金屬應變計式六分量力感測器之研究

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ABSTRACT

Abstract In a strain-gauged six-component force sensor, strain gauges bonded securely as a whole to appropriate locations of the associated elastic structural member in the sensor form at least six bridge circuit, form the voltage outputs of which the magnitudes and direction of three forces and moments are determined in an inverse matrix calculation. A six-component force sensors may be categorized into coupled and decoupled in terms of the relation between outputs from the various bridge circuits and the six force component. For the former, the existence of any force component generally produces outputs in more than one bridge. Cross sensitivities thus exist in such a sensor, ensuing a relatively complex calibration matrix. As for the later, the output of a corresponding to a specific force component is theoretically not affected by any of other force components. Since the force sensing member is generally monolithic, a completely decoupled one is not obtainable in reality. Every sensor is coupled to some degree. The measurement characteristics, which are the measurement sensitivity, the measurement isotropy and the decoupling, of a strain-gauged six-component force sensor depends mainly on the structural design of the associated elastic member which senses the external force. Generally, in a design a compromises between stiffness and flexibility of the elastic member is required. Here in this study, both coupled and decoupled six-component force sensors are designed, and are then subjected to the finite element and shape optimization analysis using a computer-aided analysis software. The optimal sizes are determined, and the stress and strain distribution in the elastic members are obtained. Based on the strain results, the outputs of the six full bridge circuits composed of strain gauges bonded to the location of maximum strain are calculated, from which the magnitude of the six external force component may be determined by matrix calculation. This thesis includes four parts. First of all, the six-component force sensors are reviewed, and the purpose and scope of the study are described. Secondly, the fundamental theories related to a six-component force sensor are discussed. these include the sensing principles, the elasticity, the finite element technique, and the shape optimization procedure. Thirdly both coupled and uncoupled six-component force sensors are designed and are analyzed. The measurement characteristics of these sensors are obtained, evaluated. Finally, suggestions for future study as related to this particular topic are proposed.

Keywords : sensor ; force sensor ; optimal design

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