ANALISIS PERBANDINGAN RESPONS BELOK KURSI RODA LISTRIK MENGGUNAKAN KONTROL *PROPORTIONAL INTEGRAL DERIVATIVE* BERBASIS *INERTIAL MEASUREMENT UNIT* DAN *ELECTROOCULOGRAPHY*

LAPORAN TUGAS AKHIR

Karya Ilmiah sebagai salah satu syarat untuk menyelesaikan jenjang strata satu (S-1) di Jurusan Teknik Elektro, Fakultas Teknik, Universitas Andalas

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Judul	Analisis Perbandingan Respons Belok Kursi Roda Listrik Menggunakan Kontrol *Proportional Integral Derivative* Berbasis *Inertial Measurement Unit* dan *Electrooculography*	Irsyad Alghi Fary
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ABSTRAK

Penelitian ini bertujuan menganalisis dan membandingkan respons manuver belok pada kursi roda listrik berbasis *differential drive* menggunakan metode *pivot turn* dan *curve turn*. Analisis dilakukan berdasarkan respons sudut *yaw* dan kecepatan sudut *yaw* (ω_z) untuk menentukan metode manuver yang memberikan performa terbaik dari aspek kecepatan respons dan kestabilan sistem. Penelitian dilakukan melalui pengujian sistem kendali *Proportional Integral Derivative* (PID) yang dituning menggunakan metode *sequential tuning. S*inyal perintah diperoleh dari *Electrooculography* (EOG), sedangkan data sudut *yaw* dan kecepatan sudut *yaw* (ω_z) diperoleh dari sensor *Inertial Measurement Unit* (IMU). Pengujian kontrol *yaw* dilakukan pada sudut target 60°, 90°, dan 120°, sedangkan pengujian kontrol ω_z dilakukan pada kondisi tanpa beban serta variasi beban 50 kg, 60 kg, dan 70 kg. Kinerja sistem dievaluasi menggunakan parameter *rise time*, *settling time*, *overshoot*, *steady-state error* (SSE), *root mean square error* (RMSE), dan *settling time*. Hasil pengujian menunjukkan bahwa *pivot turn* menghasilkan performa yang lebih baik dibandingkan *curve turn*. Pada sudut target 120°, *pivot turn* menghasilkan *rise time* 3,03 s, *settling time* 4,37 s, *overshoot* 0,09%, dan SSE 0,09°, sedangkan *curve turn* menghasilkan *rise time* 7,59 s, *settling time* 10,00 s, *overshoot* 1,93%, dan SSE 0,34°. Pada pengujian ω_z, *pivot turn* menghasilkan *rise time* 0,17–1,59 s, lebih cepat dibandingkan *curve turn* yang berada pada rentang 1,19–8,29 s. Variasi beban memengaruhi karakteristik respons transien, namun kontrol PID tetap mampu mempertahankan nilai SSE yang rendah pada seluruh kondisi pengujian. Berdasarkan hasil penelitian, kontrol PID berhasil mengendalikan sudut *yaw* dan ω_z dengan baik, serta *pivot turn* menghasilkan respons yang lebih cepat dan karakteristik respons yang lebih baik dibandingkan *curve turn.*

Kata kunci: kursi roda listrik, *Electrooculography* (EOG), *Inertial Measurement Unit* (IMU), PID, sudut *yaw*, kecepatan sudut *yaw*, *pivot turn*, *curve turn*.

Title	Comparative Analysis of Electric Wheelchair Turning Response Using Proportional Integral Derivative Control Based on Inertial Measurement Unit and Electrooculography	Irsyad Alghi Fary
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ABSTRACT

This study aims to analyze and compare the turning maneuver responses of a differential-drive electric wheelchair using the pivot turn and curve turn methods. The analysis was conducted based on the responses of the yaw angle and yaw angular velocity (ω_z) to determine the maneuvering method that provides the best performance in terms of response speed and system stability. The study was carried out by testing a Proportional–Integral–Derivative (PID) control system tuned using the sequential tuning method. Command signals were obtained from Electrooculography (EOG), while yaw angle and yaw angular velocity ($\omega_{z)}$ data were acquired using an Inertial Measurement Unit (IMU) sensor. Yaw control tests were conducted at target angles of 60°, 90°, and 120°, Meanwhile, the ω_z control test was conducted under no-load conditions and with load variations of 50 kg, 60 kg, and 70 kg. System performance was evaluated using rise time, settling time, overshoot, steady-state error (SSE), root mean square error (RMSE), and settling time. The results showed that the pivot turn method outperformed the curve turn method. At the 120° target angle, the pivot turn achieved a rise time of 3,03 s, a settling time of 4,37 s, an overshoot of 0,09%, and an SSE of 0,09°, whereas the curve turn produced a rise time of 7,59 s, a settling time of 10,00 s, an overshoot of 1,93%, and an SSE of 0,34°. In the ω_z control tests, the pivot turn achieved rise times ranging from 0,17 s to 1,59 s, which were faster than those of the curve turn, ranging from 1,19 s to 8,29 s. Load variations affected the transient response characteristics; however, the PID controller was able to maintain low SSE values under all testing conditions. Based on the research results, the PID controller successfully controlled the yaw angle and yaw rate (ω_z), while the pivot turn maneuver exhibited a faster response and better response characteristics than the curve turn maneuver.

Keywords: electric wheelchair, Electrooculography (EOG), Inertial measurement unit (IMU), PID, yaw, yaw angular velocity, pivot turn, curve turn.