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## Nozzle-to-Work Distance Measurement and Control in Wire Arc Additive Manufacturing

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# Nozzle-to-Work Distance Measurement and Control in Wire Arc Additive Manufacturing



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### What is it about?

In multi-axes Wire Arc Additive Manufacturing, keeping the correct nozzle-to-work distance is crucial to avoid collisions and process defects. Measuring this distance is challenging as the welding arc complicates the usage of conventional distance measurements without positional offset in-process. For that reason, this study investigated and evaluated the usage of several sensors (wire feed sensor, current and voltage sensor, microphone, welding camera, spectrometer, structural acoustic sensor) for a direction independent

in-process measurement. Features were extracted based on domain knowledge and selected by means of a correlation analysis. The spectrometer (Pearson's  $r = -0.90$ ) showed the most robust measurements for stable process parameters when computing the relative intensity at a wavelength of 960 nm, followed by the welding camera (Pearson's  $r = 0.84$ ) when analyzing the images with a convolutional neural network. Based on the findings, a closedloop- control was created. As a system identification revealed a high impact of the welding speed on the track height in comparison to the wire feed rate (Pearson's  $r = -0.90$  <math>\leftrightarrow -0.16

was realized by means of a simple P-control for the welding speed. The proposed approach enabled the manufacturing of multi-layer multi-bead parts with multi-axes deposition paths.

## Why is it important?

Industrialization of Wire Arc Additive Manufacturing;  
First Time Right Printing;  
Reduce Time for Process Parameter Optimization

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