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Support mechanism for a relative gravimeter using two-axes gimbal on a mobile carrier

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Modeling ground structure is one of the most important topics for the estimation of seismic hazard these days. It is said that there are high correlation between the density structure of the ground and the seismic velocity structure of the ground. The gravity survey is comparatively easier than other exploration method to estimate the density structure, so that it is very suitable for the aspect of the seismic hazard projection.

For the measurement of gravity, development of a simplified relative gravimeter is ongoing, in which a force-balanced-type accelerometer is applied as a sensor. Because these accelerometers are simple and inexpensive, the observation can be performed much easier than by using a conventional spring-type relative gravimeter which is usually used. The gravimeter is also expected to perform the observation on a mobile carrier, such as vehicle, ship, and so on, so that we can obtain gravity anomaly at the place where is difficult to measure by using other sensors.

In such a situation, we decided to use a two-axes gimbal system to support the gravimeter on a carrier. There are two main purposes: to maintain the gravity meter horizontally and to attenuate a vibration caused by the body. The 2D and 3D numerical model of the supporting system are proposed, and the equations of motion are derived by means of the Lagrange equations. By using the leap-frog method, frequency response functions of the gimbal model are obtained numerically from the equations.

Furthermore, we made an actual prototype of the gimbal. By using the support system, we conducted an excitation test. Results of the test are compared with that of the numerical analysis. Numerical model can explain the behavior of the actual gimbal partially. However, the degree of freedom of model is not enough to represent responses of the gimbal. Furthermore, the effects of cables may not be neglected to follow the real behaviors.

Keywords: gravity survey, gimbal, force-balanced accelerometer, frequency response function