Analysis of Performance of Physical Condition Detection Tool for Cocoa Fruit (Theobroma cacao L.)

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ABSTRACT

Manual cocoa pod sorting at smallholder plantations is characterized by subjective assessment, inconsistent results, and limited efficiency in handling large-scale production. Therefore, this study aimed to analyze the performance of a computer vision-based physical condition detection system for cocoa pods (Theobroma cacao L.) integrated with a conveyor system for real-time automatic sorting. The research employed a quantitative experimental method through controlled laboratory testing. The system consisted of a Raspberry Pi 5, the YOLOv11 algorithm, an ESP32 microcontroller, a webcam, a conveyor, and a servo actuator. Performance evaluation was conducted based on sorting time, sorting success rate, system stability, the effect of conveyor speed variation, and power supply voltage stability. The results showed an average sorting time of 4.5149 seconds per cocoa pod with an average sorting success rate of 82%. The best performance was achieved at a conveyor speed of 35% PWM, resulting in a 100% sorting success rate and an average sorting time of 4.5049 seconds. The sorting time standard deviation of 0.9007 seconds indicated that the system operated with satisfactory stability, while the voltage stability test demonstrated that the power supply maintained a stable output voltage throughout the system operation. These findings indicate that the developed system is capable of performing real-time automatic cocoa pod sorting with reliable performance and a stable power distribution system, making it suitable for further development.

Keywords: *computer vision, tool performance, automated sorting, cocoa fruit, YOLOv11*