Development of an Automatic Navigation System on Smart-GH Mobile robot Based on Image Processing

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ABSTRACT

Greenhouse environments are characterized by limited space and narrow pathways between plant rows, requiring an accurate and stable navigation system to support automation. This study aims to develop an automatic navigation system for a Smart-GH mobile robot based on image processing to enable the robot to follow a predefined path autonomously. The system utilizes a Raspberry Pi camera as a visual sensor to detect a yellow line as the navigation path using the HSV color segmentation method. The image processing stages include Region of Interest (ROI) selection, color space conversion to HSV, segmentation, noise filtering, contour detection, and centroid calculation to obtain positional error. The error value is transmitted to an ESP32 via serial communication and processed using a PD controller to generate PWM signals for controlling DC motors based on a differential drive system. The experimental results show that the system is capable of consistently detecting the path under various lighting conditions and maintaining stable robot movement with relatively small error values. The implementation of the PD controller effectively reduces overshoot and improves system response in correcting direction deviations. Overall, the robot successfully follows the path from the starting point to the endpoint with a high success rate. Therefore, the proposed image processing-based navigation system combined with PD control is considered effective for application in greenhouse environments.

Key words: *mobile robot*, *image processing*, HSV, PD, *greenhouse*