

Dynamic Arc Stabilization Options for Gas Metal Arc MIG/MAG Robot Welding

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Abstract - As the number of welding experts and the cost of automation are reduced, the use of robotics is becoming increasingly important in this field. The purpose of this article is to introduce the automation of the production of a given component as a use case for university studies and experimental settings for further research. The part had previously been welded by hand, but the growing annual order number has necessitated robot welding. The article presents a new welding device that uses a robotic arm equipped with relevant sensors.

Keywords—MIG/MAG welding, robot welding, welding sensors, digital education

I. INTRODUCTION

Nowadays, the number of skilled welders is declining. In order to perform quality work, the presence of welding robots is becoming more widespread, in both manufacturing and development areas. [1]

Improving production with a welding robot in most cases does not mean improving the equipment, but improving the production environment. For example, it is a common applicability advantage to repair a welded part device for proper quality production. [2] However, this solution is in most cases too expensive, time consuming and does not even provide adequate quality.

When using sensors for robotic welding [3](see Fig. 1.), it is advisable to use a non-contact welding seam tracking system. The intelligent laser sensor (SLS) must be mounted so that it faces the welding gun. The SLPr (Smart Laser Probe) (see Fig. 2.) is responsible for positioning the welding head and also for the welding wire to be in the correct connection. This intelligent laser probe, for most simple straight seams, offers significant benefits in terms of quality and productivity.



Fig. 1: Robot welding with sensor

The second section of the paper describes the basics of the problem of a welding robot like fixing the workpiece, the coordinate systems of the robot arm and welding.[4] The focus of the third section is the design of the welding jig mentioning those topics which might be important in education. The fourth section introduces a simulation environment for robot Smart Laser Probe which is a completely new and fairly effective approach to seam tracking. Leveraging the latest in electronics and digital technology, SLPr raises seam tracking to a better level of standard system performance.[5]



Fig. 2: Smart Laser Probe

II. TYPICAL APPLICATION

Smart Laser Probe is the tracking system of choice for machine welding applications such as:

- Welding lathes for air, water and all types of cylindrical tanks
- Linear machines, such as side beam, travel carriage and seam welders
- Gantry welders, such as railway wagon side and roof welders
- Simple column and boom applications

Key Features of SLPr include:

- Very high-quality, high-resolution image generation by exploiting several novel and unique design features

- Fully digital system in incorporating a completely up-to-date control structure
- User friendly operator interface
- Wide range of standard sensors and interface options for different applications.[6]

If the sensor is used during welding, the programming time is significantly shortened, and the position of the seam can be determined more precisely. I would like to explain this by an example (see Fig. 3.). Welding must be performed on an arc marked in blue.[7]

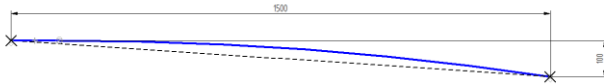


Fig. 3: Programming line by sensor

P1- the starting point of welding P2 is the end point of welding When programming, I record point P1 as the starting point where the robot will start welding. Point P2 is the end point where the welding is completed. If the sensor is switched off, the welding robot connects the two points in a straight line, so the robot would follow the dotted line. By switching on the sensor, the robot takes into account the “pattern” of the given welding radius, thus following the actual welding arc between the two points.

III. PROBLEM DESCRIPTION

As shown in Figure 4., the sensor is attached to the welding gun. One of the biggest disadvantages of Smart Laser Probe is that there is approx. 80 mm constant distance. [8]

Based on these, the robot will not actually start welding at point P1 (figure 3.), but 80 mm forward. We program a specific welding dimensions and determine the tolerance range.

As there is an 80 mm difference between the detection line and the actual welding point, the deformation due to welding is not detected by the robot within this section. This phenomenon is a problem because even in this range, a few tenths of a mm of deformation occurs due to heat input from welding. After determining the position of the workpiece, the next step was to design the fixation.

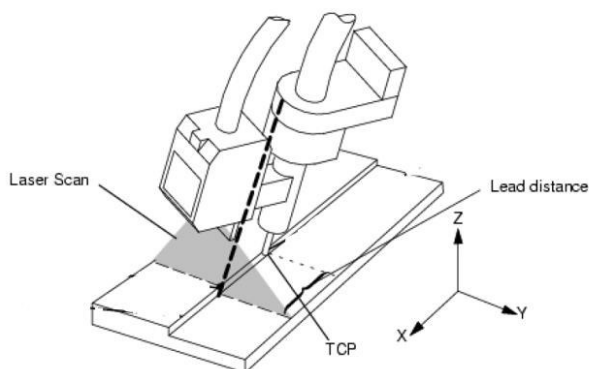


Fig. 4: Head with attached sensor

IV. PROPOSAL

The proposed solution to the aforementioned error is to use an arc sensor. [9]

Through Arc Seam Tracking (TAST) allows the robot to follow the welding seam vertically, the distance between the gun and the workpiece, observing changes in the welding current.

The information provided by TAST allows the system to adjust the robot trajectory to remain the center of the weld in the joint. The path of the robot can be set to the weaving plane and the vertical plane (z direction of the tool). You can use vertical tracking with or without subsequent subtracking, with or without weaving (see Fig. 5.). [10]

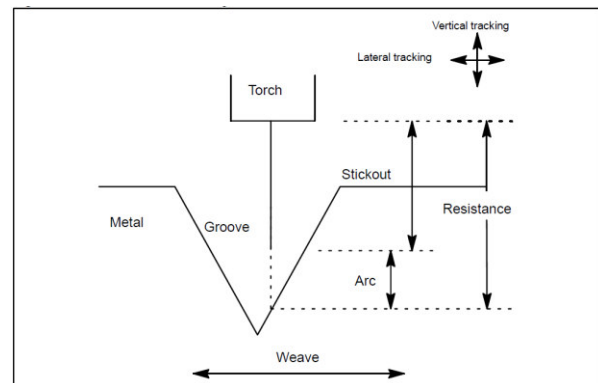


Fig. 5.: Sub tracking

The use of the six-point method for property racks are recommended to adjust the tool frame. When jogging in the tool, the z + coordinate should move along the gun nozzle and be away from work. The following requirements should be met for successful tracking:

- The material thickness should be greater than 2 mm.
- Grooves should have a consistent included angle of 90 degrees or less.
- Fillet joint scan have a maximum included angle of 90 degrees and must have at least 5 mm leg length.
- The minimum weave width must be three times the diameter of the electrode or greater.
- Tack weld, leg size, should be less than or equal than half the weld size, if possible, and concave in profile.
- The actual weld seam should deviate less than 15 degrees rotation from the taught weld seam.
- The torch must be positioned close to the center of the weld seam at the start of the weld (Touch Sensing might be necessary).
- Outside corner and lap joint fillets must use a weave width of 2 mm less than the base metal thickness.
- Fit up of the joint (gap) must be with in normal (blind) welding robot tolerances. Ideally, gaps should be consistent along the weld path
- Base metal must be ferrous or have a resistance greater than mild steel.
- TAST uses SINE type weaving only.

See Figure 6. for recommended weld joint configurations that can be used with TAST.

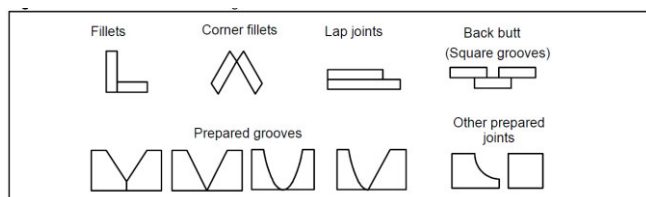


Fig. 6.: Recommended weld joint

When welding with sensors, the best solution is to use multiple sensors. In some cases, it is preferable to use an optical sensor. However, there are cases where the arc tracking sensor is the best solution. [11]

The general experience is that within a complex welded structure, and even on a given product, there are welded joints where the simultaneous use of several sensors is the most appropriate solution. [12]

Robot welding, developed with sensors, is an excellent solution for the production of more complex structures with the right quality.

At the same time, of course, the robot environment (figure 6.), such as the welding devices and jigs around the robot, must be improved. This is necessary because not everything can be solved by developing sensors alone. [13]

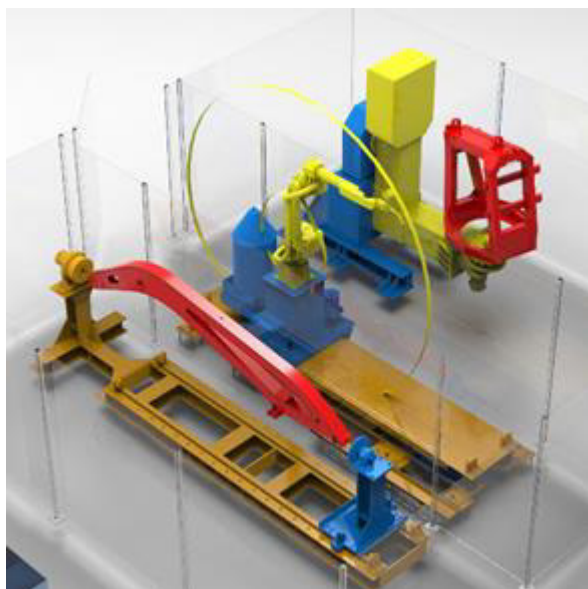


Fig. 7.: Robot environment with devices and jigs

One of the best solutions for deformation in the heat zone is still that the device for securing the welded structure is properly designed and manufactured. [14]

The device must take care that the part is not deformed during welding. After all, the right sensor follows the deformation, but this deformation may not meet the drawing specifications.

We can use very reliable, commercially available welding devices (see Figure 8.), but we can also use special,

individually designed welding jigs (see Figure 9. and 10.) for the right quality.



Fig. 8.: Commercially available welding device



Fig. 10.: Individually designed welding jig

V. CONCLUSION

Robot welding is a major advance in the production of welded structures. [15] Robots need to be further developed in order to weld complex structures to the right quality. In the world today, it is a common fact that the development of robot welding is exhausted in the development of welding jigs. This in itself is not enough. Appropriate sensor programming is also required. [16] Of course, proper work safety must always be kept in mind during the design and manufacturing processes. [17]

The most important condition for this progress is that we learn to use robots in addition to sensors, as the result of this development may be that we can develop and manufacture more complex welded structures in the right quality.

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