ABSTRAK

Pertanian presisi pada tanaman jagung menuntut ketelitian jarak tanam yang tinggi, namun kondisi lahan tadah hujan yang bergelombang sering memicu *selip* roda pada robot penyemai sehingga jarak antarbenih menjadi tidak konsisten. Untuk mengatasi masalah tersebut, penelitian ini merancang sistem penggerak penyemai benih jagung otomatis berkonfigurasi *Four-Wheel Drive* (4WD) berbasis algoritma kendali *Proportional-Integral-Derivative* (PID). Sistem dikendalikan oleh NodeMCU ESP32 yang terintegrasi dengan motor DC, motor servo, dan *rotary encoder* sebagai sensor umpan balik, menggunakan metode *tuning* Ziegler-Nichols Tipe 1. Hasil pengujian pada target kecepatan 140 RPM menunjukkan respons sistem yang cepat dengan *rise time* yang cukup cepat. Roda depan terukur stabil dengan *overshoot* 4,29%, sementara roda belakang melonjak hingga 10,71% akibat ketidakseimbangan beban mekanis. Pada pengujian akurasi penanaman sejauh 25 cm, terjadi deviasi jatuhnya benih di rentang 25–30 cm akibat faktor *selip* di tanah gembur, jeda waktu aktuator, dan pantulan benih. Secara keseluruhan, meskipun terdapat penyimpangan jarak rata-rata 1,875 cm, penerapan kendali PID terbukti mampu mempertahankan kestabilan putaran roda dan menjaga toleransi jarak tanam sesuai standar pertanian.

Kata Kunci: Kendali PID, Pertanian Presisi, Robot Penyemai, *Four-Wheel Drive* (4WD), Mikrokontroler ESP32, Jarak Tanam

ABSTRACT

Precision agriculture in corn farming demands high accuracy in planting distance, but the undulating conditions of rainfed lands often trigger wheel selip on seeding robots, resulting in inconsistent seed spacing. To overcome this issue, this study designed an automated corn-seeding robot drive system with a Four-Wheel Drive (4WD) configuration based on a Proportional-Integral-Derivative (PID) control algorithm. The system is controlled by a NodeMCU ESP32 integrated with DC motors, a servo motor, and rotary encoders as feedback sensors, utilizing the Ziegler-Nichols Type 1 tuning method. Test results at a target speed of 140 RPM demonstrated a rapid system response with a reasonably fast rise time. The front wheels measured stable with a 4.29% overshoot, while the rear wheels spiked to 10.71% due to mechanical load imbalance. During the planting accuracy test for a 25 cm target, seed drop deviations occurred within the 25–30 cm range due to wheel selip in loose soil, actuator mechanical delays, and seed bounce. Overall, despite an average distance deviation of 1,875 cm, the implementation of PID control proved capable of maintaining wheel rotation stability and keeping planting distance tolerances within agricultural standards.

Keywords: PID Control, Precision Agriculture, Seeding Robot, Four-Wheel Drive (4WD), ESP32 Microcontroller, Planting Distance