Preliminary Study for identifying Rice Plant Disease Based on Thermal Images

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Abstract. Accurate and timely identification of plant disease can help stakeholders and farmers to mitigate losses due to pests and diseases. One of the identification techniques is indirect detection using thermal imaging technology. This technology has been considered a fast way without damaging the profile of a plant. In this paper, we describe the preliminary study of the thermal images gathering, so that the rice plant disease on the leaf canopy can be identified by using a thermal imaging camera.

1. Introduction

Indonesia is one of the agrarian countries which has great potential in the agriculture sectors [1]. These sectors not only consist of the sub-sector of animal husbandry, fishery, forestry, but also the sub-sector of food crop farming [2][3]. They have contributed significantly to the growth of the national economy, especially the food crop farming sub-sector [4][5]. One of the plants which is often planted in Indonesia is a rice plant.

The rice plant is very important for the life of Indonesian people because it is the main food that is needed by most people in Indonesia[1][6][7]. Based on the data of Badan Pusat Statistik (Central Bureau of Statistics), rice production has increased from year to year [7][8]. Indeed, this condition shows that it is a good effort from stakeholders and farmers. However, rice production sometimes is still not optimal due to various problems, such as pest and disease attacks.

Pest and disease attacks can influence rice production when they are not handled properly. This condition encourages stakeholders and farmers to identify the pest and disease attacks as early as possible during the growth of the rice plant. In recent years, there are some approaches for identifying the pest and disease attacks on the plants. These approaches are based on direct and indirect identification [9][10][11]. Direct identification has limitations, such as the high cost for laboratory testing and difficult to do in the field. Meanwhile, indirect identification by using thermal imaging technology becomes one of the alternative identification methods, which is more effective and efficient than direct identification. This method is performed by considering the pressure and volatility of the plants. It will utilize an infrared thermography sensor for measuring the temperature differences on the leaf surface and plant canopy when the plants are normal and...
abnormal (i.e., diseases). Early detection system based on thermal imaging technology has been carried out by some researchers, such as the research conducted by Lindenthal et al. (2015)[10], and Oerke, et al., (2011)[11]. However, these research not focused on rice plants. Therefore, this study proposed the thermal imaging technology to measure the temperature differences for the rice plants, so that it can be a preliminary research design for the rice plants.

2. Related Work
There have been several studies to determine the level of pressure and volatility of plants, particularly to observe the level of temperature changes from the plants. The research uses thermographic sensor-based technology to obtain the temperature of the leaf of a plant, to identifying the plant disease infections.

The research performed by Zhu, et al. in 2018 [12] focuses on the rapid diagnosis of the diseases of tomato and wheat using the infrared thermal imaging. It uses an infrared thermal imaging technology to measure the plants’ temperature changes during the incubation period. This method is combined by Maximum Temperature Difference (MTD) calculation for identifying the area caused by disease or not. Based on experiment result, the combination of these approaches shows that they can determine the mosaic disease and rust on the tomato dan wheat leaf as early as possible.

Other studies are examining changes in temperature in apple plants caused by phytopathogenic fungi (Oerke, et al., 2011) [11] to explore these temperature changes, and this study uses infrared thermal-imaging technology by evaluating the spatial heterogeneity of leaves in response to local infections. The MTD calculation used in this study is not only intended to differentiate between diseased and non-diseased leaves but also for disease quantification. Based on test results, this study concluded that infectious diseases in apple plants could be detected using thermo-imaging technology according to the differences in temperature when the plant is infected. However, this method needs to be re-evaluated in field conditions, although thermal infrared imaging has great potential as a sensor technology for precision agriculture because of its high sensitivity. Future research is expected to have a combination of techniques to have diagnostic capabilities, such as hyper-spectral imaging sensors.

In 2005, technology research based on infrared thermography technology was also carried out by Lindenthal, et al. [10], which is used to identify the downy mildew fungus on cucumber leaves. The technology is based on the visualization changes of spatial and temporal in the transpiration rate of the infected cucumber leaves. After capturing the changes, these changes are analyzed by looking the maximum temperature differences in the thermogram of healthy and infected leaves. This study concluded that thermal-imaging sensor technology can assist farmers in identifying the cucumber plant infections based on the surface temperature changes.

3. Proposed Methodology
This study proposed preliminary methodology for gathering the thermal images of the rice plant leaves. The images are expected to be the basis of image processing for identifying the rice plant disease infections based on the plant temperature.

3.1. Rice Planting for Research Preparation
Rice planting was carried out in the screen house of Faculty of Agriculture, Universitas Sumatera Utara. Rice seeds used in this research are M400. They are planted on 30 poly bags, where every poly bags consist of 5 - 10 seeds. This process aims to obtain rice plants that have a height of 20 cm - 35 cm with considering the national agriculture standard. After that, the rice plants will be transferred to outdoor with expecting they can be infected the certain diseases naturally like in the rice field area.
3.2. Data Gathering Design
This study aims to identify the disease of rice plants based on thermal imaging. Based on this goal, the first focus of this study is gathering thermal imaging from the leaves of the rice plant. The images are collected by using a thermal imaging camera in a jpeg format with a resolution of 1440 x 1080. They can be seen in Figure 1.

![Figure 1: Thermal Image Samples of Leaves of the Rice Plant](image1)

3.3. Tool Prototyping for Data Gathering
In order to capture thermal image of the leaves of the rice plant adequately, this study proposes a specific box. This is performed to avoid intervening ambient temperature that can complicate the thermal image gathering, and the temperature measurement process. The prototype of box can be seen in Figure 2.

![Figure 2: The Prototype of The Proposed Box](image2)

Based on Figure 2, the height and width of the box are 100 cm x 150 cm, respectively. The inner box consists of one part that the elevation can be adjusted manually. In other words, the box has two compartments (i.e., right and left compartments), which are separated by a certain
part. This part is a place of thermal imaging camera (right compartment), where the camera lens will point to the left compartment. Therefore, the left compartment will become the place of the rice plant.

3.4. Data Gathering Technique

Measurements are taken every day in two sessions, which are in the morning (from 08.00 am to 11.00 am) and in the afternoon (from 03.00 pm to 05.00 pm). First, the rice plants will be moved to a particular room for equilibrating to room temperature (between 20° C to 25° C). This process takes 15 to 20 minutes to eliminate the outdoor temperature effect, which may exist in the rice plants. After that, the rice plants are placed one by one to the bottom compartment. The process of temperature monitoring using the thermal imaging camera is performed for 20 minutes by capturing two thermal images every 4 minutes so that one monitoring process acquires ten thermal images. In this study, the image capturing distance will be considered.

4. Final Remarks

This study aims to present the proposed approach to gather the thermal image of the rice plants which is useful for the diseases identification. The approach uses thermal imaging camera. It has been considered as the alternative approach to identify the temperature change of plants when the plants are infected by diseases though it is still performed in laboratory.

The future work, we will increase the data of thermal image. Besides, the system for identifying the disease based on the thermal images will be developing using the image processing approach.

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