Data-Driven Automation in Welding: Leveraging Advanced Machine Learning for Quality and Efficiency

Muhammad Omair Khan[1], Md Ariful Islam Mazumder[1], Ibad Ullah Azam, Shifat Shima Akter[2], Hee-Cheol Kim[1,3]*

[1] Digital Anti-Aging Health Care, Inje University, Gimhae-si, Republic of Korea

[2] Department of Industrial & Management Engineering, Inje University, Gimhae-si, Republic of Korea

[3] Department of Computer Engineering, Inje University, Gimhae-si, Republic of Korea

heeki@inje.ac.kr

***Abstract*— Automation in manufacturing has played an important role in optimizing the welding process by attaining the utmost level of quality control with high operational efficiency. This paper analyzes 15,000 welding observations that belonged to the Hanthec organization. Through comparative analysis of SVM, MLP, and Decision Tree algorithms, our research establishes an effective machine learning framework for welding parameter optimization. The Decision Tree model obtained an excellent performance with the best accuracy of 80% and perfect recall. High correlations between power and thermal aspects as high as 0.96 have been obtained. The developed framework enables systematic parameter selection and demonstrates the potential for automated decision-making in industrial welding applications, contributing to improved manufacturing quality and reliability.**

***Keywords*— Artificial intelligence, machine learning, manufacturing, welding, automation**

Muhammad Omair Khan is pursuing his Ph.D. in the Institute of Digital Anti-Aging Healthcare at Inje University. His research interest aligns with Computer Vision, Medical Image Processing, Metaverse, Artificial Intelligence, and Bio Signal Processing.

Md Ariful Islam Mozumder is pursuing his Ph.D. in the Institute of Digital Anti-Aging Healthcare & Computer Science at Inje University. His research interest aligns with Deep Learning, Computer Vision, Medical Image Processing, Digital Pathology Images, Sensor Data Analysis, Bio Signal Processing, NLP, and Blockchain.

Ibad Ullah Azam is pursuing his master's degree in the Department of Computer Engineering at Inje University. His research interests are computer vision, activity recognition, data science, and medical imaging.

Shifat Shima Akter is pursuing his Master's in the Department of Industrial & Management Engineering at Inje University. His research interest aligns with Data Science, Supply Chain Management, Business Informatics, Digital Marketing, and Artificial Intelligence.

Moon-il joo Ph.D in Software Engineering and Computer Engineering at Inje University, Republic of Korea. His research interests are computer vision, Software Engineering, Blockchain, data science, and medical imaging.

Hee-Cheol Kim Ph.D. at Numerical Analysis and Computing Science, at Stockholm University in Sweden. He is a professor and Head of Institute of the Digital Anti-aging Healthcare, Inje University, South Korea. His research inter ests include Machine learning, Computer Vision, Text mining, Bioinformatics, Blockchain, Metaverse, and XAI.