World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:9, No:07, 2015

A Mathematical Model for 3-DOF Rotary Accuracy Measurement Method Based on a Ball Lens

Authors : Hau-Wei Lee, Yu-Chi Liu, Chien-Hung Liu

Abstract : A mathematical model is presented for a system that measures rotational errors in a shaft using a ball lens. The geometric optical characteristics of the ball lens mounted on the shaft allows the measurement of rotation axis errors in both the radial and axial directions. The equipment used includes two quadrant detectors (QD), two laser diodes and a ball lens that is mounted on the rotating shaft to be evaluated. Rotational errors in the shaft cause changes in the optical geometry of the ball lens. The resulting deflection of the laser beams is detected by the QDs and their output signals are used to determine rotational errors. The radial and the axial rotational errors can be calculated as explained by the mathematical model. Results from system calibration show that the measurement error is within ±1 μm and resolution is about 20 nm. Using a direct drive motor (DD motor) as an example, experimental results show a rotational error of less than 20 μm. The most important features of this system are that it does not require the use of expensive optical components, it is small, very easy to set up, and measurements are highly accurate.

Keywords : ball lens, quadrant detector, axial error, radial error
Conference Title : ICMCE 2015 : International Conference on Mechanical and Control Engineering
Conference Location : Zurich, Switzerland
Conference Dates : July 29-30, 2015