REAL-TIME COCONUT PALM DISEASE DETECTION VIA EDGE-OPTIMIZED DEEP NEURAL NETWORKS

SHAIK JOHN SHAIDA
Research Scholar
Dept Of Computer Science and Engineering
Annamalai University

DR. P ARUNA
Supervisor
Dept Of Computer Science and Engineering
Annamalai University

ABSTRACT

In coconut farming practices, disease detection is essential since it allows for the early identification of crop ailments. Data-driven methodologies, including deep learning algorithms and image analysis, may substantially improve illness detection. Convolution Neural Networks (CNNs) are proficient at identifying visual patterns that signify sickness. This technology can identify diseases from aerial imagery and train a deep learning model on a varied data set, enabling farmers to oversee extensive regions in real-time and anticipate disease emergence using environmental data. An examination of coconut data is crucial for enhancing crop health and yield. Conventional techniques, such as manual detection and threshold-based approaches, are inadequate for extensive plantings. A salable method may include a system using drones to capture photos and analyse them via convolution neural networks (CNNs). Proactive measures to mitigate damage upon diagnosis may protect the production and long-term health of coconut palms.

Keywords: *Convolution Neural Networks (CNNs), coconut farming, coconut palms, deep learning algorithms, Conventional techniques.*

INTRODUCTION

Cocos nucifera L., also known as the Tree of Abundance, King of Palms, Tree of Heaven, and Tree of Life, is a multipurpose tree that has been essential to the daily lives of people living in humid tropical regions since the dawn of humanity. It serves as a source of food, shelter, water, fiber, and fuel, making it the most famous palm species ever seen. The exact origin coconut palm has been debated by scientists, with many believing it originated from the Old World, specifically the islands Pacific or Southeast Asia. However, studies suggest that coconuts can germinate after being immersed in water for 110 days, which can travel up to 4,900 km. After the Vedic era, the coconut palm was brought to India, but this does not definitively support its origin. The coconut tree, also known as the Tree of Abundance, King of Palms, Tree of Heaven, and Tree of Life, is an important crop for various horticultural goods worldwide. Over 90 nations farm the coconut, which is native to tropical coastal locations where they thrive on sandy littoral zones formed by waves. Traditional and sustainable coconut palm crafts are practiced in many parts of India, particularly along the coast where coconut palms grow abundantly. The coconut palm tree offers a wide variety of goods, from decorative items to functional implements, making it an adaptable material.

LITERATURE REVIEW

Xun Zhao (2024) Aiming at the problem of low accuracy of traditional target detection methods for target detection in endoscopes in substation environments, a CNN-based real-time detection method for masked targets is proposed. The method adopts the overall design of backbone network, detection network and algorithmic parameter optimisation method, completes the model training on the self-constructed occlusion target dataset, and adopts the

multi-scale perception method for target detection. The HNM algorithm is used to screen positive and negative samples during the training process, and the NMS algorithm is used to post-process the prediction results during the detection process to improve the detection efficiency. After experimental validation, the obtained model has the multi-class average predicted value (mAP) of the dataset. It has general advantages over traditional target detection methods. The detection time of a single target on FDDB dataset is 39 ms, which can meet the need of real-time target detection. In addition, the project team has successfully deployed the method into substations and put it into use in many places in Beijing, which is important for achieving the anomaly of occlusion target detection.

Abhishek Verma (2021) The coconut palm plantation industry relies heavily on expert advice to identify and treat infections. Computer vision in deep learning technology opened up an avenue in the agriculture domain to find a solution. This study focuses on the development of an end-to-end framework to detect stem bleeding disease, leaf blight disease, and pest infection by Red palm weevil in coconut trees by applying image processing and deep learning technology. A set of hand-collected images of healthy and unhealthy coconut tree images were segmented by employing popular segmentation algorithms to easily locate the abnormal boundaries. The custom-designed deep 2D-Convolutional Neural Network (CNN) is trained to predict diseases and pest infections. Also, the state of the art Keras pre-trained CNN models VGG16, VGG19, InceptionV3, DenseNet201, MobileNet, Xception, InceptionResNetV2, and NASNetMobile were fine-tuned to classify the images either as infected or as healthy through the inductive transfer learning method. The empirical study ascertains that k-means clustering segmentation was more effective than the Thresholding and Watershed segmentation methods. The MobileNet model and customized 2D-CNN model were deployed in the web application through the micro-web framework Flask to automatically detect the coconut tree disease or pest infection.

Olivier Asseu (2020) Recent advances in diagnostics have made image analysis one of the main areas of research and development. Selecting and calculating these characteristics of a disease is a difficult task. Among deep learning techniques, deep convolutional neural networks are actively used for image analysis. This includes areas of application such as segmentation, anomaly detection, disease classification, computer-aided diagnosis. The objective which we aim in this article is to extract information in an effective way for a better diagnosis of the plants attending the disease of "swollen shoot".

Mahmoud Alahmad (2018) Sequence Time Domain Reflectometry (STDR) have been demonstrated to be a powerful technique for detecting the length of cable or length of open circuit or short circuit cables. Using this method along with using smart meter on the main electrical panel board to monitor consumption if load at each circuit, enable user to monitor power consumption at each node (power outlet) only by operating a smart digital meter and an STDR circuitry on each circuit at the main electrical panel board. This paper introduces this method and examines it on dead-wire and energized wire with a load connected across it. Experimental results

are demonstrated for both types. Test result show the potential application of this approach to provide consumption information and potential cost saving via feedback for users.

Xuefei Shi (2017) In this study, we proposed a new concept: depth of drowsiness, which can more precisely describe the drowsiness than existing binary description. A set of effective markers for drowsiness: normalized band norm was successfully developed. These markers are invariant from voltage amplitude of brain waves, eliminating the need for calibrating the voltage output of the brain-computer interface devices. A new polling algorithm was designed and implemented for computing the depth of drowsiness. The time cost of data acquisition and processing for each estimate is about one second, which is well suited for real-time applications. Test results with a portable brain-computer interface device show that the depth of drowsiness computed by the method in this paper is generally invariant from ages of test subjects and sensor channels (P3 and C4). The comparison between experiment and computing results indicate that the new method is noticeably better than one of the recent methods in terms of accuracy for predicting the drowsiness.

Kerala

Coconuts have a long history in Kerala, India, dating back to around 3000 BCE. The state is known for its beautiful landscapes and abundant coconut plantations, which are highly regarded for crafting various items from coconut leaves. The coir industry in Mangalore is also flourishing. However, coconut trees in India are susceptible to various diseases, including bud rot, stem bleeding disease, leaf blight, root wilt, grass for deer, snow in Tanjore, and grey leaf discolorations. These diseases can lead to bud deterioration, stem bleeding, leaf spot, root wilt, snow in Tanjore, and grey leaf discolorations. India is the world's third-largest coconut grower, with an annual production of over 14 million coconuts. Southern India is ideal for growing coconuts due to its pleasant climate and abundant riverbeds. The Indian government established the Coconut Development Board (CDB) to aid coconut growers and increase output. Tamil Nadu, Kerala, Andhra Pradesh, and Karnataka are some most common places for coconut cultivation, with 95% of India's coconut production coming from these states. Coconuts are a multipurpose crop with numerous uses, including in drinks, snacks, and handmade goods. To maintain the health of coconut trees, it is essential to follow proper protocols and follow the appropriate protocols.

Genetic variability and varieties

Coconuts are categorized into two varieties: tall and dwarf. Tails, scientifically referred to as var typica, has a per-bearing age of six to ten years and may reach heights of 25 to 30 meters. In India, the three primary varieties are the East Coast Tall, Laccadive Ordinary, and West Coast Tall. Dwarf palms possess a reduced lifetime and more straightforward harvesting methods. They yield a substantial quantity of fruit, although their behaviour may be erratic. India recognises two types: Gangabondam in Andhra Pradesh and retail variants include Laccadive Micro, Kappadam, Andaman Giant, Calangute, Nadora, and Benaulim. The Central Coconut Research Station in Kasaragod and Nileshwar, India, was established in 1916, resulting in significant initiatives to plant coconuts.

The Central Plantation Crops Research Institute (CPCRI) in Kasaragod has forty indigenous types and eighty-six foreign cultivars. The IBPGR is the biggest germplasm bank globally, with 73 varieties, 12 dwarf species, 1 semi-tall species, and 1 hybrid species. Coconuts are susceptible to several illnesses, such as root (wilt) disease in Kerala, cadang-cadang in the Philippines, and deadly yellowing in Florida and the Caribbean.

Palm-trees classification

This research seeks to categorize palm trees according to their health status and the severity of diseases. The research categorizes palm trees into four classifications according to the symptoms seen in their stems, emphasizing the disease's severity. The palm tree exhibits indications of stress, such a lack of water or fertilize, but remains healthy and free from Ganoderma infection. The danger of infection is significantly reduced during the decomposition of wood and mycelium, allowing for the potential formation of fruiting structures with less infection present. Ganoderma inflicts harm on a minimum of 20% tissues it contacts, resulting in the palm tree exhibiting significant distress and a possible risk of toppling. Coconuts significantly contribute to Thailand's GDP and are vital for pulp and bio-diesel production. Young coconut palm trees are optimal for cultivation in tropical environments, particularly in proximity to the equator. Precision agriculture is enhanced by using real-time predictions that are current. Agricultural experts in southern Thailand possess advanced technological resource management tools, including the capability to automatically identify and diagnose issues with coconut palm trees. Technological advancements are improving coconut palm tree output via increased understanding of growth and health characteristics, the ability to monitor plant ages and survival rates, among other factors.

Approach for Disease Detection and Classification

This study aims to classify palm trees based on their health and disease severity. The study divides palm trees into four categories based on symptoms found in their stems, focusing on the severity disease. The palm tree shows signs of stress, such as a deficiency in water or fertilizer, but it is otherwise healthy and does not have a Ganoderma infection. Infection risk is drastically reduced when wood and mycelium decompose, and with only a little amount of infection, fruiting structures may start to form. Ganoderma causes damage to at least 20% tissues it touches, making the palm tree appear in great pain and potentially falling over. Coconuts are a major contributor to Thailand's GDP and are essential for pulp and bio-diesel manufacturing. Young coconut palm trees are ideal for cultivation in tropical settings, especially near the equator. Precision agriculture is made more efficient by using real-time projections that are up-to-the-minute. Agricultural professionals in southern Thailand have access to state-of-the-art technical resources management technologies, such as the ability to automatically detect and diagnose problems with coconut palm plants. Technical progress is enhancing coconut palm tree production in many ways, including a greater knowledge of growth and health traits, the capacity to monitor plant ages and survival rates, and more. High-resolution photography is one way to identify and quantify coconut palm trees. The integration of unmanned aerial vehicles (UAVs) with high-resolution

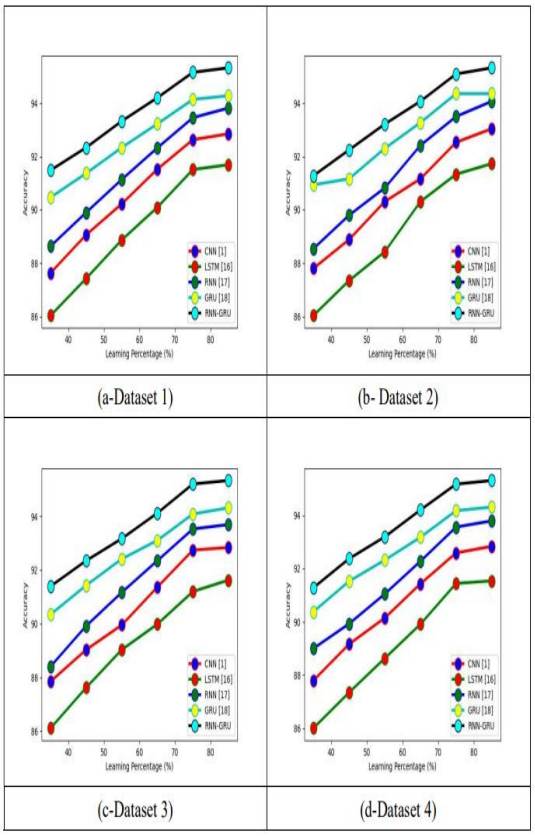
satellite imagery has revolutionized remote sensing by providing clear, high-resolution photos that aren't affected by cloud cover. Manandhar et al. devised a system that uses form feature criteria to precisely identify and quantify coconut trees from a distance. Deep learning algorithms have been used by agricultural sector management to increase output while decreasing expenditure.

RESEARCH METHODOLOGY

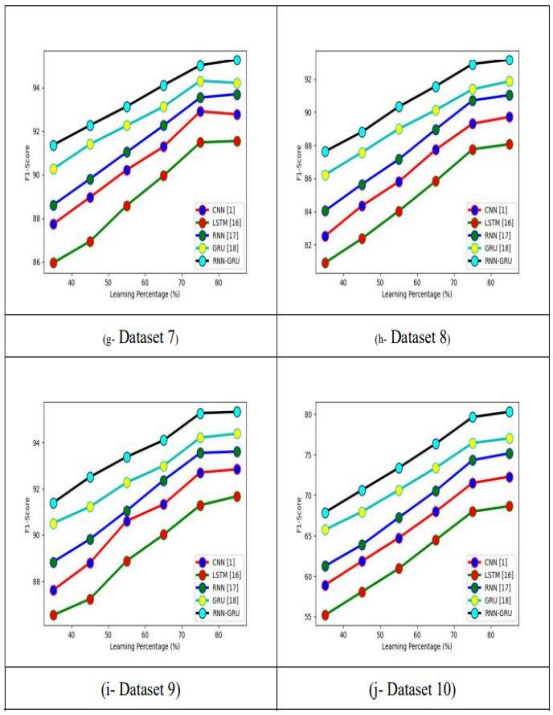
It involves identifying most significant traits from images or data that differentiate between healthy and diseased plants and quantifying them. An effective approach for identifying coconut illnesses involves integrating conventional image analysis and contemporary deep learning methodologies. Image data may be intricate and noisy, resulting in heightened computational complexity and diminished model effectiveness. Feature extraction and selection methods seek to identify relevant attributes, hence reducing dimensional and enhancing learning efficacy. The primary problem in feature selection is the identification of class-relevant traits for illness detection. The Self Adaptive Deer Hunting Optimization Algorithm (SA-DHOA) is a technique for weighted feature extraction. CNN-based deep feature optimization and ResNet-150 feature optimization methods are used for feature extraction in deep learning. Additional techniques include Grey Level Co-occurrence Matrix (GLCM), Local Binary Pattern (LBP), and Principal Component Analysis (PCA). Feature extraction and selection are essential for creating effective disease detection systems. Optimization tactics automate and enhance these processes by concentrating on the most useful aspects and rejecting noise or unnecessary data. Incorporating optimization into feature extraction and selection enables disease detection systems to attain maximum performance for certain applications.

RESULTS AND DISCUSSIONS

The values that follow are: Accuracy is one of several crucial metrics to evaluate at once; a greater rate of accuracy suggests better performance. If you want to know how well the model can differentiate between the two datasets, you need to look at the confusion matrix. In order to assess imbalanced datasets, the classification report is crucial.



Graph 1: Accuracy estimation on developed Coconut Tree diagnosis framework



Graph 2: F1-Score estimation on developed plant disease diagnosis framework with existing classifiers for different

Investigations indicate that the application of image processing techniques can enhance the grading and classification processes, potentially elevating the quality of coconut exports from Sri Lanka. This approach illustrates the potential of technological innovations to surpass traditional human methodologies regarding precision, effectiveness, and impartiality.

Table 1: Overall estimation of developed plant disease diagnosis framework with various classifiers using 10 datasets

Measures	CNN [72]	LSTM [167]	RNN [168]	GRU [169]	RNN-GRU
Accuracy	92.62738	91.50798	93.45085	94.13278	95.14925
F1-Score	86.26229	84.375	87.6964	88.89971	90.753
Specificity	92.64025	91.43935	93.48087	94.18425	95.12781
NPV	92.64025	91.43935	93.48087	94.18425	95.12781
FNR	7.41122	8.286155	6.639218	6.021616	4.786413
FPR	7.359753	8.560645	6.519128	5.815749	4.872191
FDR	19.25494	21.87637	17.31996	15.6582	13.30834
Precision	80.74506	78.12363	82.68004	84.3418	86.69166
MCC	81.61157	79.07224	83.54182	85.15767	87.65173
Sensitivity	92.58878	91.71384	93.36078	93.97838	95.21359
Accuracy	92.53136	91.33409	93.50057	94.35576	95.09692
F1-Score	92.5271	91.34396	93.50057	94.3718	95.09692
Specificity	92.58837	91.22007	93.50057	94.0707	95.09692
NPV	92.58837	91.22007	93.50057	94.0707	95.09692
FNR	7.525656	8.551881	6.49943	5.359179	4.903079
FPR	7.411631	8.779932	6.49943	5.929304	4.903079

In the prior results into perspective, examine their significance, draw conclusions, and suggest directions for further study and possible applications data. Modernization of Farm Implements The efficient use of image processing for classifying and grading coconuts is one example of how technology is influencing the modernization of traditional agricultural techniques. Despite the widespread use of image processing techniques in other industries, this research found that they might potentially improve coconut grading efficiency. Combining agricultural practices with image analysis methods is an intriguing strategy to tackle the ongoing problems with human grading systems.

CONCLUSIONS

Deep learning models, particularly Convolution Neural Networks (CNNs), have the potential to autonomously derive image properties associated with illness symptoms. Combining supervised, unsupervised, and semi-supervised learning approaches can lead to a more

comprehensive and responsive detection system tailored to the complexities of coconut plant monitoring and broader applications. The capture of complex patterns within the data is facilitated by selecting appropriate architectures, such as ResNet, VGG-16, or Efficient Net. Integrating deep learning with conventional image processing techniques can result in enhanced feature richness. Considering coconuts as a significant economic crop in Thailand, it is crucial to use advanced technology in their production and upkeep. Unmanned aerial vehicles (UAVs) are finding more applications in agriculture due to their rapid deployment and efficient capture of high-resolution photos. This study examined the feasibility of identifying and assessing the health of coconut trees using high-resolution images combined with deep learning approaches. The results showed that most affected coconut trees had Ganoderma infections and potassium deficiencies. The proposed method shows potential for coconut tree management in Thailand, making it easier to monitor coconut tree populations and their health, leading to more efficient use of workers and less time spent in the field.

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