The Study on Performance of MEMS IMU for Launch Vehicle under high vibration environment

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Inertial Measurement Unit (IMU) installed gyroscopes and accelometers is the one of the most important component for navigation and guidance system of launch vehicles. The sensors to get the information about acceleration and angle rate of rockets require high accuracy, high reliability, and environment resistance. That is why the IMU for lunch vehicle has been large in size and costly.

On the other hand, IMU for commercial use as car navigations, controllers of video games, and smartphones is installed the sensors using Micro Electro Mechanical Systems (MEMS) technology. MEMS devices are produced cheaply in large quantities during the same production process as semiconductor, and have been developed for accuracy improvement.

There are issues related to the accracy of sensors and the resistance of vibration environment, if the IMU using MEMS sensors, called MEMS IMU, is applyed to launch vihicles. For the solusion of the problem that the MEMS IMU for launch vehicle require high accuracy, we have developed the MEMS gyroscope called MARS. The high accracy of MARS is achived by digital temperature correction, and the bias instability has brought up to 0.1deg/h. [1]

And we have the system-managed approach toward solving the problem of vibration environment . To see whether resist and maintain its performance in the vibration environment of H-IIA and Epsilon rocket, We have produced the IMU installed high accracy MEMS gyroscopes and accelometers and measured experimentally. The model numbers are SiIMU02 and HGM-02A. Figure 1 shows the appearace and Table 1 shows the specification of HGM-02A. We have tested MEMS IMU in the vibration environment of H-IIA and Epsilon rocket, using both of the vibration exciter and actual flight of rocket. Although MEMS sensors vibrate itself for sensing mechanism, MEMS IMU has maintained its performance baisically.

Fig. 1. MEMS IMU (HGM-02A).

Table 1. Specification of MEMS IMU (HGM-02A).

Item	Specification
Profile	74(W)×74(L) ×60(H)[mm]
Mass	500[g]
Angle Rate Measurment Range	±100deg/s
Angle Rate Measurment Accuracy	1deg/s rms
Angle Rate Measurment Resolution	0.001deg/s
Acceleration Measurment Range	±2G
Acceleration Measurment Accuracy	0.2G rms
Acceleration Measurment Resolution	0.1mG

References

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