Improved tip tracking for an industrial robot using Iterative Learning Control

W.B.J. Hakvoort*, R.G.K.M. Aarts, J.B. Jonker

* Netherlands Institute for Metals Research
University of Twente, Laboratory of Mechanical Automation
Institute of Mechanics, Processes and Control - Twente
P.O. Box 217, 7500 AE Enschede, The Netherlands
phone: +31-(0)53-4895442, email: w.hakvoort@nimr.nl

Introduction

The laser welding process puts high demands on the manipulator that moves the laser beam with respect to the weld seam. Typically an accuracy of about 0.1 mm is required at speeds beyond 100 mm/s. From an industrial perspective the use of six-axes industrial robots is attractive as these can access complex three dimensional seam geometries. However, using standard industrial controllers the tracking accuracy of these robots is insufficient for laser welding.

Objective

The goal of this project is to improve the tracking accuracy at the tip of an industrial robot (Figure 1).

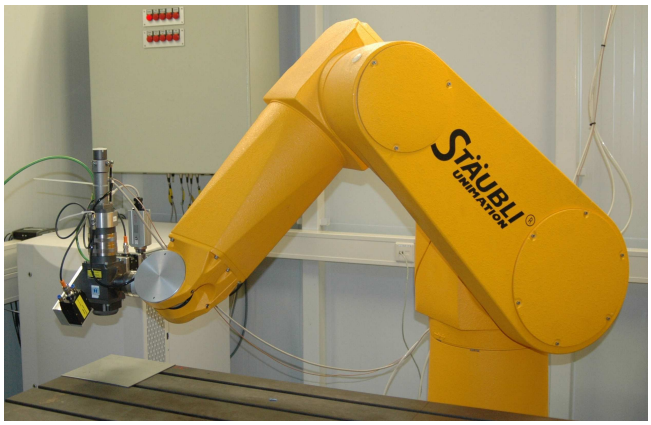

Figure 1 : The six-axes industrial Stäubli RX130 robot

Methods

The tip tracking accuracy is improved with Iterative Learning Control [1].

- An initial reference trajectory for the robot joints is obtained from CAD-data of the seam and a kinematic model of the robot.
- The robot joints track the reference trajectory, while an optical seam tracking sensor (Figure 2) measures the tip tracking error.
- Using a straightforward model of the robot the reference trajectory for the joints is updated to compensate for the measured tip tracking error.
- The last two steps are repeated until the tip tracking error converges to a steady value.

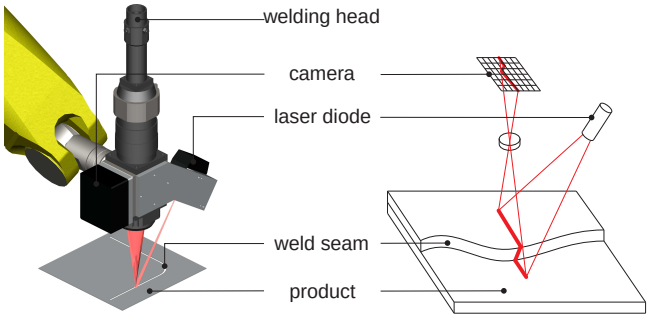

Figure 2 : Seam tracking sensor

Results

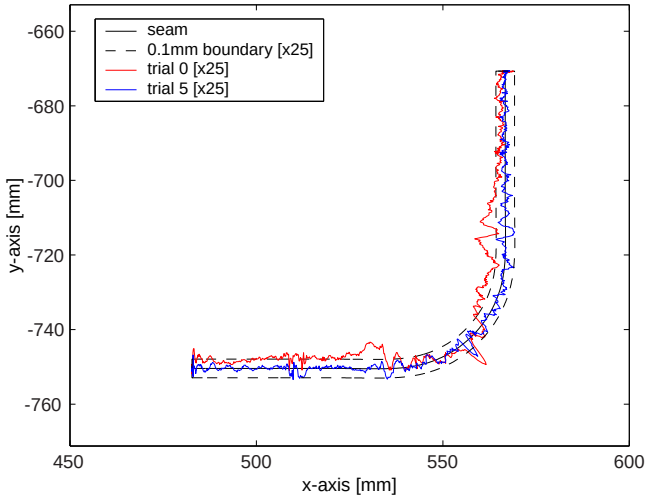

Figure 3 : Tracking error perpendicular to weld seam

Discussion

Iterative Learning Control can reduce the tracking error at the tip of an industrial robot, measured with an optical seam tracking sensor, close to 0.1 mm. The remaining error is mainly due to resonance vibrations of the robot. Further reduction of the error requires either a better robot model or smooth trajectory generation.

References

1. Hakvoort, W.B.J., R.G.K.M. Aarts, J. van Dijk, J.B. Jonker, *Iterative Learning Control for Improved End-effector Accuracy of an Industrial Robot.*, submitted for the 8^{th} IFAC Symposium on Robot Control, September 2006, Bologna, Italy.

Netherlands Institute *for* Metals Research