Laser speckle sensing for robotic manufacturing

Our approach

- Real-time tracking of robotic end-effectors for measurement of in-plane position and velocity.
- Relative measurement between workpiece and robot.
- Simple, potentially low-cost sensors, using no imaging lenses, based upon high speed processing of laser speckle patterns.
- No external measurement head and no line-of-sight requirements as with laser trackers.

Robotic tool speed sensing

- Velocity accuracies: ±0.01 mm/s.
- Velocity range: ±70mm/s (higher velocities may be possible).

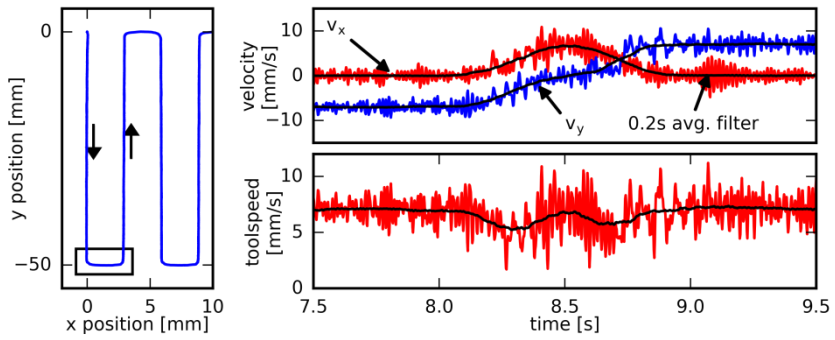
Robotic end-effector position sensing

- Position measurement including workpiece slippage and vibration.
- <100µm accuracy over meter paths.
- <0.5 µm accuracy over short (mm) paths.

Example application: tool speed measurements in wire and arc additive manufacturing (WAAM)

WAAM is an additive manufacturing process using a combination of an electric arc as the heat source and wire as feedstock.

- Speckle sensor was applied for path characterisation of a KUKA KR150 L110/2 industrial robot.
- Measurements of an oscillatory wall building strategy show a 25% reduction in tool-speed at corner radii.
- Compensation via wire feed speed eliminates excess material deposition and improves build quality.



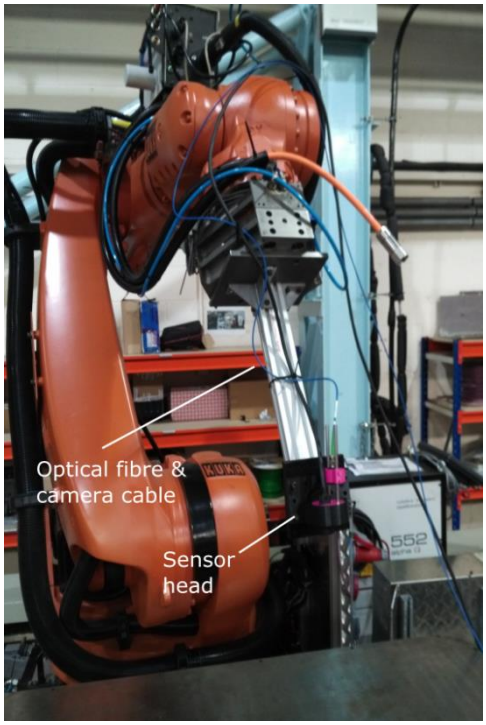


Figure 1: (right) Speckle correlation sensor installed on KUKA KR150 L110/2 robot. (left) Oscillatory wall building path and (centre) the measured robot velocity components (top-axis) and combined tool speed (bottom) when traversing the corner radii shown in the highlighted rectangle. A 0.2s averaging filter is shown overlaid for clarity.

Further information:

[1] T O Charrett, Y Bandari, F Michel, J Ding, S W Williams and R P Tatam, “Laser speckle velocimetry for robot manufacturing”, Proc. SPIE **10329** Opt. Meas. Syst. Ind. Insp. X, Munich, June 25, 2017.

[2] Y Bandari, J Ding, S Williams, F Michel, T O Charrett and R P Tatam “Compensation strategies for robotic motion errors for additive manufacturing (AM)”, in: International Solid Freeform Fabrication Symposium, Austin, Texas, 2016.

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Technologies

Optical interferometry; optical fibre sensor technology including interferometry, FBGs and LPGs; optical imaging and image processing; optical gas sensing; speckle interferometry and metrology.

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