# A methodology for error characterization and quantification in rotary joints of multi-axis machine tools.

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## Abstract

* Performed error characterization and evaluation on a *rotary* *joint multi-axis machine tool* using a calibrated double ball bar.
* Simplified measurement setup and accelerated error quantification.

## Intro

* Multi-axial machine tools are important for manufacturing.
* High accuracy is essential.
* Often have 6 DOF.
  + 3 linear (2 radial, one axial)
  + 3 angular (one pan, 2 tilt)
  + Various errors occur in the system that introduce important inaccuracies.
* Error characterization and quantification predicts the accuracy and intended usage of a machine tool.

## Background

Prismatic Joints

* Error characterization of prismatic joints:
  + Nawara L, Kowalski M, Sladek J (1989) The influence of kinematic errors on the profile shapes by means of CMM. Ann CIRP 38(1):511–516
  + 7. Soons J, Theuws F, Schllekens P (1992) Modeling the errors of multi-axis machines: a general methodology. Precis Eng 14(1):5–19
  + Suh S, Lee J (1998) 5-Axis part machining with 3 axis CNC machine tools and rotary table. ASME Trans J Manuf Sci Eng 120:120–128
  + Ferreira P, Liu C (1989) An analytical quadratic model for the geometric errors of a machine tool. J Manuf Sys 5(1):51–63
  + Mou J, Liu C (1995) A method for enhancing the accuracy of CNC machine tools for on-machine inspection. J Manuf Sys 11 (4):29–237
  + Zhang G, Ouyang R, Lu B, Veale R, Donmez A (1988) A displacement method for machine geometry calibration. Ann CIRP 37(1):515–518
  + Chen G, Yuan J, Ni J (2001) A displacement measurement approach for machine geometric error assessment. Int J MachTools Manuf 41:149–161

**Rotary Joints**

* Rotary joint error characterization was sparse.
  + Most researchers used conventional methodologies.
* No specific methodology that quantifies the 6 DOF error or a rotary joint was found.
  + Most error charac quantify radial/axial errors of a machine tool.

90s

* Talks a lot about the development of analog or digital instruments to read the error in machines.
* The paper mainly talks about hardware methods to do this.