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On The Design and Analysis of an Octagonal-Ellipse Ring Based Cutting Force Measuring Transducer

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Abstract

This paper presents study of design, modelling, and analysis of a modified octagonal ring based cutting force measuring transducer. The shape of an octagonal ring was modified by altering the geometry of the circle into an ellipse. The main objective is to increase the strain to the displacement ratio under a given load so that the sensitivity is maximized.

Analytical and three-dimensional (3D) finite element (FE) methods were deployed to estimate mechanical responses such as strain, displacement, and stress of the transducer. Results showed that compared to the octagonal ring with circle, the modified octagonal ring with ellipse had maximized the sensitivity by 15% and 25% in axial and tangential loading, respectively.

In order to assess the performance of the designed transducer, calibration tests were performed on an Instron machine under axial and tangential loading and cross-sensitivity of force measurements was analysed. Following the ISO 376:2011 standard, an extensive uncertainty evaluation was performed to validate the measurement process used in the calibration.

Calibration results showed that the force transducer with the proposed octagonal-ellipse ring was able to measure the force with average error less than 2%. The maximum average error