ABSTRAK

DESAIN DAN REALISASI SISTEM KONTROL KECEPATAN MOTOR DC MENGGUNAKAN METODE *PROPORTIONAL INTEGRAL DERIVATIVE* (PID) BERBASIS ARDUINO NANO UNTUK APLIKASI ALAT SENTRIFUGASI

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Perancangan dan pembuatan alat sentrifugasi dengan kontrol kecepatan motor *brushless* DC menggunakan metode PID telah direalisasikan berbasis Arduino Nano dengan sensor kecepatan efek Hall. Proses kontrol PID diterapkan untuk meningkatkan stabilitas putaran rotor, bahkan ketika terdapat beban tambahan. Pengujian kontrol PID dilakukan menggunakan metode Ziegler-Nichols kedua, dengan proses *tuning* parameter K_p, K_i, dan K_d hingga diperoleh hasil optimal. Rotor pada alat dirancang dengan bahan ABS menggunakan 3D *printing* yang terdiri enam lubang *tube* sampel. Hasil penelitian menunjukkan bahwa kontrol PID dapat menjaga kestabilan putaran pada setiap *setpoint* antara 2.500 hingga 6.500 RPM dengan akurasi sensor rata-rata sebesar 99,95%. Pada uji beban 30, 60, dan 90 gram, kecepatan optimal alat dicapai pada kecepatan 2.000 hingga 3.000 RPM. Berdasarkan hasil ini, implementasi kontrol PID berbasis Arduino Nano efektif dalam menjaga kestabilan dan respon kecepatan alat sentrifugasi, meskipun motor *brushless* DC memiliki keterbatasan torsi dalam memutar beban berlebih.

Kata Kunci: Alat sentrifugasi, Kontrol PID, Arduino Nano, Motor *brushless* DC, Sensor efek Hall

ABSTRACT

DESIGN AND REALIZATION OF DC MOTOR SPEED CONTROL SYSTEM USING PROPORTIONAL INTEGRAL DERIVATIVE (PID) METHOD BASED ON ARDUINO NANO FOR CENTRIFUGE APPLICATION

By

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The design and manufacture of a centrifuge with brushless DC motor speed control using the PID method has been realized based on Arduino Nano with a Hall effect speed sensor. The PID control process is applied to improve the stability of the rotor rotation, even when there is additional load. PID control testing is done using the second Ziegler-Nichols method, with the process of tuning the K_p, K_i, and K_d parameters until optimal results are obtained. The rotor of the device is designed with ABS material using 3D printing which consists of six sample tube holes. The results show that PID control can maintain rotation stability at each setpoint between 2,500 to 6,500 RPM with an average sensor accuracy of 99.95%. In the 30, 60, and 90 gram load test, the optimal speed of the device was achieved at 2,000 to 3,000 RPM. Based on these results, the implementation of Arduino Nano-based PID control is effective in maintaining the stability and speed response of the centrifuge, even though the brushless DC motor has limited torque in rotating excessive loads.

Keywords: *Centrifuge, PID control, Arduino Nano, Brushless DC Motor, Hall effect sensor*