RANCANG BANGUN DAN ANALISIS *PROTOTYPE AUTOMATED GUIDED VEHICLE* (AGV) PENGANGKUT *TOOLKIT* BENGKEL PERKAKAS BERBASIS KONTROL PID

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ABSTRAK

Distribusi peralatan kerja (*toolkit*) secara manual di bengkel perkakas memicu ketidakefisienan akibat tingginya *downtime* operator. Navigasi robot konvensional berbasis sensor inframerah sering mengalami kegagalan pembacaan akibat pantulan tumpahan oli dan debu logam. Penelitian ini bertujuan merancang dan menganalisis *prototype Automated Guided Vehicle* (AGV) pengangkut *toolkit* berbobot 0,5 kg dengan kapasitas beban 1 kg. Navigasi dikembangkan menggunakan dua sensor warna TCS34725 dan *I2C multiplexer* TCA9548A berbasis Arduino Mega 2560 untuk mendeteksi nilai RGB dan *Clear*, sehingga tahan terhadap kontaminasi oli. Kestabilan gerak dikendalikan dengan algoritma PD pada *driver* L298N dan dua motor DC *gearbox* (1:48), serta dilengkapi komunikasi nirkabel NRF24L01. Hasil *tuning* metode Ziegler-Nichols menetapkan parameter paling optimal pada $K_p = 4{,}80$ dan $K_d = 1{,}58$. Kombinasi ini memberikan respons kemudi yang tangkas, meredam osilasi, dan mencegah *integral windup* saat manuver. Uji navigasi mencatatkan tingkat keberhasilan 100% pada eksekusi belokan dan pengereman stasiun. Pada beban 1 kg, AGV membutuhkan waktu rata-rata 15,21 detik dibanding manual 11,32 detik pada jarak rata-rata 12,5 meter. Hal ini diakibatkan penambahan massa muatan meningkatkan gaya gesek kinetis antara roda karet dan lantai bengkel, sehingga menurunkan laju linear AGV pada rasio PWM konstan.

Kata Kunci: *Automated Guided Vehicle* (AGV), Kontrol PID, Sensor TCS34725, Distribusi Toolkit, Otomasi Bengkel.

DESIGN AND ANALYSIS OF AN AUTOMATED GUIDED VEHICLE (AGV) PROTOTYPE FOR TOOLKIT TRANSPORTATION IN A MACHINING WORKSHOP BASED ON PID CONTROL

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ABSTRACT

Manual toolkit distribution in machining workshops causes production inefficiencies due to high operator downtime. Conventional navigation robots using infrared sensors often fail due to light reflections from oil spills and metal dust. This study aims to design and analyze a 0.5 kg Automated Guided Vehicle (AGV) prototype with a 1 kg payload capacity. Navigation is developed using two TCS34725 color sensors and a TCA9548A I2C multiplexer connected to an Arduino Mega 2560 to detect RGB and Clear values, rendering it oil-resistant. Movement stability is controlled by a PD algorithm driving an L298N driver and dual 1:48 DC gearbox motors, integrated with NRF24L01 wireless communication. Tuning results using the Ziegler-Nichols method determined optimal parameters at $K_p = 4.80$ *and* $K_d = 1.58$*. This combination provides responsive steering, dampens oscillation, and eliminates integral windup during turns. Navigation tests demonstrated a 100% success rate in executing turns and station braking. At a 1 kg payload, the AGV achieved an average delivery time of 15.21 seconds compared to 11.32 seconds for manual delivery over an average distance of 12.5 meters. This is because increasing the payload mass raises the kinetic friction between the rubber wheels and the workshop floor, thereby reducing the AGV's linear speed at a constant PWM ratio.*

Keywords: *Automated Guided Vehicle (AGV), PID Control, TCS34725 Sensor, Toolkit Distribution, Workshop Automation.*