PENGEMBANGAN SISTEM *INSPECTION-BOX* BERBASIS YOLOV8 UNTUK DETEKSI DINI PADA MAKROSTRUKTUR PRODUK PENGELASAN WAAM

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ABSTRAK

Wire Arc Additive Manufacturing (WAAM) adalah teknologi manufaktur aditif yang membentuk komponen logam secara lapis demi lapis namun rentan terhadap cacat seperti *porosity*, *crack*, dan *spatter*. Inspeksi visual tradisional umumnya dilakukan secara manual, yang memiliki kelemahan seperti ketidakkonsistenan dan kurangnya objektivitas akibat *human error*. Penelitian ini bertujuan untuk mengembangkan sistem otomatis yang dapat mendeteksi cacat pada permukaan WAAM. Sistem ini dirancang menggunakan pencahayaan LED strip yang konsisten, antarmuka pengguna berbasis *Flask Graphical User Interface* (GUI), serta algoritma YOLOv8 yang dilatih menggunakan 5.187 gambar sebanyak 150 *epochs*, dengan *optimizer* AdamW dan *learning rate* sebesar 0,0001. Model YOLOv8 yang dikembangkan berhasil mencapai nilai *mean Average Precision* (mAP) 50-95 sebesar 77% dan F1-*Score* sebesar 88%. Eksperimen dilakukan menggunakan spesimen WAAM dengan dan tanpa *inspection-box*, menghasilkan peningkatan F1-*Score* sebesar 20% dan mAP 50-95 sebesar 8% saat menggunakan *inspection-box*. Hasil ini menunjukkan bahwa penggunaan *inspection-box* secara signifikan mempengaruhi kinerja deteksi model.

Kata Kunci: YOLOv8, *Inspection-Box*, *Wire Arc Additive Manufacturing (*WAAM), cacat makrostruktur, *porosity*, *crack*, *spatter*.

DEVELOPMENT OF A YOLOV8-BASED INSPECTION-BOX SYSTEM FOR EARLY DETECTION OF MACROSTRUCTURE IN WAAM WELDING PRODUCTS

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ABSTRACT

Wire Arc Additive Manufacturing (WAAM) is an additive manufacturing technology that forms metal components layer by layer but is prone to defects such as porosity, cracks, and spatters. Visual inspection of WAAM is typically conducted manually, which has drawbacks such as inconsistency and lack of objectivity due to human error. This study aims to develop an automated system to detect surface defects in WAAM. The system is designed with consistent LED strip lighting, a Flask-based graphical user interface (GUI), and a YOLOv8 algorithm trained on 5,187 images over 150 epochs using the AdamW optimizer and a learning rate of 0,0001. The developed YOLOv8 model achieved a mean Average Precision (mAP) of 50-95 of 77% and an F1-Score of 88%. Experiments were conducted on WAAM specimens with and without an inspection box, resulting in a 20% improvement in F1-Score and a 8% increase in mAP 50-95 when using the inspection box. These results demonstrate that the inspection box significantly enhances the model's detection performance.

Keywords: *YOLOv8, Inspection-Box, Wire Arc Additive Manufacturing (WAAM), macrostructural defects, porosity, cracks, spatter.*