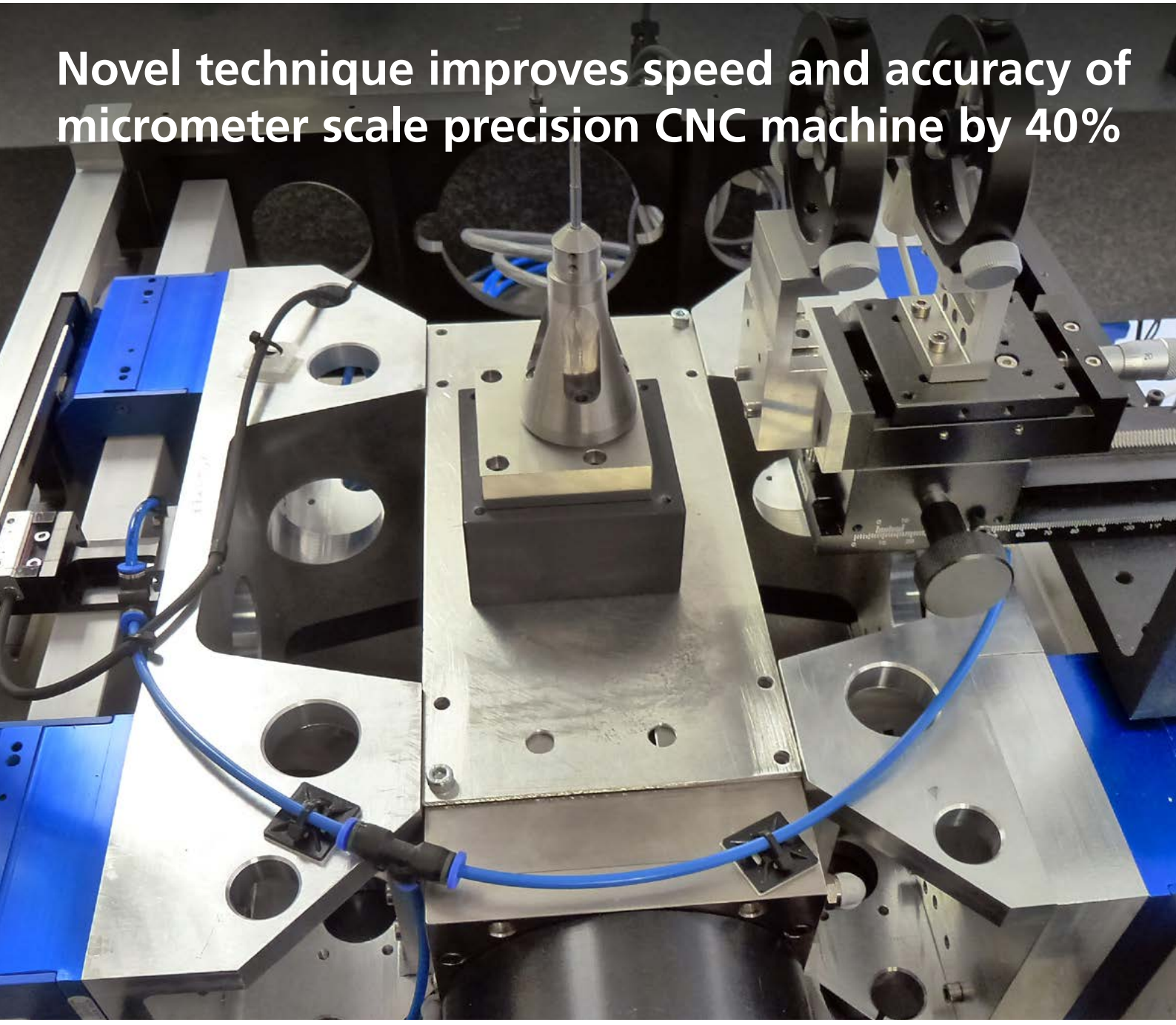
Cranfield University

Novel technique improves speed and accuracy of micrometer scale precision CNC machine by 40%



speedgoat
real-time simulation and testing

Cranfield UNIVERSITY

Rapid Controller Prototyping at a 54 kHz closed-loop rate supports innovative team at Cranfield University to increase accuracy of micrometer scale precision CNC machines by 40%

Cranfield University is a British postgraduate and research-based university specializing in science, engineering, technology and management.

The EPSRC Centre for Innovative Manufacturing in Ultra Precision is a collaboration between the Precision Engineering Institute at Cranfield University and the Institute for Manufacturing at the University of Cambridge. It aims to create ultra high precision manufacturing processes and tools for making products with nanoscale precision which can be used by companies to improve product yield and quality, and maintain a competitive advantage.

Virtual metrology frame

The goal of the project was to improve the dynamic performance of a CNC machine developed at Cranfield University. The Meso Scale Research Platform is a 6-axis micro-machining center, capable of creating nanometer scale features, over centimetres of product area.

Inaccuracies in machining occur due to tiny distortions in the machine frame. To reduce these effects the team wanted to use a measurement system to determine the displacement of the frame in real-time, and to combine the data with measurements from a conventional encoder also fitted to the platform.

A 'virtual metrology frame' concept was devised, where accelerometers were used to measure dynamic displacement without the need for a second reference frame.

Signal processing

A signal processing algorithm was developed to filter out the low frequency noise from the accelerometer measurements, and to double integrate the signals in order to estimate displacement.

For the rapid prototyping of the signal processing algorithm a target machine was needed which would offer a very low latency and high computing power. The Speedgoat Performance real-time target machine was chosen for its flexibility and because it is expressly designed for use together with Simulink and Simulink Real-Time from MathWorks, which provide powerful tools for debugging and prototyping the algorithm on a desktop computer and the target machine.

Implementation

The target machine was configured to sample the accelerometers at rate of 54 kHz. Frame displacement was then estimated using an optimized filter, and the values converted to an analog signal which was then sent to a commercial motion controller (Aerotech A3200).

The motion controller was used to read the conventional encoder and combine the measurements with the processed signal from the accelerometers, in order to drive the CNC machine's positioning servos with increased precision.

The research platform consisting of the Speedgoat target machine and development computer at the front, and the test rig at the rear

Results

The new control system allows the servo bandwidth to be improved by at least 40%. This translates to a potential 40% increase in speed of machining or in accuracy. Further refinements are planned to allow even greater improvement.

Mr. Abir is now working within the Cranfield Venture Programme to form a start-up company to commercialize the technique.

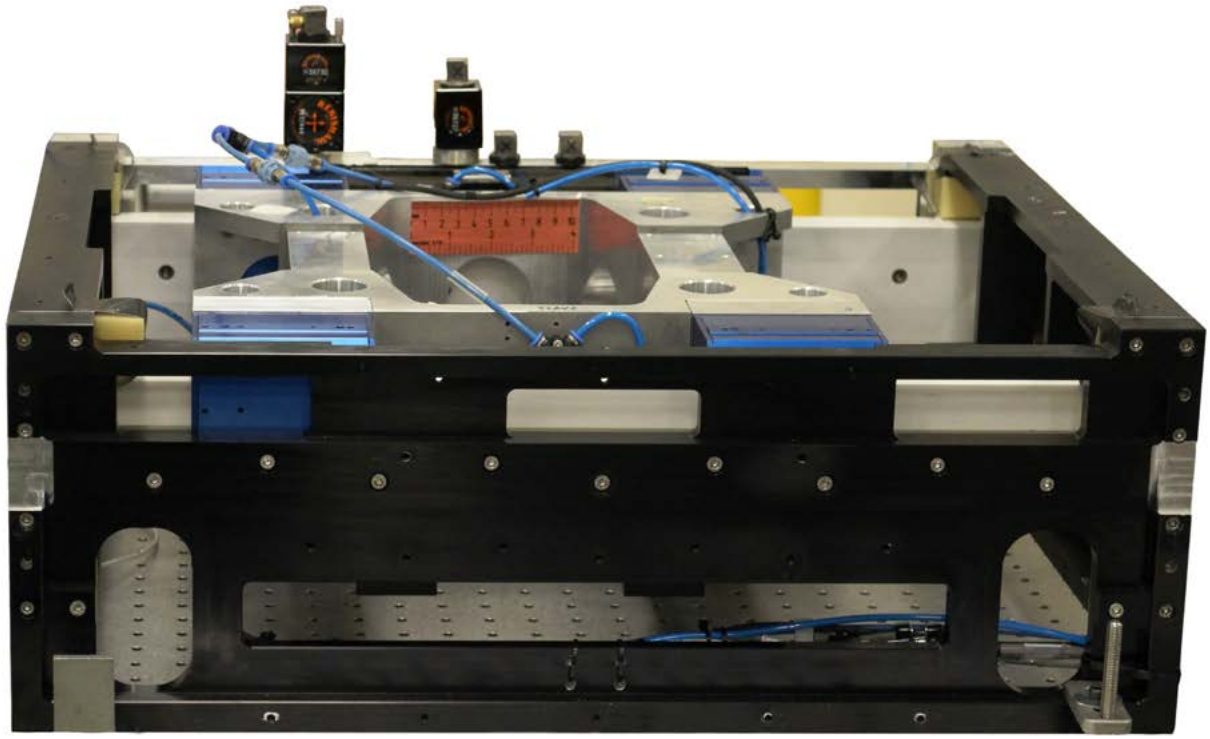
Speedgoat's value Contribution

"The setup of the Speedgoat machine, connecting the analog inputs to the accelerometers and the analog outputs to a commercial motion controller, was very easy.

The target machine works flawlessly with the Simulink software and provides me with powerful tools for prototyping and debugging."

- Mr. Abir

Jonathan Abir, Researcher, School of Aerospace, Transport and Manufacturing, Cranfield University



The test rig - a simplified version of a linear motion system

Cranfield University

Bedfordshire, England

www.cranfield.ac.uk

EPSRC Centre for Innovative Manufacturing in Ultra-Precision

www.ultraprecision.org

Speedgoat products used

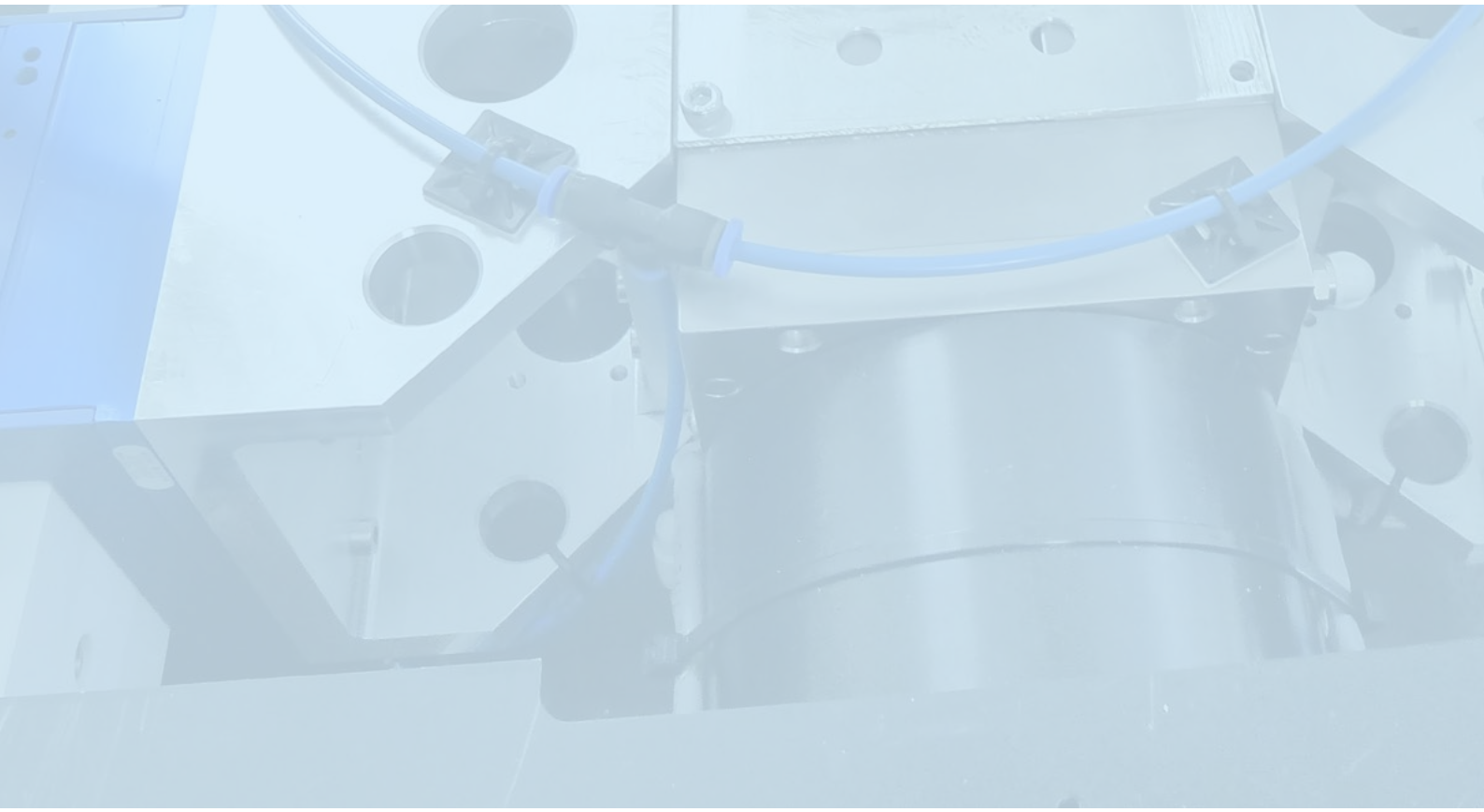
- Performance real-time target machine
- IO106 16-bit analog input I/O module
- IO111 16-bit analog output I/O module
- IO317 configurable FPGA I/O module with quadrature decoding functionality

MathWorks software used

- MATLAB®
- Simulink®
- MATLAB Coder™
- Simulink Coder™
- Simulink Real-Time™

Learn more

www.speedgoat.com/userstories



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