CHAPTER I
INTRODUCTION

1.1 Background

Tea (Camellia sinensis) is cultivated in tropical and subtropical regions in acidic soil conditions, with increasing awareness of its health-promoting properties [1]. The variability and changes in climate will impact the potential for green leafhopper (Empoasca sp.) infestations in tea plantations in Indonesia [2]. Pest infestations and diseases have distinct characteristics that can be identified through the condition of the leaves. Some pest infestations exhibit different physical signs, making them identifiable. However, pest identification is still performed manually because most tea plantations cover large areas, and some pest and disease symptoms can appear similar. If pests and diseases can be identified quickly and accurately, infestations can be prevented and managed effectively. Therefore, a method of detecting pest attacks on tea leaves based on multispectral cameras is needed to prevent decreased production.

Radar–drone system is potentially implemented to collect a large area's soil water content [3]. Vegetation that may cover the soil surface affects the detection results of soil water content using radar systems in plantation areas. Vegetation will influence the propagation mechanism of radar waves, therefore, a method to overcome this effect is needed.

In a previous study [4], the method for detecting White Leaf Disease (WLD) using Extreme Gradient Boosting (XGBoost), Random Forest (RF), Decision Tree (DT), and K-Nearest Neighbors (KNN) algorithms was implemented with a multispectral camera mounted on an Unmanned Aerial Vehicle (UAV). This study achieved a detection accuracy of 94% for WLD on a single leaf. Research [5], also detected single-leaf disease on apple, corn, grape, tomato, and potato plants using Convolutional Neural Networks (CNN) with data obtained from large, validated image datasets of healthy and diseased plants. The CNN method achieved an accuracy of 86% for detecting plant diseases. In object recognition techniques, many studies propose effective features for detecting or classifying objects, as well as traditional machine learning techniques often used as input for algorithms such as Scale-Invariant Feature Transform (SIFT), Speeded-Up Robust Features (SURF), and Histograms of Oriented Gradients (HOG). SIFT is highly efficient in object recognition applications but requires high computational complexity [6]. SURF works faster than SIFT and can detect key points

without ignoring other objects. HOG is a feature descriptor used for object detection [7]. However, HOG calculations only compute gradients of parts of an image [8]. These three traditional techniques involve complex calculations and are challenging to apply in online applications due to their computational intensity. For classification, Support Vector Machine (SVM) was considered one of the most popular methods for object recognition before the advent of deep learning. Research [9], proposed SVM for tea leaf disease recognition and detection. Later, research [10] combined SVM with K-Nearest Neighbor (KNN) and geometric moment invariance to improve image recognition results. Additionally, combining SVM with Kernel Principal Component Analysis (KPCA) can reduce feature vector dimensions. However, SVM typically requires tuning with kernel functions to achieve good performance, which is not always easy to find.

In this study, a method for detecting tea leaves affected by pests using multispectral cameras with Convolutional Neural Network (CNN) was proposed for data processing to achieve good accuracy. CNN was chosen because this architecture is faster in training data due to its use of fewer parameters compared to other neural network models. Previous researchers also strongly indicated that CNN is a network capable of achieving better performance compared to other sequential models [11].

A characteristic feature of Empoasca infestation is leaf curling, which can cause leaf death. Multispectral cameras were chosen for this study because they have different spectral features to facilitate data processing using a Convolutional Neural Network (CNN). It can also cover a large area, unlike previous studies that only used cameras to detect infestations on a single leaf. Therefore, a multispectral camera is proposed as a method in this study. This research aims to propose a method of detecting tea leaves affected by pest attacks on a large plantation area, making it easier for farmers to know the condition of tea leaves affected by pest attacks.

1.2 Problem to Solved

Empoasca pests are insect suckers that can cause damage to tea leaves, characterized by curling of the affected leaves. However, farmers have been detecting tea plants manually because some symptoms of pests and diseases look similar, so they spray pesticides on infested plants. Most tea plants grow in very large expanses and it takes a long time to detect infested tea leaves. Therefore, the problem of identifying

empoasca pests on tea leaves in large plantation areas can be solved, making it faster and easier for farmers to detect tea leaves affected by empoasca pests.

1.3 Research Objective

The proposed objective of this research is to design a method to detect pest attacks on tea leaves using multispectral cameras. Multispectral cameras are used to take images of empoasca pest attack characteristics, besides the data processing method used for image classification using CNN to get accurate results.

1.4 Problem Scope

The problem limitations discussed in this research focus on the detection method of empoasca pest attacks on multispectral camera-based tea leaves. The method used in this research is the initial phase in developing technological concepts in agriculture, especially in tea leaves affected by empoasca pests. The empoasca pest attack has a characteristic extraction of the curled leaf shape which acts as the object of research, the multispectral camera used to detect tea leaves affected by empoasca pest attacks is placed on a tea plant using a support pole. After that, the testing stage is carried out by taking pictures of tea leaves affected by empoasca pests and then the data will be processed using the CNN method. The expected accuracy is to get a high value and a small loss.

1.5 Hypothesis

In previous research [12], experiments have been carried out on deep learning-based models to detect leaf diseases in apples, tomatoes, oranges, potato grapes, etc. using images that aim to improve the accuracy of recognition and classification of plant diseases. The characteristics of apple, tomato, orange, grape, and potato plants are characterized by the presence of spots on the leaves taken from Plant Village. The method used for data processing is a Convolution Neural Network (CNN). In addition, research [13], developed a system to classify the types of tea leaf clones in the GMB series. The system developed uses digital processing using a smartphone camera. The data processing used in the study uses the CNN method with ResNet, VggNet, and AlexNet architecture.

The two studies described state that detection and classification can be done using datasets taken from Plant Village and camera technology. However, previous studies have not used feature extraction on empoasca pest attacks that have curled leaves and

when taking image data using a camera is only done on a single leaf affected by pest attacks, so that the expected results, namely the proposed design method for detecting empoasca pest attacks on multispectral camera-based tea leaves, can be achieved.

1.6 Research Method

The stages of the research methodology that will be carried out in this thesis are:

1. Literature Study

   At this stage, we study the proposed method, which is related to the detection of empoasca pest attacks on multispectral camera-based tea leaves using the characteristics of tea leaves affected by empoasca pest attacks. The data that has been collected from the multispectral camera capture will then be processed using Convolutional Neural Network (CNN) which will be studied further through pre-existing research studies.

2. Design of Empoasca Pest Attack Detection Method

   The design at this stage is carried out to detect empoasca pest attacks on multispectral camera-based tea leaves using characteristics of tea leaves affected by empoasca pest attacks. The data processing used is using Convolutional Neural Network (CNN).

3. Experimentation Process

   After the design process, a set-up was carried out to conduct experiments at PPTK-Gambung using support poles. Proses Pengolahan Data dan Analisis

4. Data Processing and Analysis

   The data that has been obtained using multispectral cameras will then be processed using the Convolutional Neural Network (CNN) method to get high accuracy.

5. Result Summarization

   The whole process will be concluded and used to answer the problems raised in this thesis research.

1.7 Research Methodology

The next stage is to conduct a terroristic analysis to prove the correctness of the proposed concept. In addition, the method of data collection and experimental testing was designed. The illustration of data collection of tea leaves affected by empoasca pests having extracts of rolling leaf characteristics based on a multispectral camera.

After conducting a terroristic analysis to prove the scientific truth of the basic concepts of the Convolutional Neural Network (CNN) method and the method of characterizing curled leaves on tea leaves. The experimental stage is carried out to prove the concept, then the stage is to compile a data processing method using the Convolutional Neural Network (CNN) algorithm to be able to verify the results of experimental testing. The overall research methodology is shown in Figure 1.1.

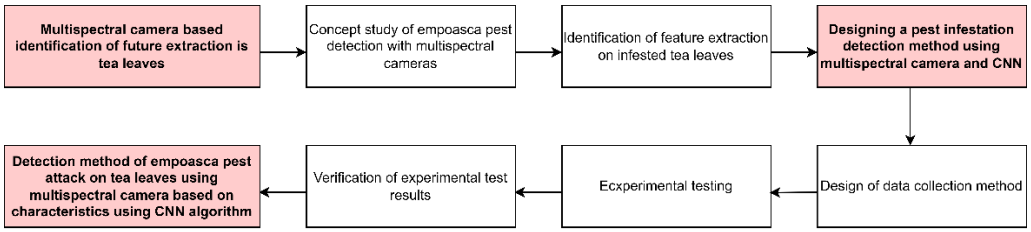

Figure 1.1 Research Method

1.8 Systematics of Writing

This research is divided into several topics that are organized systematically below:

CHAPTER I INTRODUCTION

This chapter contains background, problems, objectives, limitations, hypotheses, research methods, thesis contributions, and writing systematics,

CHAPTER II LITERATURE REVIEW

This chapter contains basic concepts and theories related to the research.

CHAPTER III RESEARCH METHODS

This chapter discusses the proposed research method and the method structure plan used.