Automation and simulation of a robot cell for stud bolt welding

SWEP International AB is a company that makes heat exchangers, devices used in heating and cooling systems across many industries. During production, small bolts need to be welded onto the surface of these heat exchangers, seen in Figure 1. Right now, this process is done manually, but the company wants to fully automate it using a robotic system. The goal is to make the process faster, more efficient, and more precise, reducing the need for human labor while ensuring consistent quality.

Figure 1: a heat exchanger with stud bolts welded to its surface

The idea is for a robot to first measure the heat exchanger carefully using a touch probe, seen in Figure 2, to determine exactly where the bolts should go. Once the robot has gathered this information, it can then weld the bolts in place using a weld gun, seen in Figure 3. Since even small variations in position could affect the final product, the robot needs to be extremely precise. This thesis builds on previous work at SWEP and focuses on improving the accuracy of the measurements, optimizing the welding process, and making the automated system easier to control and monitor. To achieve this, different welding settings, such as electrical current, welding time, and gas flow, were all tested to find the best combination for strong and reliable welds. The welded bolts were then tested by bending and twisting them to check their strength. Another key part of the project was to test different methods of measuring the heat exchanger's position to ensure that the robot places the bolts correctly every time. A safety system was also developed to monitor the welding process in real time, stopping it immediately if any settings fall outside safe limits.

Figure 2: touch probe used to measure the heat exchanger

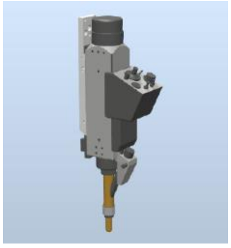

Figure 3: weld gun that performs the welding

To improve the usability of the system, a control interface was designed, allowing operators to enter work orders and adjust settings through a touchscreen that controls other hardware and the robot, seen in Figure 4. Additionally, the way the heat exchanger is positioned in the robot cell was analyzed and improved. Originally, it was placed vertically, which meant that a worker had to manually flip it so the robot could weld on both sides. In this project, a new horizontal placement was tested, which allows the robot to weld on both sides without human assistance. However, this also introduced new challenges, such as how gravity affects the welding quality, which was carefully analyzed in the thesis work.

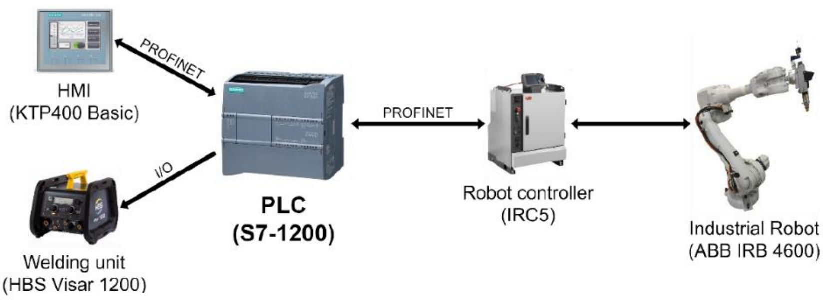

Figure 4: the hardware that controls the robot

Since a fully automated system needs to be well-planned before being implemented in a real factory, a computer simulation of the robot cell was also created, seen in Figure 5. This simulation predicted how well the system would work in practice, including how long each cycle would take and how many heat exchangers could be processed in a given time. A 3D model of the robot cell was also developed to visualize how all the equipment would fit together in the factory.

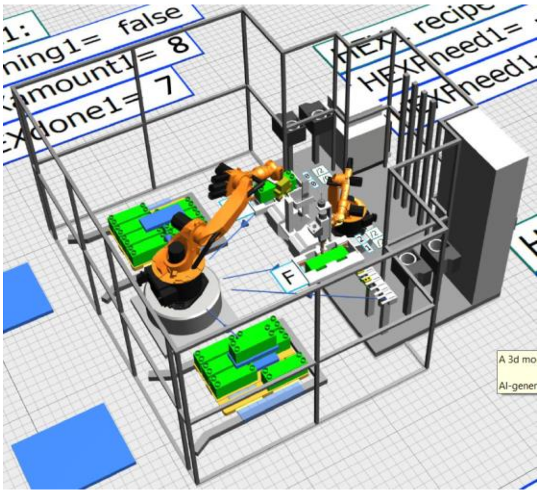

Figure 5: a simulation of the robot cell

In the end, this project provided valuable insights into the best way to measure the heat exchanger's position, how gravity impacts the welding process, and how digital tools can improve manufacturing efficiency. The findings contributed to SWEP's goal of replacing the manual bolt-welding process with a fully automated solution. The report concludes with a broader reflection on the increasing role of automation in manufacturing and its potential impact on the industry and society as a whole.

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