ABSTRACT

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Study Program	:	*Electrical Engineering*
Title	:	*Implementation of Trajectory Tracking on Differential Drive Mobile Robots Using Odometry and Simultaneous Control Methods*

This research implements a trajectory tracking system on a differential drive mobile robot using odometry and simultaneous controllers, combined with an internal PID speed controller loop. This system enables the robot to navigate between sequential coordinate targets by estimating its position through encoder-based odometry and determining motor speed commands using differential drive kinematic calculations. Two control strategies were evaluated: simultaneous control, which adjusts orientation and translation in parallel, and non-simultaneous control, which performs these adjustments sequentially. Experimental results show that both methods achieve good position accuracy, with average position errors below 5% on the X and Y axes. Non-simultaneous control yields slightly higher accuracy, while the simultaneous control method demonstrates better efficiency in terms of travel time. The robot using the simultaneous method completed the trajectory in an average time of 26.54 seconds, compared to 27.42 seconds with the non-simultaneous method. Additionally, fine-tuning of PID parameters was performed to optimize motor speed response, significantly reducing overshoot and steady-state error compared to open-loop tuning and initial Ziegler–Nichols tuning. These findings confirm that the integration of odometry, differential drive kinematics, and finely tuned PID control provides an effective and reliable approach for coordinate-based path tracking in structured environments without requiring complex path planning algorithms.

Keyword**:** *Mobile Robot, Odometry, Differential Drive Kinematics.*