ABSTRAK

Robot *wall-climbing* memerlukan sistem adhesi yang mampu mempertahankan kondisi perlekatan secara stabil pada permukaan vertikal. Penelitian ini bertujuan merancang dan mengimplementasikan sistem adhesi berbasis *Electric Ducted Fan* (EDF) dengan kendali *Proportional-Integral-Derivative* (PID), serta menganalisis kinerja kendali dalam mempertahankan selisih tekanan (ΔP). Sistem menggunakan EDF 64 mm sebagai aktuator, dua sensor BMP280 untuk memperoleh ΔP, Arduino Nano sebagai unit pengendali, dan *Electronic Speed Controller* (ESC) sebagai pengatur kerja EDF melalui sinyal PWM. Sistem bekerja secara umpan balik dengan ΔP sebagai variabel terkendali dan PWM EDF sebagai variabel manipulasi. Pengujian karakteristik EDF menunjukkan bahwa PWM 70% menghasilkan ΔP sebesar 290,01 Pa, sehingga 290 Pa digunakan sebagai *setpoint*. Parameter awal PID hasil Ziegler-Nichols Tipe 1, yaitu K_p = 1,36, K_i = 0,54, dan K_d = 0,70, menghasilkan *rise time* 0,29 s dan *overshoot* 11,83%. Setelah *fine tuning* diperoleh K_p = 1,10, K_i = 0,40, dan K_d = 0,60 dengan *rise time* 0,20 s, nilai puncak 314,22 Pa, *overshoot* 8,35%, dan *settling time* sekitar 7,02 s. Pengujian statis pada permukaan vertikal menunjukkan bahwa prototipe mampu tetap menempel dengan mempertahankan ΔP mendekati *setpoint*. Hasil ini menunjukkan bahwa kendali PID dapat diterapkan untuk mengatur sistem adhesi EDF dan memperbaiki karakteristik respons tekanan.

Kata kunci: *wall-climbing robot*, sistem adhesi, *Electric Ducted Fan*, PID, selisih tekanan (ΔP), PWM.

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ABSTRACT

A wall-climbing robot requires an adhesion system capable of maintaining stable attachment on vertical surfaces. This study aims to design and implement an Electric Ducted Fan (EDF)-based adhesion system using a Proportional-Integral-Derivative (PID) controller and to analyze the control performance in maintaining differential pressure (ΔP). The system uses a 64 mm EDF as the actuator, two BMP280 sensors to obtain ΔP, an Arduino Nano as the control unit, and an Electronic Speed Controller (ESC) to regulate EDF operation through a PWM signal. The system operates in a closed-loop configuration, with ΔP as the controlled variable and EDF PWM as the manipulated variable. EDF characteristic testing showed that 70% PWM produced a ΔP of 290.01 Pa; therefore, 290 Pa was selected as the setpoint. The initial PID parameters obtained using the Ziegler-Nichols Type 1 method, namely K_p = 1.36, K_i = 0.54, and K_d = 0.70, produced a rise time of 0.29 s and an overshoot of 11.83%. After fine tuning, K_p = 1.10, K_i = 0.40, and K_d = 0.60 were obtained, resulting in a rise time of 0.20 s, a peak value of 314.22 Pa, an overshoot of 8.35%, and a settling time of approximately 7.02 s. Static testing on a vertical surface showed that the prototype remained attached while maintaining ΔP close to the setpoint. These results indicate that PID control can be applied to regulate the EDF adhesion system and improve the pressure response characteristics.

Keywords: wall-climbing robot, adhesion system, Electric Ducted Fan, PID control, differential pressure (ΔP), *PWM.*

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