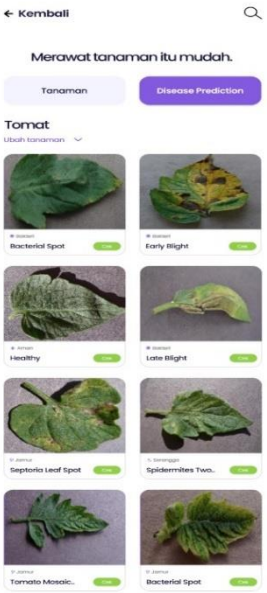

Figure 3. Types of Diseases on Tomato Leaves

Furthermore, in the menu below, there is a start menu option to take pictures of plants that are predicted to have the disease; the display can be seen in the image below. Furthermore, the user can focus on the condition on the toman plant and take photos to display the image can be seen in the image below.:

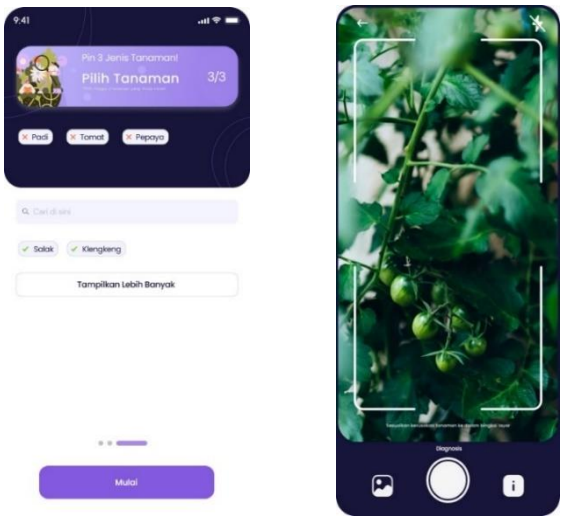

Figure 4. Camera View on system

In the first experiment, when you have taken a photo or taken a sample on tomato leaves, then the system can predict the type of disease in tomato plants then there is a description; in this case, the researcher experimented

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on tomato plants that have Early Blight disease with a prediction of 100%, Early Blight is a disease Tomatoes are potentially destructive, infecting leaves, stems, and fruit of tomatoes. This disease can lead to total crop failure if left untreated.

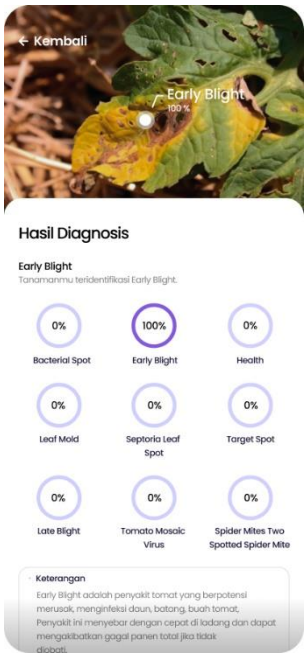

Figure 5. Display on a system with Early Blight diagnosis

In the second experiment, conducting samples of disease on tomato plants suspected of being infected with Bacterial Spot disease, when analyzed by taking photos, it was found that 90% were identified as Bacterial Spots and 10% as Health. Bacterial spot disease due to bacterial spots can become a deadly disease when the weather is warm and humid. Display on a system with Early Blight diagnosis

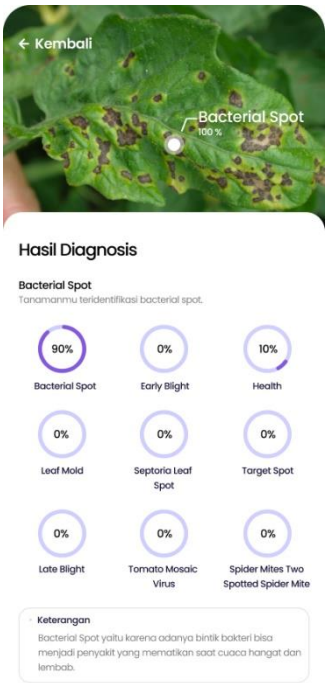

Figure 6. Display on system with Bacterial Spot diagnosis

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In the experiment in Figure 7, the results of the leaves photographed are 100% healthy, no disease has been identified, seen from the plants that do not have symptoms of disease on tomato leaves

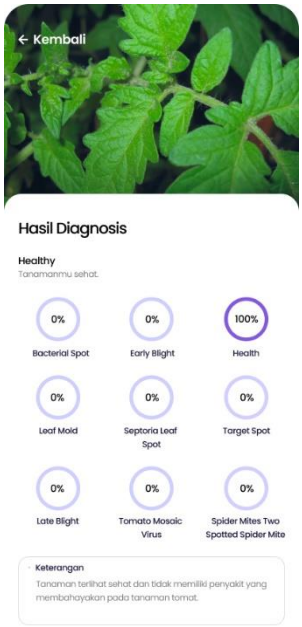

Figure 7. Display on system with Health diagnosis

In the experiment in Figure 8, the leaves that were photographed detected late blight 100%; late blight is a tomato disease that has the potential to damage, and infect leaves, stems, and tomatoes, this disease spreads quickly in the field and can cause total crop failure if not treated.

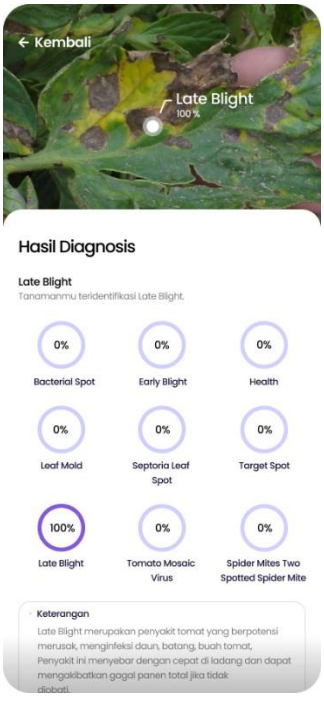

Figure 8. Display on system with Late Blight diagnosis

In the picture below, the display of images allows for the types of pests on tomato plants such as armyworms, leaf miners, leaf caterpillars, sucking insects, black leaf caterpillars, fruit flies, and grasshoppers, but this display only displays images but not explain in more detail

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Figure 9. Display Pest Type

Table 1. Disease Identification Tests on Tomato Plants

No	Types of Diseases on Leaves	Disease Identification Results	Application Results
1	Bacterial Spot	Identified Bacterial Spot 90% Health 10%	Success
2	Early Blight	Identified Early Blight 100%	Success
3	Healthy	Identified Healthy 100%	Success
4	Late Blight	Identified Late Blight 100%	Success
5	Septoria Leaf Spot	Identified Septoria Leaf Spot 100%	Success
6	Spider mites	Identified Spider mites 95% Health 5%	Success
7	Target Spot	Identified Target Spot 100%	Success
8	Tomato Mosaic Virus	Identified Tomato Mosaic Virus 100%	Success
9	Tomato Yellow Leaf Curl Virus	Identified Tomato Yellow Leaf Curl Virus 100%	Success

DISCUSSIONS

With the Application including the Convolutional Neural Network (CNN) and Recurrent Neural Network models, this system can choose a neural network model for the learning module (RNN). In this Application the researcher uses From the results of research using samples of disease on tomato leaves; researchers use tomato leaves as a test for the type of disease Bacterial Spot, Early Blight, Healthy, Late Blight, Septoria Leaf Spot, Spidermites, Target Spot, Tomato Mosaic Virus, Tomato Yellow Leaf Curl. The virus has fairly good accuracy, with a presentation of 90% to 100% accuracy seen from experiments on the camera with four shots, and the fourth one is accurate, as, in the first shooting experiment, the tomato leaf sample test had Early Blight disease with a prediction of 100% accuracy. The second experiment carried out disease samples on tomato plants suspected of being infected with Bacterial Spot disease with an accuracy level of predicting 90% identified Bacterial Spot and 10% Health; the third experiment with photo shoots of leaves that were photographed healthy 100% not identified any disease, In the last subsequent investigation photographed leaves detected late flash 100%

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CONCLUSION

This application has been successfully built using MobileNetV2 with Tensorflow.js and can run image training data and multiple validation data. The model can classify the tested images well, namely Bacterial Spot, Early Blight, Healthy, Late Blight, Septoria Leaf Spot, Spider mites, Target Spot, Tomato Mosaic Virus, and Tomato Yellow Leaf Curl, with each of four camera portrait samples having an accuracy of 90% to 100% depending on the type of disease, this research needs further research so that more types of plant diseases can be predicted

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Applications for Detecting Plant Diseases Based on Artificial Intelligence

By Bita Parga Zen

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[1)2)3)]Informatics Engineering Departement, Telkom Institute of Technology Purwokerto
[1)]bita@ittelkom-pwt.ac.id, [2)]hiro@ittelkom-pwt.ac.id, [3)]diandra@ittelkom-pwt.ac.id

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framework is a program structure that makes it easier for programmers to create an application so that it will be easier for programmers to make changes (Utami, Zen, and Rauna 2021)

To support research on the application of researchers using the Laravel framework, Laravel is a PHP based web-framework for building high-end web applications using its significant and graceful syntaxes (Kausar Bagwan and Swati Ghu 2019) In laravel there is a routing that bridges between requests from users and controllers (Sinha 2019) that the Laravel framework is preferable for large-scale Web projects that require faster delivery with fewer resources (Laaziri et al. 2019) Use case is a model for the behavior of the actor to the information system to be made (Pritoni et al. 2021) Use case describes an interaction between one or more actors and the information system that will be created, so that it can be seen how the influence of an actor on the system being developed (Loucopoulos, Kavakli, and Mascolo 2022) Database Management System (DBMS) is a software that is used to help maintain and utilize large collections of data and information (Alvarez and Ayala 2022) MySQL is a DBMS software that is fast and easy to use so that it can be used for various needs (Ongo and Kusuma 2018) This software can be used to manage data quickly and flexibly (Ariandi, Hadi, and Lusinia 2022)

MobileNetV2 is a development model of MobileNetV1, in the image classification experiment using ImageNet, MobileNetV2 shows better accuracy results than MobileNetV1 with fewer parameters (Xiang et al. 2019) In MobileNetV2, there are two types of blocks, residual obstructions with stride one and with stride 2; the two blocks are arranged to form the MobileNetV2 architecture. Based on the MobileNetV2 hardware library, consists of 155 layers which are divided into 16 blocks (Sandler et al. 2018). Furthermore, Python is an interpretive programming language with object-oriented and dynamic semantics using Python. Python has high-level data structures, dynamic typing, and dynamic binding Furthermore, Python is an interpretive programming language with object-oriented and dynamic semantics using Python. Python has high-level data structures, dynamic typing, and dynamic binding (Nagpal and Gabrani 2019)

Smalltalk is an object-oriented programming language developed by Xerox PARC. The basic idea of Smalltalk includes all are objects, objects can communicate with each other through messages or news (Broman 2021). Tensorflow.js is a library built on top of deeplearn.js to create deep learning modules right from the web browser! Deep learning is a branch of machine learning and artificial intelligence. With Tensorflow.js, we can implement Convolutional Neural networks, Recurrent Neural networks, and so on (Arvanitis 2021).

METHOD

In this architectural drawing, there are several stages of research carried out on the application consisting of the Client being able to register, changing passwords, logging in, and also predicting diseases in plants. Login Users can log in by entering their email and user password. Change Password can change the password; the system will send a token to the user an email to confirm the user wants to change the password. When the appropriate token is, then the user can change the password. After the user successfully enters the application, the user will be faced with a dashboard; on this page, the user can see a list of plants and diseases that this application can diagnose later. This application can also predict disease by uploading photos of plants affected by the disease and getting predictions or diagnosis results in real-time.

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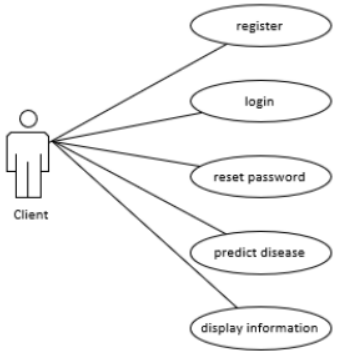

Figure 1. Usecase Diagram for Client

Figure 2 depicts the specifics of architectural design. The user's input data may be accepted by the input module. The user enters data using a webcam image, but the input data can either be saved as files or take the form of live images produced by a camera device. The type of plant that contracts the illness is then determined by data input, which is subsequently modified and stored on the server. Pre-processing of the input data can be done by the input module to make it suitable for teaching the learning JavaScript code.

By selecting one of the system's suggestions, which include well-known models like the Convolutional Neural Network (CNN) and the Recurrent Neural Network, a user can select a neural network model for the learning module (RNN). The JavaScript Tensorflow.js library provides a number of useful methods that a user can use to create their own neural network. The Learning Module begins learning from the labeled input data placed in the Data Storage Module of the Web once the neural network model to be used has been chosen.

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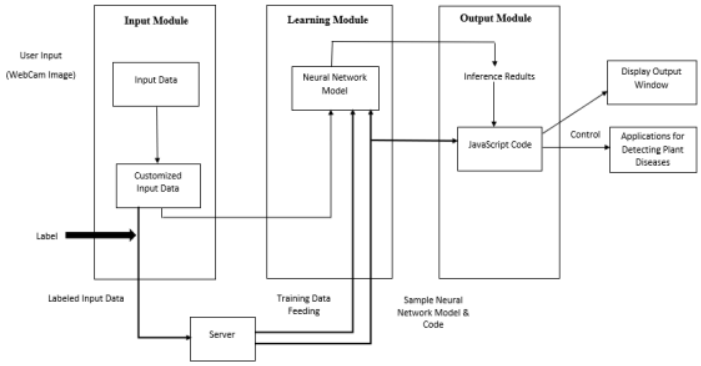

Figure 2. Functional Architecture

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In this section, each researcher expected to be able to make the most recent contribution related to the solution to the existing problems. Researchers can also use images, diagrams, and flowcharts to explain the solutions to these problems.

RESULT

In this study, researchers used tomato leaves as a test for types of diseases such as Bacterial Spot, Early Blight, Healthy, Late Blight, Septoria Leaf Spot, Spider mites, Target Spot, Tomato Mosaic Virus, Tomato Yellow Leaf Curl Virus, by including examples of plant species included in the application, for more details can be seen in the picture.

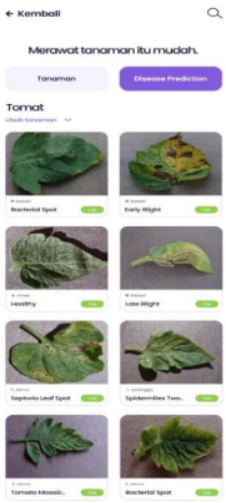

Figure 3. Types of Diseases on Tomato Leaves

Furthermore, in the menu below, there is a start menu option to take pictures of plants that are predicted to have the disease; the display can be seen in the image below. Furthermore, the user can focus on the condition on the toman plant and take photos to display the image can be seen in the image below.:

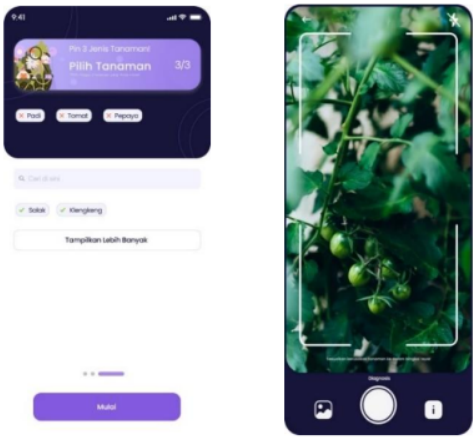

Figure 4. Camera View on system

In the first experiment, when you have taken a photo or taken a sample on tomato leaves, then the system can predict the type of disease in tomato plants then there is a description; in this case, the researcher experimented

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on tomato plants that have Early Blight disease with a prediction of 100%, Early Blight is a disease Tomatoes are potentially destructive, infecting leaves, stems, and fruit of tomatoes. This disease can lead to total crop failure if left untreated.

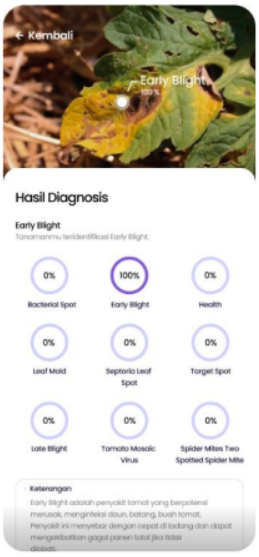

Figure 5. Display on a system with Early Blight diagnosis

In the second experiment, conducting samples of disease on tomato plants suspected of being infected with Bacterial Spot disease, when analyzed by taking photos, it was found that 90% were identified as Bacterial Spots and 10% as Health. Bacterial spot disease due to bacterial spots can become a deadly disease when the weather is warm and humid. Display on a system with Early Blight diagnosis

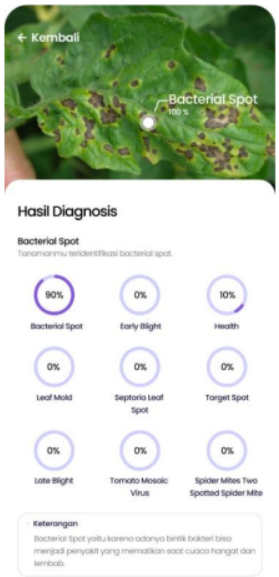

Figure 6. Display on system with Bacterial Spot diagnosis

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In the experiment in Figure 7, the results of the leaves photographed are 100% healthy, no disease has been identified, seen from the plants that do not have symptoms of disease on tomato leaves

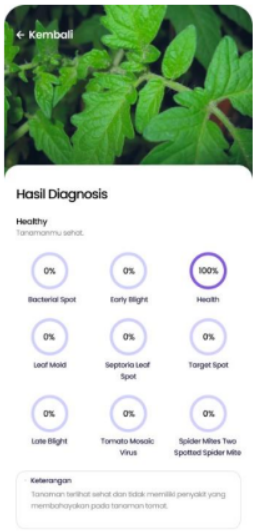

Figure 7. Display on system with Health diagnosis

In the experiment in Figure 8, the leaves that were photographed detected late blight 100%; late blight is a tomato disease that has the potential to damage, and infect leaves, stems, and tomatoes, this disease spreads quickly in the field and can cause total crop failure if not treated.

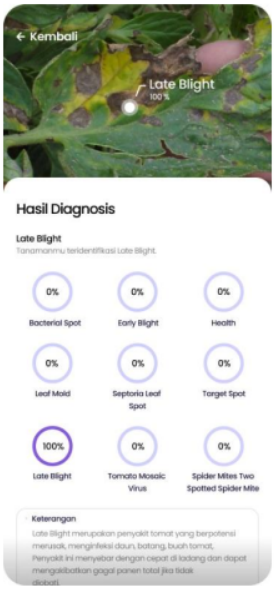

Figure 8. Display on system with Late Blight diagnosis

In the picture below, the display of images allows for the types of pests on tomato plants such as armyworms, leaf miners, leaf caterpillars, sucking insects, black leaf caterpillars, fruit flies, and grasshoppers, but this display only displays images but not explain in more detail

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Figure 9. Display Pest Type

Table 1. Disease Identification Tests on Tomato Plants

No	Types of Diseases on Leaves	Disease Identification Results	Application Results
1	Bacterial Spot	Identified Bacterial Spot 90% Health 10%	Success
2	Early Blight	Identified Early Blight 100%	Success
3	Healthy	Identified Healthy 100%	Success
4	Late Blight	Identified Late Blight 100%	Success
5	Septoria Leaf Spot	Identified Septoria Leaf Spot 100%	Success
6	Spider mites	Identified Spider mites 95% Health 5%	Success
7	Target Spot	Identified Target Spot 100%	Success
8	Tomato Mosaic Virus	Identified Tomato Mosaic Virus 100%	Success
9	Tomato Yellow Leaf Curl Virus	Identified Tomato Yellow Leaf Curl Virus 100%	Success

DISCUSSIONS

With the Application including the Convolutional Neural Network (CNN) and Recurrent Neural Network models, this system can choose a neural network model for the learning module (RNN). In this Application the researcher uses From the results of research using samples of disease on tomato leaves; researchers use tomato leaves as a test for the type of disease Bacterial Spot, Early Blight, Healthy, Late Blight, Septoria Leaf Spot, Spidermites, Target Spot, Tomato Mosaic Virus, Tomato Yellow Leaf Curl. The virus has fairly good accuracy, with a presentation of 90% to 100% accuracy seen from experiments on the camera with four shots, and the fourth one is accurate, as, in the first shooting experiment, the tomato leaf sample test had Early Blight disease with a prediction of 100% accuracy. The second experiment carried out disease samples on tomato plants suspected of being infected with Bacterial Spot disease with an accuracy level of predicting 90% identified Bacterial Spot and 10% Health; the third experiment with photo shoots of leaves that were photographed healthy 100% not identified any disease, In the last subsequent investigation photographed leaves detected late flash 100%

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CONCLUSION

This application has been successfully built using MobileNetV2 with Tensorflow.js and can run image training data and multiple validation data. The model can classify the tested images well, namely Bacterial Spot, Early Blight, Healthy, Late Blight, Septoria Leaf Spot, Spider mites, Target Spot, Tomato Mosaic Virus, and Tomato Yellow Leaf Curl, with each of four camera portrait samples having an accuracy of 90% to 100% depending on the type of disease, this research needs further research so that more types of plant diseases can be predicted

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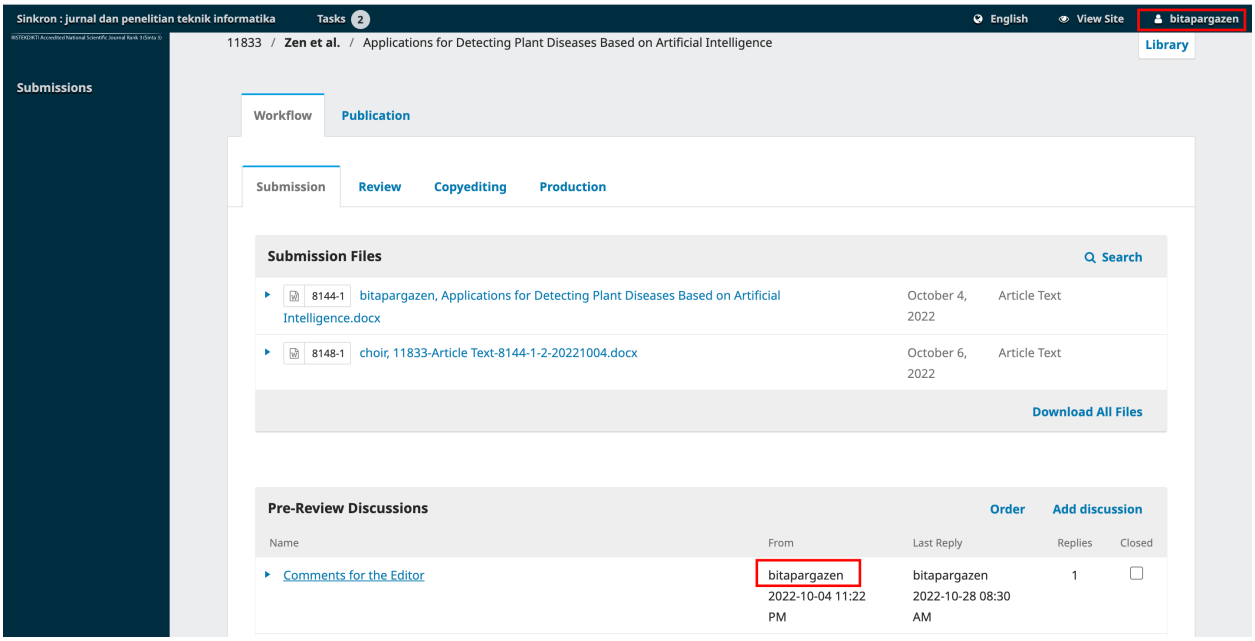

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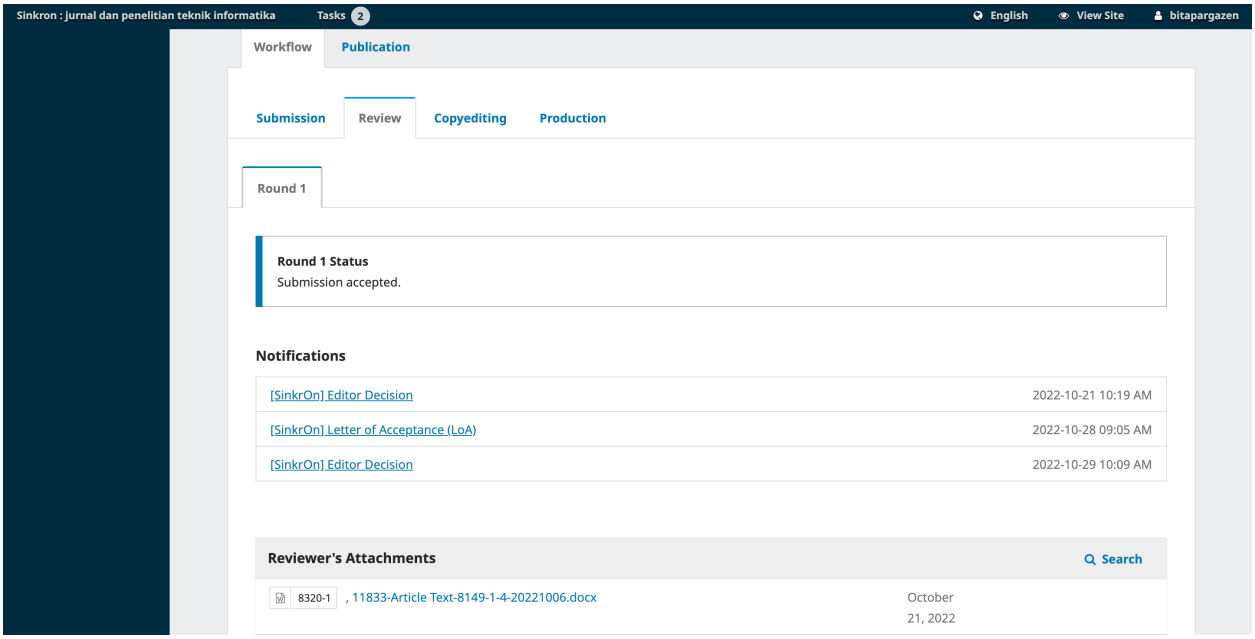

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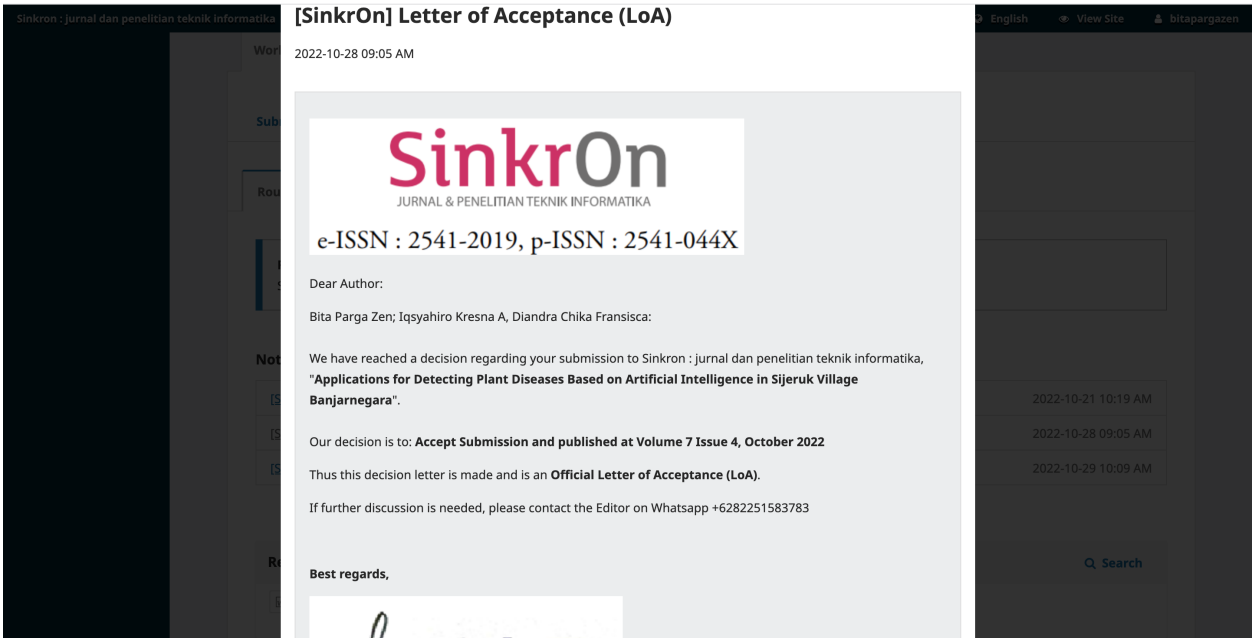

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Dear Author:

Bita Parga Zen; Iqsyahiro Kresna A, Diandra Chika Fransisca:

We have reached a decision regarding your submission to Sinkron : jurnal dan penelitian teknik informatika, "**Applications for Detecting Plant Diseases Based on Artificial Intelligence in Sijeruk Village Banjarnegara**".

Our decision is to: **Accept Submission and published at Volume 7 Issue 4, October 2022**

Thus this decision letter is made and is an **Official Letter of Acceptance (LoA)**.

If further discussion is needed, please contact the Editor on Whatsapp +6282251583783

Best regards,