

ABSTRAK

Industri pengemasan modern menuntut sistem otomatis yang mampu mendeteksi dan mengoreksi orientasi produk secara *real-time* guna meningkatkan efisiensi dan akurasi produksi. Kesalahan orientasi kemasan yang sering terjadi akibat pergerakan acak di jalur konveyor dapat menyebabkan kerusakan produk, gangguan penutupan kemasan, dan penurunan kualitas pengemasan secara keseluruhan. Penelitian ini merancang dan mengimplementasikan sistem *five bar robot* untuk koreksi otomatis orientasi box menggunakan algoritma *Canny Edge Detection* dan *Hough Transform*. Sistem ini dirancang untuk melakukan koreksi orientasi box dalam rotasi sumbu *yaw* atau rotasi pada sumbu *z* menggunakan web camera dan algoritma *Canny Edge Detection* dan *Hough Transform* yang hasilnya digunakan sebagai referensi koreksi oleh sistem kontrol robot. Pada *end effector five bar robot* terdapat *suction cup* dan motor stepper untuk proses *pick and place* berdasarkan hasil perhitungan *inverse kinematics*. Hasil pengujian menunjukkan bahwa algoritma berhasil mendeteksi sudut orientasi kemasan dengan rata-rata *error* $2,48^{\circ}$ dari 80 data pengujian dan rata-rata *confidence level* 94,78%. Sistem koreksi orientasi secara keseluruhan mencapai tingkat keberhasilan 86,67% dari 60 kemasan yang diuji, dengan rata-rata waktu siklus 32,44 detik per operasi *pick and place*, sehingga sistem dapat menyesuaikan orientasi box secara tepat sebelum ditempatkan ke dalam box *packaging*.

Kata kunci: *five bar robot*, koreksi orientasi, *Canny Edge Detection*, *Hough Transform*, *Inverse Kinematics*.

ABSTRACT

Modern packaging industry demands an automated system capable of detecting and correcting product orientation in real-time to enhance production efficiency and accuracy. Packaging orientation errors that frequently occur due to random movement on the conveyor line can cause product damage, packaging closure disruption, and overall packaging quality degradation. This research designs and implements a five bar robot system for automatic box orientation correction using Canny Edge Detection and Hough Transform algorithms. The system is designed to perform box orientation correction in yaw axis rotation or rotation about the z-axis using a web camera and Canny Edge Detection and Hough Transform algorithms, whose results are used as a reference for robot control system correction. At the five bar robot end effector, there are a suction cup and stepper motor for pick and place process based on inverse kinematics calculations. The test results show that the algorithm successfully detects packaging orientation angle with an average error of 2.48° from 80 test data and an average confidence level of 94.78%. The overall orientation correction system achieves a success rate of 86.67% from 60 packages tested, with an average cycle time of 32.44 seconds per pick and place operation, enabling the system to adjust box orientation precisely before placing it into the packaging box.

Keywords: five bar robot, orientation correction, Canny Edge Detection, Hough Transform, Inverse Kinematics.