RUBBER CARE - A MOBILE APPLICATION TO DETECT THE DISEASES OF RUBBER CULTIVATION IN SRI LANKA

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Abstract **- Sri Lanka's rubber plantations are a cornerstone of its agricultural sector, but they are susceptible to various diseases that can threaten rubber production. This research presents a prototype system for the detection of rubber plant diseases, specifically designed for Sri Lankan plantations, utilizing image-based analysis without reliance on complex machine learning or convolutional neural networks. The prototype system employs a straightforward image capture mechanism, allowing local farmers and plantation workers to easily capture images of rubber plant leaves using common mobile devices. These images were used to establish visual criteria and rules for identifying and classifying different disease symptoms. The system's performance was evaluated through field testing in Sri Lankan rubber plantations, considering factors such as specificity, sensitivity, and practicality for users. The results of the prototype system demonstrate its potential for accurate and accessible identification of rubber plant diseases, providing a cost - effective solution for early disease detection and intervention in Sri Lankan rubber plantations. This research contributes to improving disease management practices in Sri Lankan rubber plantations, ensuring the resilience of this vital industry without the need for complex technology.**

Keywords—Detection, Rubber cultivation, Planters, Supervisors, image data set, prototype, mobile application

I. INTRODUCTION

Sri Lanka's rubber industry, with a rich history dating back to the early 20th century, plays a crucial role in the country's economy. The nation's favorable climate and fertile soil provide an ideal environment for producing high-quality natural rubber. However, the industry faces significant challenges from various diseases that threaten the health and productivity of rubber trees, potentially jeopardizing its sustainability. The main diseases affecting rubber cultivation includes, Pestalotiopsis, phytophthora, Corynespora, Colletotrichum, Oidium [1]. According to the reports of Rubber Research Institute of Sri Lanka these diseases not only affect the growth of rubber trees but also hinder the overall development of the natural rubber sector by limiting production. To boost natural rubber yield, consulting experts and implementing effective measures is crucial. However, the current manual diagnosis process is slow and often inaccurate, compounded by plantation workers' limited knowledge of rubber diseases. Rubber cultivation in Sri Lanka primarily takes place in several main areas across the country and Sabaragamuwa, Southern, Northwestern are the most popular rubber planting areas. [1]. considering the technology facilities and people's literacy of Sri Lankan culture in these fields, we must select the most suitable platforms for these discussions. According to these facts, physical interviews and hard copy questionaries are the most suitable platforms for the planters and we can use google forms with the facilities that they have in the situation.

The primary objective of this research work is to develop a prototype aimed at addressing the challenges faced by the rubber cultivation industry in Sri Lanka. In this undertaking, mobile applications emerge as the most suitable approach, particularly considering the needs of rubber planters in the country. By utilizing images, they can effortlessly input data into the system and obtain the desired information. Image processing encompasses a broad array of applications, such as image analysis, image classification, object recognition, and 3D imaging, among others. This project involves scanning and analyzing plant leaf images using an image classification model.[3].

II. LITERATURE REVEIEW

A. Domain Overview

The Rubber Research Institute (RRI) plays a key role in guiding the industry, emphasizing precise rubber tree cultivation, and facilitating replanting efforts. The industry spans large estates managed by reputable companies and numerous smallholders, with foreign producers capitalizing on Sri Lanka's high-quality rubber supply. Sri Lanka's resilient rubber industry involves both upstream and downstream operations. Upstream activities include the production and marketing of high-quality natural raw rubber products, such as tires, clothing, and rubber sheets. The

industry consumes both locally produced and imported rubber, with notable exports of sole crepe and latex crepe rubbers to the USA, Germany, Italy, Belgium, and the UK. Factors affecting the industry include tree age, tapping technique, and management practices. Disease control, fertilization, and pruning are crucial for maintaining healthy plantations. Leaf diseases can negatively impact rubber tree health and productivity, affecting photosynthesis and nutrient absorption.

Recent technological advancements in agricultural technology aim to enhance rubber yield by detecting and managing diseases early. State-of-the-art monitoring systems use technologies like hyperspectral imaging, drones with multispectral cameras, and IoT sensors to collect high-resolution data on parameters such as chlorophyll content, temperature, humidity, and soil moisture. AI-driven platforms analyze this data to identify disease patterns, assess plant health, and enable proactive plantation management. Predictive models help anticipate disease risks, providing recommendations for planting schedules, irrigation practices, and crop rotations, ensuring long-term sustainability, and safeguarding rubber yields.

B. Framework analysis

The development of disease detection systems in image processing using deep learning relies on key frameworks and theories for accurate and effective results. Central to many algorithms is the use of convolutional neural networks (CNNs), specialized in processing images to automatically identify illness patterns by learning from input photos. Transfer learning is crucial, involving the adaptation of pre-trained CNN models optimized for large-scale datasets like ImageNet for disease detection.[4] This approach leverages features learned from generic images, tailoring them to the specific task of illness diagnosis and often improving performance with limited data.

To enhance model resilience, data augmentation is employed, artificially expanding the training dataset through transformations such as rotations, flips, and scaling. Ensemble learning strategies, combining predictions from multiple models, contribute to improved generalization and overall accuracy.[10] In medical applications, interpretability and explainability are significant concerns addressed by methods like Grad-CAM, which offer insights into model decision-making.

C. Existing Systems

There are some existing applications that develop by using image processing techniques, and to develop this application, they use different framework designs and
algorithms. Plantrix and Agrio are applications that developed plant disease detection, and these are mostly rating applications that we can find in the Google Play Store. And Rubber Buddy is one of the applications that we can identify as developing in Sri Lanka.

Rubber Buddy is a mobile application to empower rubber planters in Sri Lanka. The application consists of
Four parts, the detection of pests in immature rubber plantations and rubber nurseries, the detection of leaf disease, the detection of cover crops, and the detection of weeds. Machine learning models created using various convolutional neural network (CNN) architectures, such as mobile net version 2 (MobileNet v2), VGG 16, VGG 19, and residual networks (ResNet), are used to recognize images captured using mobile phone cameras. Following image recognition, the program will offer rubber planters professional advice and management techniques. The program was created to function in offline mode utilizing TensorFlow Lite technology because most rubber plantations are situated in regions with poor network access. [5].

Plantix is a popular mobile application that uses artificial intelligence and image recognition to detect plant diseases and nutrient deficiencies. It covers a wide range of crops and provides recommendations for disease management and treatment. Plantix is a mobile application that utilizes image processing and computer vision algorithms to detect plant diseases and nutrient deficiencies. It employs the OpenCV framework for image manipulation and feature extraction from leaf images.[2] The application uses a vast database of plant disease images to train its machine-learning models for disease classification. Plantix incorporates a backend web development framework, such as Django or Flask, to handle user interactions and data management, allowing users to upload images, receive diagnoses, and access disease management recommendations.Agrio Plant Disease Detection Mobile Applications, Agrio is another AI-powered mobile application designed for disease detection in plants. It uses computer vision algorithms to analyze leaf images and diagnose various diseases, enabling farmers to take timely action. It is another AI-powered mobile application focused on plant disease detection. It employs computer vision and deep learning frameworks like TensorFlow or PyTorch to analyze leaf images and identify disease symptoms accurately.[8] Agrio's design involves a user-friendly interface that allows farmers to capture images of affected leaves using their smartphones. The application's machine learning models are continuously updated with new data to improve disease detection accuracy.

Plant diseases are crucial to the development of agriculture since they can particularly affect the quality and quantity of plants. In general, fungi, bacteria, viruses, and mold are the causes of plant illnesses. Plant diseases are often diagnosed by farmers or professionals using only their eyes. However, this method can be time-consuming, expensive, and inaccurate. As a result, deep learning-based plant disease detection and categorization offer a quick and accurate way. For the purposes of study,

instruction, and analysis, photographic images of plant infection signs are used to diagnose plant diseases.[6] Deep learning technology and computer image processing are used to provide speedy and accurate detection, and studies show that deep learning techniques are useful for classifying plant diseases.[7]. Enhancing image analysis's dependability, correctness, and accuracy for spotting and classifying plant sickness has been a top priority. To extract plant disease representation from trained CNNs, using visualization approaches.

III. METHODOLOGY

The goal of Design Science Research (DSR), a research methodology, is to develop novel artifacts that solve real-world issues in a variety of fields. It is especially pertinent in industries like information systems, engineering, and technology were developing new solutions and designing them is crucial. DSR seeks to develop physical, practical objects that can be used in real-world settings in addition to new information.

The research focuses on addressing challenges in detecting diseases in rubber plant leaves through image processing. Motivated by the critical need for swift and accurate identification, the process involves a literature review, theoretical foundation, conceptual design, and development. The system is implemented, tested, and empirically evaluated for accuracy and robustness using diverse datasets. An iterative improvement phase refines the system based on evaluation results, ensuring continuous enhancement. Comprehensive documentation preserves methodologies and outcomes, and communication and knowledge dissemination share research outcomes with peers, practitioners, and stakeholders through conferences and academic journals.

A. Fact collection mechanisms

In this research project focused on developing an efficient method for detecting leaf disease on rubber plants, questionnaires and interviews play pivotal roles in gathering valuable insights from rubber producers and experts. The questionnaires, available in Sinhala, Tamil, and English, aim to inclusively capture practitioners' experiences, providing crucial information on disease frequency, challenges faced, and current management strategies. The goal is not just to collect data but to emphasize the necessity for a technologically advanced disease detection system. The gathered information serves as a compelling argument for the development of a rubber plant leaf disease detection system based on image processing. It positions the rubber farmers as key contributors to advancing disease control paradigms by bridging the gap between real-world knowledge and technological advancements.

Interviews with rubber experts and supervisors are carefully planned to extract in-depth knowledge and extensive experience in rubber farming and disease management. These interviews delve into complex insights beyond surface observations, aiming to understand various facets of disease detection, treatment, and prevention. The experts' opinions on disease characteristics, challenges unique to rubber production, and their decision-making processes are explored. Overall, the combination of questionnaires and interviews creates a comprehensive foundation for the development of a robust rubber plant leaf disease detection system, aligning technology with the practical experiences and expertise of those involved in rubber cultivation.

B. Data Analysis

In this research project, thematic analysis was employed as the selected method for analyzing the gathered data. The data collection process encompassed two separate approaches,

- Conduct interviews and questionnaires for gathering data to identify the requirements.
- Collecting images for training the model.

The first part of thematic analysis was done by using research questions and answers. According to the research question there are main 3 objectives in this work.

- Object 1 - To identify the most prevalent diseases in rubber cultivation in Sri Lanka.
- Object 2 - To identify the existing methods of disease detection and challenges.
- Object 3 - To propose a user-friendly solution suitable for the rubber industry in Sri Lanka.

In first objective, analysis aimed to identify the most common diseases affecting rubber plants in Sri Lanka. The data collected were analyzed to investigate the types of diseases that rubber farmers and agricultural officers had observed or dealt with. Additionally, the analysis examined the frequency of disease occurrences and the methods used for reporting diseases. The second objective was focused on understanding the current disease detection methods employed in rubber cultivation. The various approaches, including visual inspection by farmers, laboratory-based testing, and the use of government or non-government support, were explored. Furthermore, the analysis delved into the challenges associated with these methods, such as time-consuming processes, accuracy, and accessibility of support.

Final objective was aimed to propose a user-friendly solution for disease detection in the Sri Lankan rubber industry. The data were analyzed to understand preferences for mobile apps or handheld devices and the desired features of such a system, including real-time analysis and a user-friendly interface. Additionally, the analysis examined respondents' awareness of and willingness to adopt technology, along with any concerns or reservations they may have had about technology adoption and access to technology in rubber cultivation in Sri Lanka.

In the data set creation process, there are several steps to follow. The image dataset for the rubber tree plants leaf disease detection system was developed by capturing images of leaves affected by the above selected disease types. The research objectives were

clearly defined to focus on the accurate identification of diseases in rubber tree leaves. Image collection involved methods, such as capturing photos using cameras and smartphones, along with augmenting existing datasets through transformations like rotation, scaling, and cropping to increase image diversity. All images are captured by using white background and image size was 1936 x 129.

Images were captured, meticulous labeling was undertaken, and recording essential details for each image to provide crucial information for subsequent training and evaluation of the disease detection system. The images were organized and stored in distinct folders, categorized based on the specific disease affecting the leaves. This organizational structure was implemented to ensure the dataset's clarity and accessibility. Data augmentation techniques were applied to create variations of existing images, potentially enhancing the model's ability to generalize and accurately detect diseases.[9] The image dataset for the rubber tree plants leaf disease detection system was crafted through a systematic process that encompassed clear objective definition, diverse image collection methods, thorough labeling, organized storage, preprocessing, and strategic dataset division for model development and evaluation.



Fig 1. Healthy Rubber Leaf



Fig 2. Phytophthora



Fig 3. Pestalotiopsis



Fig 4. Pestalotiopsis

IV. PROPOSED SYSTEM

Proposed system application's home page serves as the central hub within the Research System mobile application, serving as the main screen that users encounter upon launching the app. Its primary purpose is to offer users a comprehensive overview of the app's diverse features and functionalities. Beyond being an informational gateway, the home page is designed for user convenience, enabling swift access to the most frequently performed tasks. This intuitive layout ensures that users can efficiently navigate through the app, streamlining their interactions and enhancing their overall experience. In essence, the home page functions as the app's core, providing users with both a snapshot of its capabilities and a practical launchpad for their research-related activities.



Fig 5. Landing Page



Fig 6. Home Page (a)

Once an image is captured and incorporated into the scanning process, users are presented with a dedicated disease decryption page within the Research System mobile application. This specialized page serves as a valuable resource for users seeking in-depth information about various diseases. Here, users can access comprehensive details regarding diseases, including vital information about their symptoms, causes, and available treatments. This feature empowers users with the knowledge needed to better understand the diseases they are researching, aiding in their quest for information, diagnosis, and treatment options.

The disease decryption page represents a pivotal aspect of the app, providing users with the means to access critical health-related insights quickly and efficiently. Each disease displays separate information according to the detection disease.

The diseases treatment page provides users with the immediate treatments that they can do for the diseases and recommend the fungicides they can use for the diseases separately. Users can learn more details using Read more on Wikipedia. Users can share their images with others and save the images.

After detecting the diseases users can share their images with the others in the community with adding enquiry. And by using the community page users can like and comment on the other images and answer foe their questions. Community page displays the username and the location.

The recent page within the Research System mobile application offers users a convenient and efficient way to access their most recently detected images. This feature serves as a practical resource for users to quickly locate and retrieve resources they have recently used or are currently working on. By displaying a list of the most recently detected images, this page simplifies the process of revisiting important materials, streamlining the user experience. Whether users need to reference recent research, continue work on an

ongoing project, or simply keep track of their most recent activities, the recent page provides easy access to these resources, ultimately enhancing productivity and user satisfaction within the app.



Fig 9. Community Page



Fig 10. Recent Page

V. DISCUSSION

In the Discussion, it is crucial to emphasize the significance of the results obtained in the context of the original aims and objectives of this research, which centered on the development of prototypes and an image dataset for a system to detect plant diseases in rubber cultivation. The results obtained from these prototypes and the dataset hold substantial implications for the rubber industry. The prototypes' potential to accurately detect diseases in rubber plants and the creation of a comprehensive image dataset offer a promising direction for cost-effective and efficient early disease identification. This could significantly contribute to mitigating crop losses and enhancing overall rubber cultivation practices. These findings are particularly important for the rubber industry, as they present an opportunity to advance productivity and sustainability.

The research findings should be compared to previously published data in the field. Upon such comparisons, it becomes evident that these prototypes and the dataset provide valuable resources for further research in disease detection. This comparative analysis reaffirms the novel contribution of this work in the field of plant disease detection.

VI. CONCLUSION

In conclusion, the major conclusions drawn from this investigation can be concisely stated as follows: The development of prototypes and an image dataset for a system to detect plant diseases in rubber cultivation show promise in providing practical solutions for an industry that often grapples with disease-related losses. To pave the way for future research endeavors, it is suggested to explore the integration of machine learning models to enhance disease prediction and the implementation of real-time monitoring systems for early disease detection, utilizing the resources provided by these prototypes and the dataset. These future research avenues hold the potential to further advance disease management in rubber cultivation and improve the industry's overall sustainability and productivity.

REFERENCES

[1] Sri Lanka Export and Development Board, 2023. Natural Rubber Industry In Sri Lanka - EDB Sri Lanka. [Online] Available at: https://www.srilankabusiness.com/rubber/about/industry-capability.html [Accessed 01 July 2023].

[2] Rupavatharam S and Kennepohl A and Kummer B and Parimi, V. (., 2018. Automated plant disease diagnosis using innovative android App (Plantix) for farmers in Indian state of Andhra Pradesh. Rupavatharam S and Kennepohl A and Kummer B and Parimi, V (2018).

[3] Sri Lanka Export and Development Board, 2023. Natural Rubber Industry In Sri Lanka - EDB Sri Lanka. [Online] Available at: https://www.srilankabusiness.com/rubber/about/industry-capability.html[Accessed 01 July 2023].

[4] Swain Anisha Image Processing Framework for Machine Learning, 2018. What is an Image Processing Framework for Machine Learning[Online]Available at:https://medium.com/@anishaswain/noise-filtering-in-digital-image-processing-d12b5266847c [Accessed 13 July 2023].

[5] Aparna Jayawardena Kasuni Ganegoda Sakuni Imbulana Gavin Gunapala Nuwan Kodagoda Thilini Jayasinghe, 2022. Rubber Buddy: A Mobile Application to Empower Rubber Planters of Sri Lanka. Aparna Jayawardena Kasuni Ganegoda Sakuni Imbulana Gavin Gunapala Nuwan Kodagoda Thilini Jayasinghe,, Issue 09-10 December 2022.

[6] Ayesha Siddiqua Muhammad Asha Kabir Tanzina Ferdous Israt Bintea Ali, 2022. Evaluating Plant Disease Detection Mobile Applications: Quality and Limitations. Ayesha Siddiqua Muhammad Asha Kabir Tanzina Ferdous Israt Bintea Ali,.

[7] Laxmi M. Tech Scholar, 2022. Detection And Classification Of Plant Leaf Disease Using. [Online] Available at: https://www.ilkogretim-online.org/[Accessed10072023].

[8] Zeng T, (28 February 2022. Rubber Leaf Disease Recognition Based on Improved Deep Convolutional Neural Networks With a Cross-Scale Attention Mechanism. [Accessed10JULY2023].

[9] J. Arun Pandian, G. Geetharamani and B. Annette, "Data Augmentation on Plant Leaf Disease Image Dataset Using Image Manipulation and Deep Learning Techniques," *2019 IEEE 9th International Conference on Advanced Computing (IACC)*, Tiruchirappalli, India, 2019, pp. 199-204. [Accessed 07 July 2023].

[10] M. Kirola, K. Joshi, S. Chaudhary, N. Singh, H. Anandaram and A. Gupta, "Plants Diseases Prediction Framework: A Image-Based System Using Deep Learning," *2022 IEEE World Conference on Applied Intelligence and Computing (AIC)*, Sonbhadra, India, 2022, pp. 307-313, [Accessed 10 July 2023].