Micromachines for a safer world

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Tiny sensors known as accelerometers are everywhere. The near-weightless technology can measure the impact of a dangerous tackle on a football player's helmet, control the flow of highway and runway traffic, analyze a golf pro's swing, orient the next generation of smart phones, and keeping fighter jets and missiles on target.

And as sensing devices improve, the possibilities for what they can measure are infinite. Teams of Tel Aviv University scientists are at the heart of the tiny world of MEMS — microelectromechanical systems — to make these systems even smaller, cheaper, and more sensitive by marrying old-school mechanics with advanced electrical engineering.

"The widespread penetration of miniature MEMS sensors into the devices surrounding us is transforming our way of life," says Dr. Slava Krylov of Tel Aviv University's Faculty of Engineering, where his theoretical and practical work is leading to applications that could transform multiple industries.

Adding mechanics to electronics

In a recent publication of the IEEE Sensors Journal, he and his doctoral student Assaf Ya'akobovitz outlined ways to improve the sensitivity of accelerometers by using an efficient yet simple and manufacturable design, which can be applied in sport, communication, transportation and defense.

Dr. Krylov and Ya'akobovitz showed, theoretically and experimentally,

how amplification techniques developed at their lab can be used for improving the performance of micro-accelerometers. Instead of electronically amplifying the extremely small signals produced by the accelerometer, the researchers incorporated a mechanical amplification, a sort of a miniature clock hand, in order to generate a larger signal output, thereby reducing the devices' noise and improving their sensitivity.

Today, Dr. Krylov points out, almost every kind of machine used in transportation and communication relies on accelerometers. They are applied in high-end navigation devices for airplanes and missiles, and built into iPhones as motion sensors. His latest advances in sensitivity enhancement could be applied to all of these current uses, and in lucrative and untapped business applications as well, he says. In the car safety industry alone, the market is worth hundreds of millions of dollars per year.

Keeping space missions on track

Dr. Krylov's device architecture uses a tiny electrode, a silicon chip, and a mechanical transformer coupled with an optical sensor to amplify the tiniest changes in motion and acceleration. Currently, the device is about 1 millimeter in diameter, but it can be manufactured at an even smaller size than that. "It's always better to be smaller," he says, explaining that the accuracy of the devices is especially critical on space missions, when a fraction of distance and time can alter the course of a space vehicle or satellite forever.

Designed to be created in mass numbers for the mass market, Dr. Krylov is also taking the core technology from his accelerometers to be applied in new mind-boggling directions — to harvesting clean energy and in novel medical applications. But these developments, he says, are farther in the future.

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