IMPLEMENTASI SISTEM PENGENDALIAN SUHU MENGGUNAKAN METODE PID (PROPORTIONAL INTEGRAL DERIVATIVE)

Nama Mahasiswa	: Novrizal Irfan
Nim	: 3204221529
Pembimbing	: Ir. M. Afridon, S. T., M. T.

ABSTRAK

Kondisi suhu gudang yang tidak stabil dapat mempercepat kerusakan produk, sementara sistem ventilasi konvensional ON/OFF sering memicu fluktuasi suhu dan pemborosan energi. Penelitian ini mengimplementasikan sistem pengendalian suhu gudang otomatis menggunakan metode Proportional Integral Derivative (PID) berbasis mikrokontroler. Sistem dibangun menggunakan Arduino Uno R3, sensor suhu analog LM35, modul AC Light Dimmer Robotdyn 2-channel, layar LCD 2004A I2C, dan dua unit exhaust fan AC 220V dengan penalaan parameter PID Kp = 5.0, Ki = 0.05, dan Kd = 0.2. Pengujian kalibrasi sensor LM35 menghasilkan tingkat akurasi sebesar 98.90% dengan rata-rata error absolut 0.38˚C dan rata-rata error persentase 1.10%. Fenomena dead-band zone pada aktuator di bawah daya 65% berhasil diatasi menggunakan skema *Piecewise Output Mapping* pada rentang kerja efektif 65% - 95%. Selain itu, instruksi *setState(OFF)* saat kondisi *error* ≤ 0 efektif memutus tegangan sisa (0.015V) dan mengeliminasi *humming noise*. Pengujian respon waktu dari suhu awal 34.6˚C menuju setpoint 30.0˚C menghasilkan Rise Time 24 detik, Delay Time 16 detik, dan Steady-State Error 0.0˚C. Sistem kendali terintegrasi ini terbukti responsif, presisi, dan stabil dalam menjaga kestabilan suhu ruangan Gudang.

Kata Kunci: Pengendalian Suhu, PID, Arduino Uno, Sensor LM35, *Exhaust Fan*,.

Implementation of a Temperature Control System Using the PID (Proportional-Integral-Derivative) Method

Nama Mahasiswa	*: Novrizal Irfan*
Nim	*: 3204221529*
Pembimbing	*: Ir. M. Afridon, S. T., M. T.*

ABSTRACT

Unstable warehouse temperatures accelerate product damage, whereas conventional ON/OFF ventilation systems cause thermal fluctuations and energy waste. This study implements an automatic warehouse temperature control system using the Proportional Integral Derivative (PID) method based on a microcontroller. Built with an Arduino Uno R3, LM35 analog temperature sensor, Robotdyn 2-channel AC Light Dimmer module, 2004A I2C LCD display, and two 220V AC exhaust fans, the system utilizes tuned PID parameters of Kp = 5.0, Ki = 0.05, and Kd = 0.2. Calibration testing of the LM35 sensor achieved an accuracy of 98.90% with an average absolute error of 0.38°C and an average percentage error of 1.10%. The actuator's dead-band zone below 65% power was successfully mitigated using Piecewise Output Mapping within an effective operating range of 65% - 95%. Furthermore, executing the setState(OFF) command when error ≤ 0 completely isolated residual voltage (0.015V) and eliminated humming noise. Time-response testing from an initial temperature of 34.6°C to a 30.0°C setpoint yielded a Rise Time of 24 seconds, Delay Time of 16 seconds, and Steady-State Error of 0.0°C. The integrated control system proved to be responsive, precise, and stable for warehouse thermal management.

*Keywords**:** Temperature Control, PID, Arduino Uno, LM35 Sensor, Exhaust Fan.*