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The Study of Crosstalk Suppression in Wheel Force Sensor

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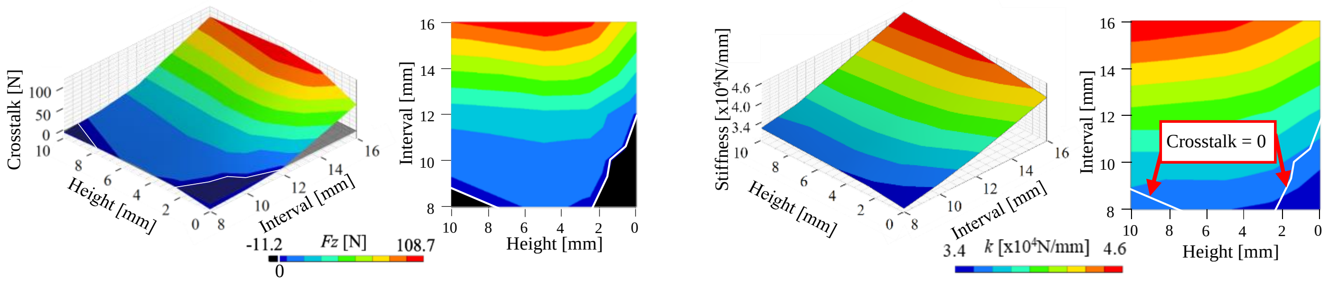
A six-axis wheel force sensor (WFS) is used in vehicle development to measure the six-axis force (*Fx*, *Fy*, *Fz*, *Mx*, *My*, and *Mz*) applied to the wheel. Higher accuracy of the sensor is demanded, and crosstalk must be suppressed by detecting the load in the unloaded directions from the strain gauges attached to the WFS. Hence, the strain that should be used in the calculation of loads and moments must be considered, and deformations that will result in crosstalk from a structural perspective must be avoided.

The purpose of this study is to present a guide for structural improvements to suppress crosstalk and propose several effective design modifications. In this study, a finite element (FE) model of the WFS was constructed to simulate an actual calibration test by reproducing the tightening torque and stiffness of the bolt and the friction of the contact surface. The crosstalk was calculated, and the outputs were confirmed when the WFS was applied to the loads and moments. A guide for structural improvements for suppressing crosstalk and improving accuracy is presented herein.

The WFS is composed of steel and bolted to the hub of the measurement vehicle through a hub adapter. It is connected by sensing components located every 60°to the center of the WFS. The sensing components are deformed when a load is applied to the wheel. The sensing part comprises a radial beam that is wide in the in-plane direction, and two thrust beams that are wide in the off-plane direction and on either side of the radial beam. To suppress the effects of the other components, the analysis was performed using all components as rigid bodies except the WFS. The result of the FE analysis shows that the *Fz* output in the Fy test was the largest among the crosstalks; therefore, structural modifications were considered to reduce the *Fz* output. To reduce it, the output of the radial beams should be reduced, and the structure of the radial beam should be modified to prevent shear deformation during the Fy test.

This study was conducted by combining reductions in the interval between the thrust and radial beams, and the height of the upper component of the radial beams. Sixteen different models were created by combining four different intervals between the thrust and radial beams (16, 12, 10, and 8 mm) and four different heights (10, 5, 2.5, and 0 mm) to verify the *Fz* output in the Fy test. Figure 1(a) shows a triaxial graph with the *Fz* output from the Fy test (crosstalk) on the vertical axis, and the intervals and heights as the axes in the horizontal plane. The black plane indicates crosstalk below zero, and the white line, which is the boundary between the contour and the black region, indicates zero crosstalk. The crosstalk decreases as the interval decreases and then remains unchanged, except at the height of 2 to 0 mm. Figure 1(b) shows a triaxial graph of the horizontal plane with the same axes as that shown in Figure 1(a), although the vertical axis represents the stiffness. As shown, the stiffness decreases as the interval decreases and does not change significantly with the height, except at 4 to 0 mm. Comparing the white line in Figure 1(a) with that in Figure 1(b), the conditions for a model with zero crosstalk and high stiffness can be confirmed. The optimum conditions were confirmed to be an interval of 11.5 mm and a height of 0 mm. In particular, the model created in this study demonstrated zero crosstalk and high stiffness when the interval and height were 12 and 0 mm, respectively.



(a) Crosstalk changes between interval and height (b) Stiffness changes between interval and height

Fig.1 Comparison between crosstalk and stiffness

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