Engineering: Global Research Scholars: Summer in Germany – TUD

Zhichao Sun

Department of Civil and Environmental Engineering, College of Engineering, University of Illinois at Urbana-Champaign

INTRODUCTION

This research aimed to make the 3-D printing process easier by writing a program with multiple user interfaces that the user can simple input the parameters of certain shapes (Stars and polygons for now) and get the code that the robot can understand directly. Welding parameters were studied and tested for the optimization of welding performances.

STATE OF THE ART

Wire + Arc Additive Manufacturing (WAAM) is a method that uses arc welding to build the component in layers. A metal wire is fused in place using a welding torch to form the desired blank.

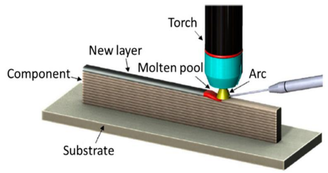


Figure 1. WAAM (https://doi.org/10.3390/ma12071121)

Cold Metal Transfer (CMT) is the digital process control detects a short circuit and then helps to detach the droplet by retracting the wire: during welding, the wire moves forward and is pulled back again as soon as the short circuit occurs.

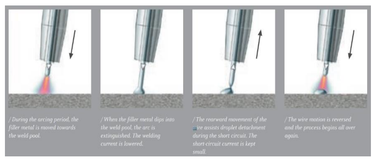
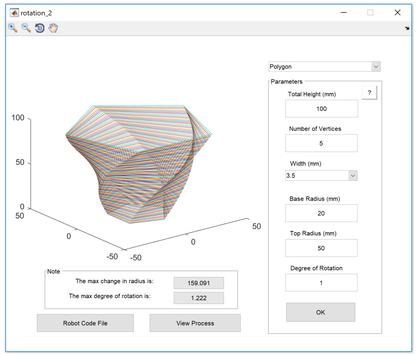


Figure 2. Cold Metal Transfer (www.digitalweldingsolutions.com/CMT.pdf)

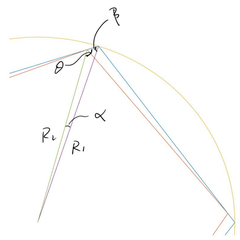
USER INTERFACE

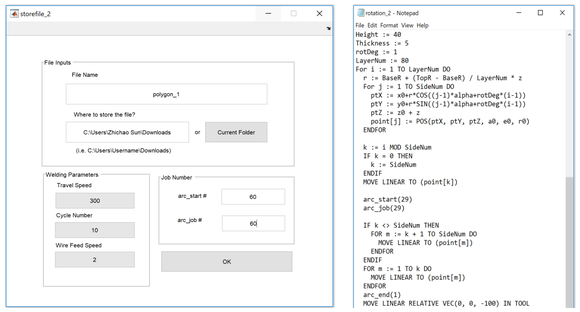
The user interface works as a bridge to link the user with the robot. In the program, the users can input the parameters of the shape they want, get the robot code file, and visualize of the welding process.



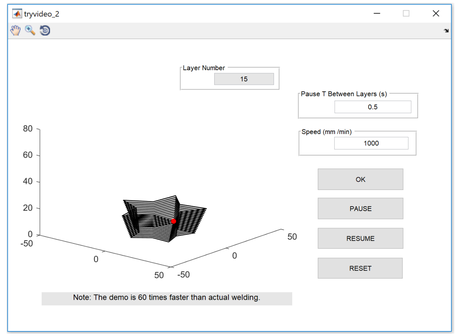
The first user interface asks the user the parameters, calculates the limitations and generates the 3D model. To make sure the inputs are reasonable, limitations including maximum change in radius and maximum degree of rotation were calculated and shown in the note panel.

Two adjacent layers are shown and the maximum degree of rotation occurs when the vertices of the next layer is on the current layer. A larger angle means some material will fall outside of the model.





The second user interface asks the users for a robot code file name, where to store it, and two robot parameters. Then they get the text file and is ready to print. The parameters on the lower left corner decides the welding performance and are to input in the robot.



The third user interface is the visualization of the welding process. The users can set up the pause time between layers and the travel speed of the arc.

WELDING PARAMETERS

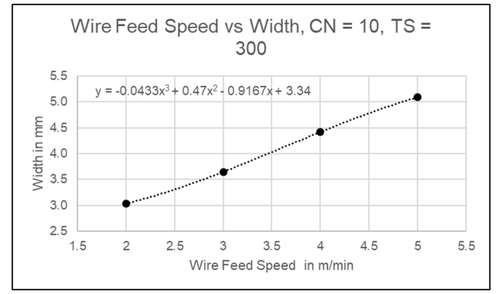
For simplicity, among many parameters, three of them were chosen and studied, travel speed, cycle number and wire feed speed. Travel speed (TS) is how fast the welding arc is moving relative to the work piece. Cycle number (CN), as shown in figure 2, is the number of times the tip goes back and forth before a short pause time. Wire feed speed (WFS) determines both electrode melting rate and current.

The first experiment was with fixed CN, increase TS and WFS at a fixed ratio to find out their influences on width. From prediction, as TS increases, width decreases, and as WFS increases, width increases. Based on the prediction, it turned out that at different cycle number, either TS or WFS dominates the performance of width.

CN	TS	WFS	Width
5	↑	↑	↓
10	↑	↑	↑
15	↑	↑	↓
20	↑	↑	↑

Based on the experimental data, several width predictions were made and then tested. (Desired widths are needed in the program, and thus is focused on.)

The second experiment was to fix two of the parameters and find the correlation of one parameter with width and also to prove the assumption mentioned before.



It proved the assumptions. Based on the function in the graph, further width predictions could be made and tested. However, since only four points were added, the width predictions can only be used in this range.

CONCLUSION AND FUTURE STEPS

User interface can link users with robots and make 3d printing more accessible and faster. Travel speed has a negative correlation with width, and wire feed speed has a positive correlation with width. Lastly, the effect of travel speed and wire feed speed on v number.

In this research, more shapes could be added for users to choose in the future. In the welding parameter part, the effect of travel speed and wire feed speed on width at different cycle numbers as mentioned in experiment 1 should be investigated. More points could be added in the second experiment for better prediction use.

ACKNOWLEDGEMENTS

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