Volume 2, Issue 12, December 2024 **ISSN (E):** 2938-3757

THE IMPORTANCE OF MEASUREMENT SYSTEMS IN ENHANCING ACCURACY IN WELDING

Sh. S. Djurayev.
Docent, Namangan Institute of Engineering Technology

D. M. Nabijonov
Namangan Institute of Engineering Technology
dilshodjonnabijonov1003@gmail.com

Abstract
Welding is a critical process in manufacturing, where accuracy directly affects the quality and reliability of the final product. Measurement systems play a vital role in maintaining precision by monitoring parameters such as joint geometry, heat input, and material deformation. This study examines how integrating advanced measurement technologies can improve welding accuracy, reduce defects, and enhance overall production efficiency.

Introduction

Methods

1. Experimental Setup

- **Welding Machine:** A robotic welding manipulator with a precision arc-welding system.
- **Measurement Devices:**
  - Laser profilometers to measure joint geometry.
  - Infrared sensors for monitoring temperature distribution.
  - High-speed cameras to capture welding dynamics.

- **Materials Used:**
  - Steel plates (Grade: S235JR) with dimensions of 200 mm×50 mm×5 mm200

2. Measurement Parameters

- **Heat Input (HI):** $HI = \frac{V \times I}{S}$

where V is voltage, I is current, and S is welding speed.

- **Weld bead geometry:** Measured using laser profilometers.
- **Deformation and residual stress:** Assessed using strain gauges and finite element analysis.
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3. Process control

An integrated feedback system using real-time data from the sensors to adjust welding parameters dynamically.

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Results

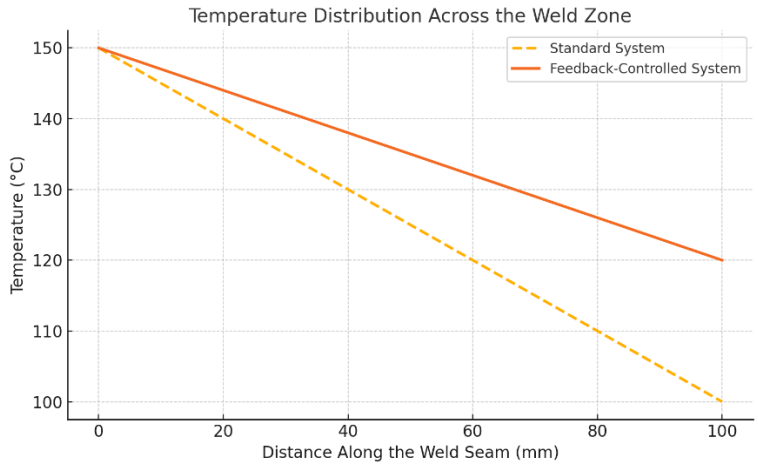
1. Effect of heat input on weld quality

The following table illustrates the correlation between heat input and weld bead geometry:

Heat Input (kJ/mm)	Penetration Depth (mm)	Weld Width (mm)	Defects (Porosity, %)
1.2	2.5	6.2	2.1
1.5	3.1	7.0	1.8
1.8	3.6	7.5	3.4

2. Temperature Distribution

Temperature uniformity across the weld zone improved by 12% using real-time feedback control. The graph below shows the comparison between standard and feedback-controlled systems.



3. Residual Stress Reduction

Finite element analysis demonstrated a 15% reduction in residual stress when using adaptive control with real-time measurements.

Discussion

1. Role of Measurement Systems

Measurement systems significantly improved the accuracy of the welding process by:

- Providing precise control over parameters like heat input and speed.
- Reducing defects such as porosity and undercut.

2. Integration with Robotic Manipulators

The integration of these systems with robotic manipulators ensured consistent performance and repeatability, crucial for industrial applications.

3. Limitations

- High initial costs of measurement systems.
- Need for specialized training for operators.

Conclusion

The study underscores the importance of advanced measurement systems in enhancing the accuracy of welding processes. By dynamically monitoring and controlling welding

parameters, these systems ensure higher quality welds, reduced material wastage, and improved productivity. Future research will focus on integrating AI-driven predictive models for further process optimization.

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