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FUTURE OF INERTIAL NAVIGATION SENSORS

Inertial sensors have become a mandatory part of most electronic devices. Once being expensive and low-precisive, they have evolved and got a much higher performance and reliability at significantly reduced prices. However, each type of existing inertial sensor still suffers from different errors: either systematic or random and there is much space for advancements providing lower cost, higher precision, and size reduction. This section introduces some of the future trends in inertial sensor technologies.

Nuclear magnetic resonance gyroscope. It is based on the nuclear magnetic resonance effect – property of a particles' (kernels, electron, atom, etc.) spin to precess by a moment of angular momentum. NMR has an important advantage: it's not affected by vibrations and accelerations. For the last years, they have reached significant development of its design and implementation. Some scientists predict nuclear magnetic resonance gyroscopes to reach high levels of accuracy in high dynamic applications within a decade.

Hemispherical resonator gyroscope technology (HRG). The principle of operation is based on the precession caused by vibration on the rip of a "wine glass" shaped quartz resonator. HRG is highly reliable because it doesn't include any moving parts and consists of 2-3 pieces of machined fused quartz. It is also exceedingly accurate, compact, and has an ultra-low low angular random walk. However, HRG is exceptionally hard to manufacture, and only a few companies can produce it in series. Consequently, HRG is relatively expensive so for now it is used in specific fields, such as satellites and spacecrafts [1].

Particle Imaging Velocimetry Gyroscope (PIVG). Particle Imaging Velocimetry is a branch of fluid dynamics science in which the properties of fluids and fluid flows can be determined through neutrally buoyant tracking particles, which mimic the actual dynamics of the flow. For now, every commercially available type of gyroscopes suffers from bias instability. The main advantages of the PIVG include being nearly drift-free, a high signal-to-noise ratio (SNR) in comparison to commercially available high-end gyroscopes, and its low cost.

Cold atom inertial sensors. After decades of research in the field of cold atoms, the technology has reached a stage where commercialization of cold atom interferometers has become possible. The inertial sensors of this type are characterized by having higher performance than typical optical gyroscopes. Moreover, because of the low temperature of the trapped cold atoms, they provide a high signal-to-noise ratio and low noise measurements in general.

Micro-Opto-Electro-Mechanical-Systems (MOEMS) inertial sensors. They were born as an inheritor of Micro-Electro-Mechanical Systems (MEMS). While MEMS-based sensors include an electronic capacitive that detects the motion of an inertial mass, MOEMS combine optical effects of light interference, mechanical effects of deformation, and the conversion of electrical impulses into a digital code with subsequent processing and presentation in an understandable format to the user. They are proving to be an attractive and low-cost solution to a range of device problems requiring high optical functionality and high optical performance. [2]

To sum up, after reviewing some of the future trends of inertial sensors, it is noticeable that its development is aimed at the improvement of accuracy, reliability, and reduction of size, weight, and price.

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