Design and test of a robotic cell for stud bolt welding in heat exchangers for SWEP International AB

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MSc Thesis TFRT-6149
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Popular Science Summary

SWEP International AB is a Swedish company which manufactures a wide range of heat exchangers. It is in a process of expansion and improvement of its manufacturing procedures, and this project was a part of that process.

The project targeted automating production steps where stud bolts are welded on a heat exchanger. Until now, this has been a manual process where an operator uses steel templates to position the bolts in the right place and manual welding guns to weld the bolts. These templates are needed because there are strict requirements for the position and perpendicularity of the stud bolts that need to be accomplished. There are a lot of different templates that can be used depending on the position requirements and the type of heat exchanger that is being welded, and this means that a lot of storage space is needed for them and a lot of time is lost every time the templates has to be changed. These are some of the reasons why this project happened. By doing the welding process with a robot, the company can save time and get rid of all the steel templates.

The project was divided in two main parts: in the first one the scope was to create a digital model a semi-automated solution where a robot calculates the position of the bolts and welds them in that position and an operator loads, turns and unloads the heat exchangers in the work table, and then test and verify it in a real cell with an actual ABB robot. The fact that it is a semi-automated solution is because it is easier to test it in a real robot cell, and it is also easier to compare the results with the results of the manual welding process and see if it is actually worth the change. In the second one, the scope was to start studying the possibilities of developing a fully automated solution where all the tasks are performed

by robots and no operators are needed. The fully automated solution was investigated to compare the results with the semi-automated solution and see if it would be worth it for the company to fully automate the process.

During the simulation phase of the semiautomated solution the first step was to decide how the tools would be mounted in the robot and which layout of the work space would be the best to optimise the process. Once this was done, some pieces were designed and manufactured to be able to create this layout in the real robot cell. Then a program to find the edges of the heat exchanger and calculate its center was designed. This point is used as the zero point for the coordinates of the stud bolts. Finally, a program to calculate the orientation of the top surface of the heat exchanger was created. This orientation is used to adjust the orientation of the welding gun in order to accomplish the perpendicularity requirements.

In the verification phase the programs created for the simulation had to be optimised and adjusted to the real robot operation. Some reasons for this were the performance of the measuring equipment or the irregular shape of the heat exchangers.

In the end, the calculation of the positions and the perpendicularity correction were carried out correctly, but they still need some improvements to optimise the entire procedure and reduce cycle times.

Regarding the fully automated solution, a simple digital model was created to start studying the performance that the whole system would have and some simulations where run, but not much more work could be done due to time restraints.
Since the project couldn't be finished, it is not possible to compare the welding results with the manual welding process results, but all the work done sets the base for the automation of the welding process in the future.