

Measurement of intra-axis errors of the rotary C-axis of a machine tool considering the effect of the ball erroneous positioning

R.L. Woulaché^{1,2*}, J.J.R. Mayer^{1*}

¹Department of mechanical engineering, École Polytechnique, Montreal, Canada

²Department of Physics, University of Yaoundé I, Yaoundé, Cameroun

* rosalie.woulache@polymtl.ca; rene.mayer@polymtl.ca

Rotary axis is key machine tool component in 4- and 5-axis machine tools and their motion precision, as quantified by their intra-axis error motions, may impact the dimensional quality of machined parts. There is a need to measure such errors in situ using commercially available and easily installed means. In this work, five of the six intra-axis errors, i.e., two radials, two tilts and the axial errors of the rotary C-axis of a five-axis machine-tool are measured taking into account the potential radial motions of the balls. The intra-axis errors are estimated from raw data gathered using a commercially available sensors cluster made of five orthogonally mounted capacitive sensors and two precision hemispheres nominally co-linearly mounted with the axis of rotation. Only the rotary C-axis moves during the data acquisition process while others axis are fixed. This is to avoid contamination of the intra-axis error motions of the C-axis with others axis. To ensure a good quality of data to be treated, crosses are included at the beginning, middle and end of each test to separate clockwise and counterclockwise rotation. The test is repeated three times to assess its repeatability. Simple geometric modelling and least square methods are applied to locate the axis average line in the machine frame and remove the effect of any unwanted ball eccentricity positioning. Simulations are conducted to verify the method, and it is applied to the C-axis of a 5-axis machine tool yielding error motions of the order of a few micrometers and arcsecs.