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Deep learning driven mobile robot to detect and classify tomato leaf diseases

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Tomato (*Solanum lycopersicum L.*) is a nutritious fruit widely grown as a vegetable in Sri Lanka, with various varieties including HORDI tomato hybrid 03, Thilina, etc. Plant diseases affecting tomato crops result in reduced production and require continuous manual monitoring for diagnosis. Due to the increasing agricultural yields, plant diseases are also on the rise, often affecting the leaves. Traditional methods of disease detection are time-consuming and pose challenges for large-scale farmers. This research focuses on employing a deep learning-driven mobile robot to detect and classify tomato leaf diseases, offering a more efficient and farmer-friendly approach. The system comprises a rover with an adjustable robotic arm holding a camera that can reach a height of up to 03 feet that travels across tomato fields to detect tomato plants and capture images of the tomato leaves. The control system of the mobile robot consists of three stages; the first stage controls the robot chassis with an Arduino board, interpreting user commands for movement. The second stage uses another Arduino board to manage behavior, including obstacle avoidance and navigation. The third stage involves a Raspberry Pi board controlling a camera module for imaging and video capturing for object recognition. I2C, SPI, and serial communication protocols facilitate smooth coordination between the boards, allowing easy development, debugging, and upgrades of individual components. The acquired data via the robot system were utilized for disease diagnosis, classification, and decision-making in the care of tomato plants. Two deep learning-driven computer vision models were developed for disease prediction. The object detection model enables the robot to identify leaves and locate the robot arm. The classification model is employed for the classification and prediction of tomato leaf diseases. The object detection model was trained using 352 annotated tomato leaf images, including leaf blight, leaf miner, and powdery mildew and the model demonstrated a precision of 67.0%, a mean average precision of 65.6%, and a recall of 61.7%. In addition to the object detection model, the deep learning classification model was trained using a dataset of 3360 tomato leaf images, encompassing healthy leaves as well as leaves affected by diseases namely; leaf blight, leaf miner, and powdery mildew. The developed classification model achieved an accuracy of 99% and a loss of 1% on the test data. Further, an Android mobile application was developed utilizing the same object detection and classification models, to enhance farmer accessibility and convenience for efficient management of tomato crops.

Keywords: Android application, Computer vision, Deep learning, Mobile robot, Tomato leaf diseases

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