Utilizing Image Recognition and Machine Learning to optimize Rubber Tree Tapping Techniques for Enhancing Yield and Ensuring Tree Health

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Abstract

Inefficient rubber tapping techniques among inexperienced farmers in Sri Lanka are causing significant challenges in the natural rubber industry, leading to reduced yields and tree trunk damage. This issue threatens the sustainability and economic viability of rubber production in the country. While various automated tapping technologies exist, there remains a critical gap in accessible, intelligent tools to guide farmers toward precise, tree-friendly tapping methods. This research aims to develop the Rubber Tapping Assistant Program (RTAP), an innovative application leveraging image recognition and machine learning to provide real-time guidance on optimal rubber-tapping techniques. The primary objectives include collecting a comprehensive dataset of rubber tree images, developing accurate prediction models for tapping techniques, and creating a user-friendly mobile application for farmers. The study uses a multi-layered methodology, combining data collection from rubber plantations, the development of machine learning models using the YOLO algorithm, and the creation of a mobile application interface. RTAP includes a tapping location prediction model using Random Forest, XGBoost, and AdaBoost regressors. A tree distance prediction model utilizes the YOLOv8 classification model. Tree Region of Interest (ROI) point prediction and tapped area damage prediction models employing YOLOv8s, YOLOv9m, and YOLOv10s detection models. These models work collectively to provide comprehensive guidance on optimal tapping practices. Initial results show a mean square error of 0.0073 for tapping location, 99% accuracy for tree distance, and average accuracies of 80% and 60% for ROI and damage models, respectively. The damage prediction model is designed to assess trunk health and suggest appropriate tapping strategies. This research is expected to bridge the gap between traditional knowledge and modern technology in rubber farming, potentially transforming tapping practices and improving the economic stability of Sri Lanka's natural rubber sector.

Keywords: *rubber tapping techniques, machine learning, RTAP, rubber trunk defect detection*