EPSON

Precise, Stable Inertial Measurement Unit (IMU)

June 2011

Sensor: A high-performance 6-axis sensor created by combining gyroscopes on 3 axes (±300 deg/s) & accelerometers on 3 axes (±3 G)
Angle random walk: 0.24 deg/√hr
Gyro bias instability: 6 deg/hr
Initial bias error: ±0.5 deg/s
Dimensions (W x D x H): 24.00 x 24.00 x 10.00 mm
Weight: 7 g
Current consumption: 30 mA
Operating voltage: 3.3 V

Product Features

Epson's inertial measurement unit (IMU) featured smallest-in-class size and power consumption[1, 2]. With outstanding precision and stability measurement capabilities, the IMU was able to accurately sense inertial motion, from the slightest of tilts to large movements. The small form factor, light weight, and low power consumption made it easier to embed in products than earlier IMUs, giving product engineers more design freedom. Engineers were able to easily embed this IMU in a wide variety of industrial systems used to analyze and control inertial motion, analyze and control motion, control moving objects, control vibration and stabilize, and navigate.

[1] Compared to other small IMUs that had been used in industrial applications (per Epson research conducted in May 2011)
[2] An IMU is a device that is used for sensing inertial motion. It is comprised of triaxial angular rate sensors and triaxial accelerometers. IMUs are primarily used to measure and control the behavior of moving objects.

Story Behind the Creation

Initially, IMUs were embedded in specialized equipment for aerospace applications and other uses that require highly accurate, stable measurement of inertial measurement. Later, however, IMUs developed for industrial applications began finding their way into a variety of products.

What the new and expanding industrial markets wanted were IMUs that offered greater accuracy and stability yet were also smaller and more energy efficient, as these attributes would make them easier to build into products.

Epson, a rare company with both a semiconductor and a quartz crystal device business, took an original approach to developing IMUs. It first developed quartz crystal gyroscopic (angular rate) sensors by capitalizing on unique "QMEMS" technology to fabricate microelectro-mechanical systems (MEMS) from quartz, a material known for its excellent frequency stability and high precision[3].

It then combined these gyroscopic sensors with semiconductor technology and expertise accumulated in the development of GPS modules and other position information devices to complete the IMU.

[3] Gyroscopic sensors measure the rotation angle (angular rate) of an object per unit of time around a sensing axis.

Reception and Market Impact

In October 2011 Epson announced the M-Tracer, a wireless motion measurement system that combined an IMU with software that analyzes the motion data captured by the IMU and from it produces 3D graphics. Epson collaborated with experts in various fields to develop the M-Tracer system and applications. One venture with a major golf products manufacturer yielded a golf swing measurement system, which opened the door to new businesses in the sports and health sector.

In 2013, Epson added new products to its IMU family, including smaller, water-resistant and dust-resistant units that offered even better performance. The products were ideal for use in tiny, lightweight devices used in the medical and rehabilitation fields because they felt light and enabled greater freedom of movement.

In September 2013, Epson used Moverio smart headsets combined with IMUs in real-world tests to evaluate picking and sorting operations in a logistics facility. These tests demonstrated that workers were able to navigate more accurately and safely with the system, which captured their location, posture, and movements while sensing their line of sight. In addition, in September 2015, IMUs were built into the Epson Moverio Pro BT-2000, a smart headset for industrial applications. These headsets increase operational efficiency and productivity by logging movements with high accuracy.
Epson IMUs were also used for a period of two years, starting in 2013, in tests of a structural health monitoring system as part of a research project contracted from Japan's Ministry of Education, Culture, Sports, Science and Technology. By measuring and providing otherwise invisible data on the movement of structures during an earthquake, IMUs helped structural engineers quickly evaluate and determine the condition of structure following seismic activity. In this way, IMUs have helped contribute to a safer, more secure world.

(Written in March 2017)