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Thi Dieu Linh Nguyen
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Prediction of the Welding Process Parameters and the Weld Bead Geometry for Robotic Welding Applications with Adaptive Neuro-Fuzzy Models

- Minh Duc Vu,
- Chu Anh My,
- The Nguyen Nguyen,
- Xuan Bien Duong,
- Chi Hieu Le,
- James Gao,
- Nikolay Zlatov,
- Georgi Hristov,
- Van Anh Nguyen,
- Jamaluddin Mahmud &
- Michael S. Packianather
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Abstract

The weld bead geometry is the important information for determining the quality and mechanical properties of the weldment. The welding process parameters or variables that affect the weld bead geometry in the conventional arc welding process include the following: the welding voltage U, the welding current I, the wire feed speed WFS, the contact tip to work distance D, and the welding speed S. Modeling and predicting the weld bead geometry play an important role in welding process planning, to determine the optimal welding process parameters for achieving the improved weld quality. There have been lots of efforts and studies to develop modeling solutions and simulations to determine the weld bead geometry (Height H and Width W) from the welding process parameters (U, I, WFS, D, S) as the inputs. The welding process parameters can be determined based on the experiences, and the conventional analysis of variance (ANOVA); however, the high welding quality and accuracy are not always obtained. With the advancement of computer vision technologies, digital images from cameras and videos can be used for training the deep learning models, to accurately identify and classify objects. The digital images for evaluating the welding quality and the characteristics of welding objects can be captured via the use of the high-speed camera, and there are emerging data acquisition systems that can handle a huge dataset. In this paper, an adaptive neuro-fuzzy inference system (ANFIS) model is proposed to determine weld bead geometry from the main welding process parameters U, I and S. The proposed ANFIS model was successfully developed for the first basic investigations, as the foundation for further developments of innovative robotic welding systems which can be used for higher educations or research in Smart Manufacturing, with potentials for industrial applications.

Keywords

- **Welding robots**
- **ANOVA**
- **ANFIS**
- **weld bead geometry**
- **GMA welding**
- **gas metal arc welding**
- **GMAW**
- **metal inert gas welding**
- **MIG**

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Author information

Authors and Affiliations

1. **Department of Aerospace Engineering, Le Quy Don Technical University, Hanoi, Vietnam**
   Minh Duc Vu
2. **Institute of Simulation Technology, Le Quy Don Technical University, Hanoi, Vietnam**
   Chu Anh My & The Nguyen Nguyen
3. **Center of Advanced Technology, Le Quy Don Technical University, Hanoi, Vietnam**
   Xuan Bien Duong
4. **Faculty of Science and Engineering, University of Greenwich, Gillingham, Kent, ME4 4TB, UK**
   Chi Hieu Le & James Gao
5. **Institute of Mechanics, Bulgarian Academy of Sciences, 1113, Sofia, Bulgaria**
   Nikolay Zlatov
6. **University of Ruse "Angel Kanchev", 8 Studentska Street, 7004, Ruse, Bulgaria**
   Georgi Hristov
7. **Welding Engineering Laser Processing Centre, Cranfield University, Cranfield, UK**
   Van Anh Nguyen
8. **College of Engineering, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia**
   Jamaluddin Mahmud
9. **School of Engineering, Cardiff University, Cardiff, CF24 3AA, UK**
   Michael S. Packianather

Corresponding author

Correspondence to Chu Anh My .

Editor information

Editors and Affiliations

1. **A1 Building, Hanoi University of Industry, Bac Tu Liem, Hanoi, Vietnam**
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2. **School of Engineering and Technology, Universidad Internacional De La Rioja, Logroño (La Rioja), Spain**
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3. **Swinburne University of Technology, Hanoi, Vietnam**
   Anh Ngoc Le
4. **Warsaw University of Technology, Warsaw, Poland**
   Maria Ganzha

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