World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:9, No:07, 2015

Wireless Gyroscopes for Highly Dynamic Objects

Authors : Dmitry Lukyanov, Sergey Shevchenko, Alexander Kukaev

Abstract : Modern MEMS gyroscopes have strengthened their position in motion control systems and have led to the creation of tactical grade sensors (better than 15 deg/h). This was achieved by virtue of the success in micro- and nanotechnology development, cooperation among international experts and the experience gained in the mass production of MEMS gyros. This production is knowledge-intensive, often unique and, therefore, difficult to develop, especially due to the use of 3D-technology. The latter is usually associated with manufacturing of inertial masses and their elastic suspension, which determines the vibration and shock resistance of gyros. Today, consumers developing highly dynamic objects or objects working under extreme conditions require the gyro shock resistance of up to 65 000 g and the measurement range of more than 10 000 deg/s. Such characteristics can be achieved by solid-state gyroscopes (SSG) without inertial masses or elastic suspensions, which, for example, can be constructed with molecular kinetics of bulk or surface acoustic waves (SAW). Excellent effectiveness of this sensors production and a high level of structural integration provides basis for increased accuracy, size reduction and significant drop in total production costs. Existing principles of SAW-based sensors are based on the theory of SAW propagation in rotating coordinate systems. A short introduction to the theory of a gyroscopic (Coriolis) effect in SAW is provided in the report. Nowadays more and more applications require passive and wireless sensors. SAW-based gyros provide an opportunity to create one. Several design concepts incorporating reflective delay lines were proposed in recent years, but faced some criticism. Still, the concept is promising and is being of interest in St. Petersburg Electrotechnical University. Several experimental models were developed and tested to find the minimal configuration of a passive and wireless SAW-based gyro. Structural schemes, potential characteristics and known limitations are stated in the report. Special attention is dedicated to a novel method of a FEM modeling with piezoelectric and gyroscopic effects simultaneously taken into account.

Keywords : FEM simulation, gyroscope, OOFELIE, surface acoustic wave, wireless sensing
Conference Title : ICWCSN 2015 : International Conference on Wireless Communication and Sensor Networks
Conference Location : Zurich, Switzerland
Conference Dates : July 29-30, 2015