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A Project Presented to the

Faculty of the Electrical and Allied Department

Technological University of the Philippines Taguig

Campus Taguig City

In Partial Fulfillment of the Requirements for the Subject

System Architecture and Integration 2

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Group No. 3

SDG 15: LIFE ON LAND

BSIT-NS-T-3A-T

Submitted to:

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TITLES

1. ALOEINTEL: Machine Learning–Based Aloe Vera Harvest Readiness Assessment Using YOLOv8 for Plant Age Estimation and Visual Disease Analysis

2. SMARTVERA: Machine Learning–Enabled Aloe Vera Harvest Readiness Assessment Using YOLOv8-Based Visual Analysis of Plant Maturity and Disease Conditions

3. HARVESTVERA: A Machine Learning Framework Utilizing YOLOv8 for Intelligent Aloe Vera Harvest Readiness Determination Through Visual Disease Analysis and Age Estimation

4. VERAINSIGHT: An Intelligent Machine Learning System Using YOLOv8 for Aloe Vera Harvest Readiness Evaluation Through Plant Age Estimation and Visual Disease Detection

5. Project: Pamada. A YOLOv8-Powered Machine Learning Approach for Smart Aloe Vera Harvest Readiness Assessment Based on Visual Maturity and Disease Analysis

CHAPTER 1: THE PROBLEM AND ITS BACKGROUND

1.1 Introduction

One of the pillars of global sustainability has been subjected to humankind as production and faced the challenge of varying climatic conditions, changing population, and the erosion of natural resources. The above challenges have made it more difficult to have more efficient and informed agricultural practices in areas like crop monitoring, as well as decision making. The traditional farming practices are mostly subjective to manual inspection and are experienced through farming practices which are time consuming (Rurangi et. al 2007); therefore, cannot be applied in the modern agricultural production to ensure the high accuracy levels are met.

Aloe vera (Aloe barbadensis Miller) is a very valuable medicinal plant that is widely cultivated and used either in therapeutic, cosmetic or trade purposes. Quality and economic value of aloe vera play a significant role in determining the age, maturity and physiological state of a certain plant when it is harvested. Visual signs, which in most cases are used by growers, involve color, the texture of the surface, and the structure and based on which, growers can identify the readiness and well-being of the plant. These tests are however, predominantly subjective, and thus can result in making unsound harvest choices, and poor quality of the products. Further, aloe vera is prone to such infections as aloe rust, bacterial soft rot, anthracnose (leaf spot), basal stem rot, root rot, and aloe cancer, as well as aloe scale insects and aloe mite infestations which affect both the condition and the outputs of the plants otherwise.

This is also the case with the aloe vera farms in Taguig city due to low quality of aloe vera as well as inadequate decisions on harvest. The local growers will use the manual method and rely on their eyes and more traditional method of evaluating the maturity and health of the plants; hence, they will always have the risk of fallibility and variation in the machines. Such limitations show that there should be some improved systematic and objective way of monitoring the aloe vera farming in the area.

The available forms of cultivating the aloe vera are mostly reactive particularly in monitoring health of the plants where the intervention is normally taken when the symptom is observed. A slight change in color or pattern on the leaf surface can reveal information about the stress of a plant or its ill health whereas this is not necessarily the area of systematic study. This limitation raises the significance of objective real time assessment methods which may contribute to sound and prompt cultivation decisions.

Recent advances in the fields of image processing and machine learning have given the opportunity to develop live surveillance of plants. By the use of the implementation of the image acquisition based on cameras, through which the computer vision makes possible to receive the images of the crop live and process the color of the leaf, pattern on the surface and structural information. The combination of these visual features with machine learning models may be applied to identify the stage of a plant development, assess the well-being of a plant, and offer support throughout the process of identifying the extent of harvest maturity without being intrusive. YOLOv8 (You Only Look Once version 8) is one of the most recent deep architectures to date, capable of high-performance when attempting to perform real-time object detection and classification tasks and has faster speed and the accuracy and low levels of computation-efficiency, and is one quality required in practice in an agricultural setup.

Moreover, there are present AI technologies that can self-learn, and that is why new pictures added by users must be automatically added to the dataset of the model that will allow the model to update and to increase its predictions. This will ensure that later on the system would be more accurate with the diagnosis it provides as far as diseases are concerned, the state of plants and when they should be harvested.

The paper presents a self-learning, real-time framework meant to evaluate the economic maturity of the aloe vera harvest and measurement of the plant health in the aloe vera farms in Taguig City based on the YOLOv8 architecture and implementing the visual analysis and predictive disease-risk analysis. The implementation of the system will be based on both mobile and web based applications that will provide the farmer with expedient applications to gauge the plants on the ground. To offer the system usefulness, the system performance will be systematically compared with the existing traditional manual ways of checking the disease against the actual systems based on its accuracy, detection speed, consistency, and the possibility to identify the disease at its early stages. This way, this research will improve accuracy in harvesting, reduction of losses of crops, as well as sustainable aloe production.

1.2 Background of the Study

Plant diseases and pests continue to pose a major problem in the global agriculture sector with an estimated yearly loss of 20-40 percent of crop production, which damages the economy on an annual basis of more than USD 220 billion USD (FAO, 2023). Such losses are mostly caused by traditional methods of disease monitoring that are based on manual inspection and observation. These methods are subjective and tend to be reactive, and they only recognize the problems when they become visible, and until then they are already causing significant damage to crops.

Aloe vera is a commercially useful medicinal plant, and it is found in pharmaceuticals, cosmetics and personal care products. Aloe vera market around the globe is expected to turn into approximately USD 27.9 billion by 2032 increasing at an average of 8.3 percentage points of compound annual growth rate (CAGR) of USD 14.5 billion in 2024 (Future Market Insights, 2024). Although aloe vera is economically important, it is very vulnerable to several diseases and pests such as aloe rust (inflicted by Phakopsora pachyrhazi), soft rot caused by bacteria, anthracnose (leaf spot), basal stem rot, root rot, aloe cancer, scale insects infestations and aloe mite damage which may affect the quality as well as the yield of the aloe therapeutic gel. The symptoms of the disease in the early stages are mostly insidious and they can be confused with normal environmental stress and properly diagnosis of the disease is especially difficult in the case with small-scale growers who may as well manage the farms within the territory of Taguig City.

The developments in machine learning and image processing have shown high potential in monitoring plant health. Convolutional Neural Networks (CNNs) are known to be highly accurate in automated detection of various diseases through the image of the leaves. YOLOv8 (You Only Look Once version 8) is one of the most contemporary deep learning architectures that provided a state-of-the-art object detector with real time performance and high accuracy, thus being especially useful when it comes to utilizing rather limited resource capable devices. Plant visual indicators like color, surface effect and morphological structure are useful in assessing plant health and maturity which is important in knowing when the plant is ready to harvest.

To overcome these difficulties, the paper will suggest an AI-based real-time aloe vera harvesting and plant health assessment solution that will be used in the aloe vera farms at

Taguig City and will be implemented in the YOLOv8 architecture with the addition of self-learning. The system will be available in mobile and web applications which will make the system more convenient to the farmers by offering them on-site disease detection and harvest assessment applications. Images posted by users get inserted into the database of the system allowing the model to keep improving its predictions and become more accurate as time passes. One of the secondary functions is the detection of diseases to offer context into preventive action. Also, the effectiveness of the system will be compared to the traditional manual inspection methods to reveal its effectiveness in the meaning of accuracy, speed, and early-detecting the characteristics. The solution targets to help in timely harvesting, minimization of losses in crops and enhance improved quality of the aloe vera products, as well as have sustainable cultivation practices.

1.3 Statement of the Problem

Economic returns and agricultural productivity obtained through the process of aloe vera farming greatly relies on early identification of the health problems with the plant, proper evaluation of the crop at the time of harvesting, and the promptness of disease treatment. The existing systems of tracking aloe vera development, as well as the identification of diseases, are mostly manual and responsive, which results in late responses and losses of crops and low-quality products. The current AI-based products are mainly targeting the basic food crops and undeserving specific medicinal plants such as aloe vera. In addition, existing systems are frequently resource-intensive, which cannot allow small-scale growers to implement them in real-time, and do not learn as time passes and react to changing plant traits or disease outbreaks.

Another significant drawback of the existing methods is the absence of the self-learning processes, which will enable the system to become more accurate in its predictions as more plant images are gathered with time passing. In the absence of such ability, no disease detecting and harvest readiness measurement can be taken, which restricts the resourcefulness of the system in dynamic conditions of the real world.

1.3.1 Main Problem

What mechanisms can be designed into an AI-based system with self-learning capability to detect when a crop is ready for harvesting, and when the plants are healthy and early diseases begin to develop so as to minimize losses of crops, enhance the quality of products, and enable the predictive capacity to get better and better?

1.3.2 Sub-Problems

1. **Delayed Disease Detection –** The conventional surveillance system detects diseases when they are visibly manifested, thus unable to intervene at the initial stages, causing more damage to crops.
2. **Lack of Predictive Prevention –** Current systems fail to predict the possible risks of diseases or prescribe preventive actions before the disease symptoms set in.
3. **Crop-Specific Model Limitations –** With the existing machine learning, the models are not trained on aloe vera on its morphological features, growth cycle, and disease phenotype.
4. **Poor Real-Time Deployment –** The current AI-based disease detection needs a lot of computing power, and it is not suitable to be deployed into the field.
5. **Static Models Without Self-Learning –** Static models are not capable of this since the currently existing systems do not undertake the process of boosting prediction accuracy by automatically incorporating user-posted images or data.
6. **Incomplete Health Assessment –** Visual data visualization is currently an underestimated indicator of health including color indications of leaf color and surface pattern, which are essential in assessing maturity and health of the plant.

1.4 Objectives of the Study

1.4.1 General Objective

Devise a machine learning-based application to determine the maturity, health, and disease of aloe vera plants and assists in making decisions to be able to harvest the crops in a timely manner and prevent their diseases by treating them in advance. Image processing and machine learning will be utilized in the system to analyze the leaf color, surface pattern, and structural characteristics, identify common diseases, and offer foreseers of recommendations to preventative actions. The objective of the study is to enhance the quality of harvest and decrease the loss of crops as well as encourage sustainable development of aloe vera.

1.4.2 Specific Objectives

1. Design AI-based disease surveillance system which will identify common aloe vera diseases (leaf spot, sunburn, root rot) and healthy plants using deep learning and image processing and will not rely on manual inspections.

2. Use real-time recording whereby images of the plants can be captured in real time to analyze the maturity of the plants, their color, and surface pattern.

3. Create predictive analytics applications that combine past image history analysis and the environment of prediction and give early warnings and preventative measures that are viable.

4. Introduce a self-learning (self-feeding) feature that would generate images uploaded by users to the set, which would be integrated into the dataset reflecting a continual update of the model and the enhancement of predictions, which will lead to increasingly more accurate disease detection and harvests readiness images.

5. Implement the system on a platform that is accessible (either web or mobile) to inform growers real-time regarding the health of plants, their readiness to harvest, and possible threats of diseases.

6. Compare system performance and reliability to that of the traditional methods based on the accuracy of detection, response time, impact on the incidence of disease, and enhancement of crop yield and quality using pilot case studies.

7. Determine user adoption, usability, and scalability by analyzing aspects of training needs, cost-effectiveness, and practicability in a variety of cultivation situations.

1.5 Significance of the Study

The study will be relevant to every party, whose interests lie in aloe production, consumption and production. The system will allow making more informed decisions, resource utilisation and productivity of plants will improve because it will ensure that the health of plants, the necessity to harvest and early detecting of diseases are perceived real-time. In particular, the following categories will be interested in the study:

Farmers:

Farmers (when to irrigate when humidity, when to apply fungicides etc), application of specific areas will be sent in the form of real-time notices and preemptive recommendations. It will assist in minimizing losses in crops, ensuring that production is of high standard, and improving the economy in terms of aloe production.

Agritech Providers and Cooperatives:

It may also be connected with the existing software platforms through standard APIs to provide technology firms and cooperatives the ability to monitor and predict analytics services on subscriptions. The paper also establishes a roadmap in relation to the massive roll out and commercialization of AI-based disease management tools by the agritech sector.

Research Institutions and Future Researchers:

Anonymized longitudinal and simulated performance of data collected in the study will be means of continuing the exploration of the subject of aloe vera epidemiology, plant pathology of aloe vera and AI-based monitoring of crops. These findings can be utilized by plant pathologists, data scientists and future researchers to develop improved predictive models, disease-environment interactions and adapting AI methods to other high value crops or medicinal crops.

Policy Makers and Planners:

The system will also be helpful in monitoring the disease and mapping the risks at the regional level and help detail powerful decisions on the way the resources, subsidies programmes and investing in infrastructure could be distributed. These lessons may influence the policy making process and the rural development programs and would aid in the sustainable farming of aloe vera besides the economic development of the same in the broad context.

Product Manufacturers and Consumers:

Such manufacturing companies of the aloe vera that produce cosmetic, pharmaceutical and nutraceutical products will have enhanced supply of high quality raw materials thereby avoiding such breakages of supply chains. The products will be of superior quality and consist of reliable active ingredients that will allow the consumers to build trust and satisfaction.

Individual Growers and Plant Enthusiasts:

The given paper is also dedicated to the creation, designing, and testing of an AI-based web application that should be used in the case of aloe vera disease detection and prevention. It is a combination of image processing, deep learning and predictive analytics offering real-time analysis of the environmental wellness of plants, harvests preparedness and preventive advice. The points of focus of the study are:

1.6 Scope and Delimitation

The paper design focuses on design, development, and testing of an AI-based web application which would diagnose and avoid aloe vera diseases. The system is an integration of the image processing system, deep learning, and predictive analytics to provide real time information on the overall plant health, harvest readiness and preventive recommendations. The significant information about the research is:

1.6.1 Scope

1. **AI and Image-Based Disease Detection:**
    - Employs the use of Convolutional Neural Networks (CNNs) to identify four principal aloe vera diseases; healthy, sunburn, leaf spot, and root rot.
    - With real-time detection and confidence scores, it can detect this and therefore act in time.
2. **Web-Based Admin Interface:**
    - Real-Time Analytics: Displays both the data of the system performance and disease detection.
    - Catalog Management: They allow easy organization of plant databases and inventory.

- User Control & Profile Control: The administrative control as a grower is simplified.

3. **Preventive Treatment Recommendations:**
   - Offers evidence-based interventions to management, such as preventive care measures, disease explanations, symptoms and treatment options that should be used.
4. **Daily Smart Follow-Up System:**
   - Has a follow up option that is calendar based and it produces customized prevention plans.
   - Forces its users to scan their aloe vera plants every day because the system would have been capable of tracking the health of the plant, the progression of the disease and, therefore, give new recommendations, depending on the current condition.
5. **Data Management and Storage:**
   - Cloudinary database was used as a cloud based to store the user accounts, history of analysis and system analytics.
   - The local database will be applied in case of the poor internet connectivity; it will be based on MySQL.
6. **System Architecture:**
   - Developed based on Node.js/Express and Python Flask/CNN model inference server which is multi-user, and authenticated using JWT simultaneously and high security.
   - Records analysis and system performance that enables end user to track the health of the plant through time and system administrators to measure the accuracy and user interaction.

7. **Disease Coverage:**

   - Only eight conditions of aloe vera of common type are integrated in this system. Regional disease variations, rare diseases, and unclassified disease strains are not covered in the given study.

8. **Pests Detection:**

- ○ It involves the common pests of aloe vera plants like the mealybugs and spider mites that can be analyzed through the image analysis and are prevented and detected at the early stage.

9. **Advanced Analytics and Forecasting:**

    - The system has facilitated the strength of the analytical applications regarding the plant health i.e. yield forecast and post harvest quality forecast. The system, on the other hand, is not involved in the prediction of the large-scale disease outbreak.

1.6.2 Delimitations

This paper is going to avoid the following:

1. **Mobile and offline deployment:**
    - ○ It is a strictly web-based system; there is no support of lightweight mobile or offline applications.
2. **Advanced Imaging, Automation, and Sensor Integration:**
    - ○ There is no support of advanced imaging technologies, automated mechanisms of treatment, or any real-time integration of environmental sensors.
3. **Commercial deployment beyond small-scale operations:**
    - ○ This research is beyond commercial farm management on a large scale.
4. **Single-Plant Scanning:**
    - ○ The system is made to be able to scan only single images of the plants. The scanning needs to be activated one plant at a time and the system does not translate to simultaneous or mass scanning on a number of aloe vera plants.

CHAPTER 2: REVIEW OF RELATED LITERATURE AND STUDIES

2.1 Foreign Literature

The reviewed foreign literature emphasizes the fact that it is crucial to know the right age, on which Aloe vera should harvest can be made as the plant maturity significantly affects the quality, as well as, quantity of the harvest. Harvesting Aloe, Aloe (2020) states that the Aloe vera is generally ready to harvest after roughly three years and the harvest must be done quickly to prevent the numerous bioactive compounds being destroyed. The manual has pointed out that premature or delayed harvesting can adversely influence the quality of the gel which is the main source of therapeutic effect of the plant.

Similarly, the Aloe bulletin on Good Agricultural practices (2019) is also quite practical in its advice to the growers since it states that the thick and leathery leaves are already harvestable in the eight months after planting and are most useful in the early flowering period. The bulletin also stresses that when picking mature leaves one should be extra careful to use the leaves in the preparation of gel and juices such that maximum quality and quantity of the products can be produced.

Also, the research article Cultivation and Processing of Aloe Vera to Enhance Community Income (2022) shows that other aspects of sufficient cultivation like proper spatial arrangement and land preparation will finish the growth and maturity of the plant immensely. The other form introduced in the research is the economic benefits of picking Aloe vera at the right time, which translates to the increased processing and consequently higher revenue of the smallholder groups.

Still on the technological approaches to measuring the maturity of crops, Moya et al. (2024) demonstrated the effectiveness of deep learning of crop detection and maturity classification. The given experiment consisted of applying the latest version of the object detection model named YOLOv5 to define the location and maturity of rocoto chili peppers initially planted in Ecuador. As was noticed, the research provided impressive results of 99.99 percent accuracy of classification activities and 84 percent accuracy of crop detection, even though it was required to work with images obtained in natural field conditions and action of environmental changes such as leaves, flowers, and other changes in light intensity. Relevance of this approach is that this model was trained using images depicting crops in their natural habitats, immature and mature but kept in real life conditions and potential environmental constraints rather than in a laboratory environment, which was controlled. This strategy shows that systems that are provided by AIs can be applicable in assessing the maturity of the plant under natural agricultural conditions, which shows that this strategy can act as one of the useful forecasters that the maturity of the plant in other more lucrative crops like in the aloe vera.

In all these foreign sources there is one emphasis where the determination of the maturity of Aloe vera plants before harvesting was of special importance. They also suggest that the application of the visual analysis or the intuitive approach may be unsafe, and the decision to use the technology of image analysis based on the use of AI is explained by the desire to create the objective information concerning the age of the plants and their readiness to harvest. The clear case of the efficiency of the YOLOv5 as the crop maturity detector, which Moya et al. (2024) study has confirmed is another positive sign that the deep learning strategies can be easily deployed to assess the aloe vera maturity in order to adopt and maintain an eye on it in the field.

2.2 Foreign Studies

The mentioned overview of foreign research is a collective illustration of the agronomic and technological principles which are applicable to create an AI-supported concept of the system, which is Aloe vera harvest-maturity and disease-indication. Muhammad et al. (2021) examined automated Aloe vera disease classification with deep learning, which revealed that Convolutional neural networks (CNNs) like AlexNet and VGG19 could be used to extract and classify features in large image datasets successfully classifying Aloe vera healthy and diseased leaves with high accuracy. This paper brings out the potential of AI-based image analysis to enhance the monitoring of plant health and lessen the use of manual inspection, which is usually labor-consuming and inconsistent.

On this background, Koli et al. (2025) have established a holistic architecture of an Edge AI-based system to be utilized in real-time Aloe vera plant disease detection. The crucial issue that their study discussed is that Aloe vera plants are getting more susceptible to leaf diseases that cannot be detected at the initial stages causing low productivity and quality, and methods that are based in the laboratory are currently expensive and time-consuming to perform large-scale monitoring. The study suggested an edge AI-based system architecture that combined a Convolutional Neural Network that has been trained on Aloe vera disease dataset of 3,495 JPEG images classified into three categories with healthy leaf, leaf spot, and aloe rust. This model of Aloe vera leaf disease classification using resnet50 attained an amazing form of 99.15% accurateness, 99.20% exactness, 99.21% memorization and 99.20% F1 rating, which guarantees that it offers high classification preciseness. More importantly, by now deploying the quantized version of TFLite model on Raspberry Pi 4 B, real-time disease detection can be achieved with an inference latency of around 4.9 seconds and a smaller model size of 23.4MB, thus it can be deployed to edge computing applications in precision agriculture. This paper shows that Edge AI can be used to create real-time decisions with limited resources in resource-constrained systems and presents a low-latency, energy-efficient and scalable solution that aloe vera disease detection in the field is specifically designed to.

Banjaw (2019) performed a field experiment to find out adequate harvest age of Aloe vera and experimented with the plant at 12, 14, 16, 18, and 20 months after transplanting. These findings revealed a significant increase in the harvest period yield of dimensions of the plants at 20 months plentiful dimensions as well as leaf size and leaf mass, and that delay of harvesting could enhance yield in select agro-ecological settings. This is an indication that biological performance and harvest quality are key predictors depending on plant age and maturity.

The other study on Aloe vera harvesting was done on the impact of harvest dates on growth features and aloin content. Even though this study was based on the physiological and biochemical variation linked to various periods of harvesting, it offers significant information on the impact of time of harvesting on morphological characteristics and chemical formulation that may eventually determine the quality of products and their market price. These results highlight the importance of more objective and data focused ways of establishing the most suitable harvest period of Aloe vera plants.

To go hand in hand with these agronomic concepts, Sonali and Dhotre (2023) created a better deep learning classifier to identify and classify diseases in Aloe barbadensis Miller by using CNN models with transfer learning and data augmentation. Their results once again point to the fact that machine learning methodology can lead to improved accuracy and resilience of systems of detecting various plant diseases, especially when they are trained on a wide variety of leaf image data. This validates the possibility of micro-controlling the advanced AI models in agricultural use in real-time assessment of plant health.

These foreign studies conducted collectively offer a powerful empirical/methodological basis to the current study. The agronomic study of the harvest time of the Aloe vera plants highlights that the age of plants is a key determinant of yield and quality, and the machine learning analyses explain that deep learning models are very effective in correctly detecting disease in plant images. Of particular importance is the Edge AI implementation by Koli et al. (2025) that has shown that complex deep learning models could be successfully run on low-cost edge devices to detect aloe vera disease in real-time to bridge the gap between laboratory-scale experiments and the real field. These observations support the creation of an AI-assisted platform that with the help of the image analysis would determine the maturity of the plants as well as their health conditions, as a more objective and scalable instrument to enhance the decision to harvest and prevent the diseases when working with Aloe vera fields.

2.3 Local Literature

The reviewed local literature shows the overall knowledge about the Aloe vera cultivation, nature, and uses in Philippine context and provides the background of the research of how Aloe vera grows and how it can be put into the practice. The guide Aloe Vera Production (2019) provides the description of the agronomic practices in the local and small-scale farms, which states that the harvesting of Aloe vera is possible since the second year of planting and can last up to five years in favorable conditions. As well highlighted is the fact that harvesting is a very labor-intensive activity and that leaves regenerate once they are removed and hence the need to have a number of harvesting processes during the lifetime of the plant.

StuartXchange (2020) also describes Aloe vera (also locally known as sabila) as a succulent shrub that has thick and fleshy leaves and also a growth species that accommodates the tropical climate. The source also dwells on the fact that the plant regenerates itself once the leaves are removed, which, again, is in line with the local harvesting and planting practices of consecutive harvesting and continuous production of leaves on long-term basis.

An article in the Manila Bulletin (2021) on the tradition of growing Aloe vera in Filipino households discusses the utility of the culture of not following the usual labeling of caring such as watering of plants, picking of mature leaves to make the gel, used to treat small cuts and cause skin irritations. This is the generally used sight and touch criterion of maturity and harvest appropriateness of the leaves by local cultivators.

According to Hi-tech medical news of HelloDoctor Philippines (2021), medical and health potential of Aloe vera is easy to farm in the Philippines and has been traditionally used to treat cuts, prevent inflammation and overall wellness. This parochial medical perspective supports the truth that Aloe vera plantation and harvesting topic is relevant to the cultures in the Philippines and is more specifically within the home growers and small holders where the growth of the plants is viewed in terms of the maturity to utilize and harvest.

In relation to the topic of technology-based plant diagnosis, the article by Dizon et al. (2019), the title of which is iDahon: An Android-Based Terrestrial Plant Disease Detection Mobile Application through digital Image Processing with Deep Learning Neural Network Algorithm, demonstrates that the idea of using digital image processing and deep learning algorithms to interpret the features of the leaf image captured by the smartphone cameras is successful. Although the given work research problem is the detection of the disease, the authors refer to the possibility of the image-based analysis to objectively evaluate the state of the plants and exclude the application of the subjective approach to study the vegetation. This justifies the extension of similar image-processing procedures to the determination of Aloe vera plant maturity and harvesting.

All these sources play a role in the possession of localized information regarding Aloe vera cultivation, harvest period and use alongside indicating the enhanced significance of image-processing technologies in the study of vegetation. They demonstrate that maturity indicators such as the thickness of the leaves and regeneration patterns are emphasized in the Philippines cultivation literature that implies that more objective, technologically assisted instruments should be used to define the age and maturity of the plants, and this is what the proposed research will be conducted by making use of the images.

2.4 Local Studies

The studied local literature offers empirical reality on the performance and cultivation aspects of Aloe vera in the environment of the Philippines, this context is important to the development and maturation of the plant before harvest. In one study, the growth, yield, and bioactive content of Aloe vera plantlets that had been propagated in vitro and successfully acclimatized to an open field were measured in a field of the University of the Philippines Los Banos (Sarmiento, Aspuria, Aguilar, and Sta. Cruz, 2020). This study investigated the impact of planting distance, the potting media as well as the fertilization on the plant performance which showed that the agronomic management practices could influence the vegetative development as well as the bioactive compounds accumulated in the plants which are indicators of the overall plant maturity and crop capacity.

The other valuable local investigation determined the antimicrobial activity of in vitro culture-derived Aloe vera roots (Marfori and Rapiz, 2021) which found that decision-made tissue-cultured roots had high antimicrobial effects against various bacteria and fungal organisms than the roots obtained with field-grown plants. Even though this research did not address the issue of the harvest age, but instead bioactive properties, the results of this research would help understand the physiology of the plants and likely value-added applications of Aloe vera, as growth and development stage affect these applications.

Furthermore, one of the school based investigatory projects has explored the impact of various contents of soil nutrient profile on the growth of Aloe vera in South Cotabato (Kaging, 2019). This paper has discussed the impact of soil mixture on plant height, thickness of leaves and weight three months later implying that nutrient accessibility and soil quality are critical factors in the environment that influences the early growth and swelling processes of Aloe vera. Despite its limited area, the study offers local based evidence of environmental effects on the growth of plants, which can be applied in general terms of maturation and harvesting preparedness.

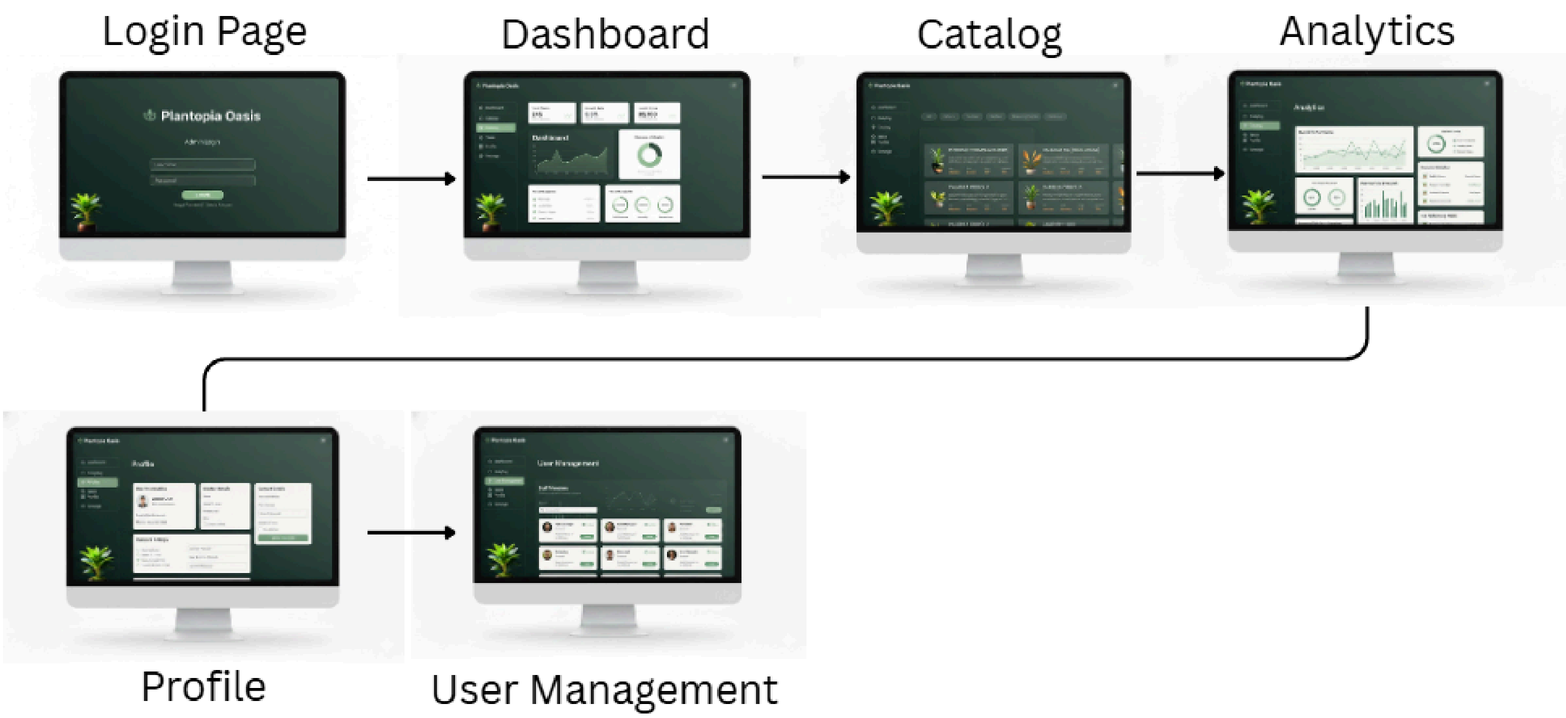
Finally, a similar Filipino journal article (EJournals.ph, 2020) determined the feasibility of Aloe vera leaf extract (AVLE) to in-situ generation of meriplants, which suggests using Aloe vera biomass to create the vegetative propagation pathway and possibly optimize the breeding or propagation approach. This study indirectly facilitates the appreciation of the developmental stages of plants bearing in mind that extracts of leaves are used in meriplant production which implies that more interest is placed on the vegetable characteristic of performance and growth of Aloe vera in the local agriculture.

Regarding the analysis of plants with technology assistance, a recent Philippine study by (Dioses, et al. 2024) on the Detection of Philippine Rice Plant Diseases Using a ResNet50 CNN Approach showed the efficacy of convolutional neural networks to identify plant conditions accurately based on the help of the image analysis of plant leaf features. Despite the paper addressing the rice disease detection, it elucidates the increasing trend of deep learning and image processing methodologies in Philippine agricultural studies to objectively detect the condition of the plants and their development. This confirms the relevance of the CNN-based image analysis methods of determining Aloe vera growth features and maturity levels, to supplement the conventional agronomic measurements.

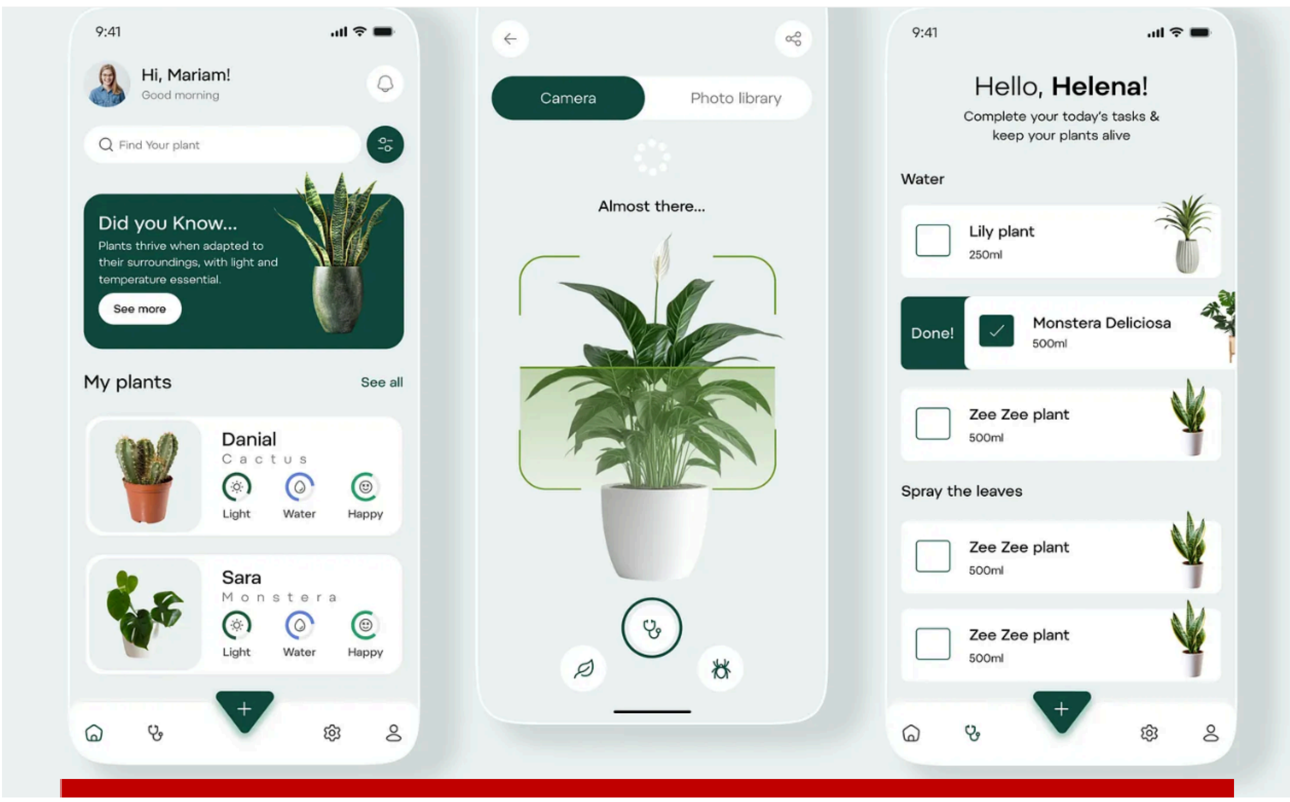
All these local studies highlight the fact that growth performance, agronomic situation, environment and new image based technologies are major determinants of plant development. Although they do not specifically target the harvest age, their outcomes on the measure of plant growth, physiological characteristics, and growing techniques are empirical proof of the focus of the current research on measuring plant maturity and performance, are supplemented by the necessity of objective and technology-based technology-based methods in the local agriculture, which include picture-based age measurement methods.

Visualization:

Web-Based Admin Side



Mobile Phone UI



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