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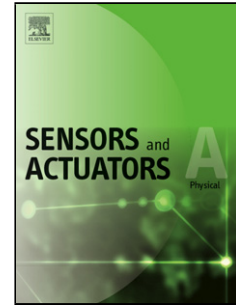
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# Introduction of a hybrid sensor to measure the torque and axial force using a magnetostrictive hollow rod

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## Highlights

- In this paper, a hybrid sensor to measure the torque and axial force using a magnetostrictive hollow rod is presented.
- Two orthogonal pickup coils are used to separate the detection of the axial and circular magnetic flux density changes.
- Applying torques causes changes in induced voltage of the circular pickup coil. But applying axial forces causes changes in both induced voltage of the circular and axial pickup coil.

## Abstract

In this paper, a hybrid sensor to measure the torque and axial force using a magnetostrictive hollow rod is presented. The magnetostrictive material is made up of vanadium permendur alloy. Axial and circular magnetic fields are used in order to excite the sensor. An axial coil and a single wire passing through the material are used in order to generate axial and circular magnetic field, respectively. In order to detect axial and circular flux changes, two orthogonal pickup coils are used. Theoretical modeling of the sensor has been done using piezomagnetic equations of magnetostrictive materials. In order to achieve an estimation of applied magnetic fields to the material, the sensor has been simulated numerically. Then, the sensor has been fabricated and tested under influence of axial forces and torques. Tests show that the sensor can detect and measure the axial force and torque simultaneously. Applying torque causes changes in circular magnetic flux density and applying axial force causes changes in both circular and axial fluxes. That is an indicator for load type detection of the sensor. The ranges of the axial force and torque measurement are 10 kN and 20 Nm, respectively. The torque measurement accuracy of the sensor is  $\pm 14.81\%$ FS, measurement sensitivity of the axial pressure load is  $0.012 \frac{mV}{N}$  and measurement sensitivity of the torque is  $1.18 \frac{mV}{N \cdot m}$ .

**Keywords:** Magnetostrictive, Permendur, Axial Force Measurement, Torque Measurement, Hybrid Sensor

## 1. Introduction

Measurement of the force and torque is one of the important requirements in science and engineering. One of the methods of measurement is using magnetostrictive materials. Since yet,

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