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DETERMINATION OF THE OVERALL DIMENSIONS OF THE DEPOSITED PART DURING WIRE AND ARC ADDITIVE MANUFACTURING USING WIRE SENSING TECHNOLOGY

At all times, an important tool for increasing the production efficiency has been the production cost reduction of manufacturing a particular product. One of the relevant methods for achieving this goal is additive manufacturing (AM) technologies. Among different AM technologies there is one called Wire and Arc Additive Manufacturing (WAAM). It is based on Gas Metal Arc Welding (GMAW) methods and uses standard welding equipment such as welding robots and suitable robotic welding machines. Objects that are manufactured according to this technology are not limited in size compared to some other AM technologies. One of the features of WAAM is its relatively high heat input. The large amount of heat that is introduced into the part through the electric arc does not have enough time to dissipate completely. As a result, effect of heat accumulation appears. This effect leads to the increased interpass temperature, which affects, first of all, the shape and dimensions of the deposited object. The above problem becomes critical with increasing height of the part and complex geometric structures such as overhanging or horizontal components.

To improve the traceability of the object deposition process, it is proposed to use a standard welding seam finding system in order to control the overall dimensions of the part. Currently the following systems are widely used: Through-Wire Touch Sense, Through-Arc Seam Tracking, Laser Sensing, 2D Camera, Laser Seam Tracking, 3D Camera [1, 2]. These searching technologies are listed in ascending order of cost and complexity. Among them, the Through-Wire Touch Sense system is one of the simplest.

The searching process consists in the physical contact of the welding wire with the surface of the conductive part about to weld. The system uses a low voltage circuit to detect the joint during low-speed search [3]. For accurate joint detection, the

use of automatic wire cutters is recommended in order to ensure consistent wire stick out during every search. Touch sensing can be either built-in into the welding power source or developed and integrated as a separate package into the robot controller.

Searching process performed by wire sensing is slower than laser technologies. This is due the fact that it takes some time for the robot to physically move to the location of the detection, and then slowly approach the point to achieve the best accuracy (searching speed is up to 50cm per minute).

Since the search is carried out with a certain length of wire stick out, this allows to determine the coordinate of the touch point. Based on the data of several search points, it can be concluded in which direction the deposited part is displaced and, therefore, in which direction it is necessary to adjust the deposition trajectory.

The following algorithm for applying the touch sensing searching system is proposed:

1. before the searching procedure, the welding wire has to be cut off with a predetermined stick out (for example, 15 mm) using the torch cleaning station (the robot has to be calibrated to use the torch with this wire stick out);

2. the searching program with a specific angle of the torch to the surface of the part (for example, 45 deg) is starting at predetermined deposition stage (for example, every 10 mm of height);

3. the welding wire is touching the part in programmed points;

4. searched point coordinates are compared with CAD model coordinates;

5. if the difference in coordinates is greater than the specified one, the program has to stop with a message about the need to correct the trajectory.

The introduction of such a searching system into the deposition program could increase control over the manufacturing process, receive feedback on the part and improve quality control.

At the same time, this does not require the cost for additional equipment, as is the case with laser searching systems. Learning this system should not take long, as it is based on the functions built into the controller.

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