

New Expectations for MEMS Devices

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Vietnamese Exchange Students and Japan's Aging Society

There are three Vietnamese students working in our laboratory, and all of them are excellent at their work. In fact, all three had papers selected for presentation at the international conference MEMS 2011, which will be held in Cancun, Mexico in January this year.

According to *The University of Tokyo Guidebook*, the number of foreign students accepted at the University of Tokyo in 2010 accounted for 250 of the total 14,172 undergraduate students and 2,084 of the total 13,820 graduate students, and the numbers increase each year. After graduating from high school in Vietnam, the three students in my lab passed the entrance examination for the University of Tokyo and entered the undergraduate program as international students sponsored by the Japanese government. All three continued on to graduate school and are now enthusiastically conducting research in our lab.

Students in countries of East Asia and Southeast Asia receive a rich education in fundamental subjects, such as mathematics and physics. This has proven to be an advantage for the Vietnamese students, even after entering the University of Tokyo. Further, there are no barriers to the wealth of information on the Internet for students who have no problems with the English language. Using information available over the Internet gives these students a capacity to perform advanced simulations that appears to surpass that of the average Japanese student at the University of Tokyo.

The ability to attract capable young people with such enthusiasm from overseas may benefit Japan, for which the declining birthrate and proportion of elderly in the population is expected to increase, as they may play an important role in helping to reform our social system and to improve its efficiency through science and technology. Because Japan's declining birthrate and aging population is advancing faster than the rest of the world, I believe that it is the country best-suited to proposing and popularizing new lifestyles.

The Role of MEMS Devices in Our Coexistence with Machines and Robots

In order to maintain our international competitive edge despite our aging society, we will have to make efficient use of our environment, resources, and labor force, and optimize traffic logistics, for example. Collaborative work among people and industrial robots is increasing at factories, and the popularization of service robots and household robots, not necessarily humanoid in form, has begun to appear a reality. As was reported in an article in the *Mainichi Shimbun* on January 2, 2011 entitled "2010 Traffic Death Toll at 4,863, with Half Aged 65 and Above," safety is a vital issue in taking measures to produce an efficient transportation system for our aging society. Yet this problem applies to the younger generation as well as the elderly.

MEMS devices serve as a core technology for improving the reliability and safety of machines that coexist with humans. These devices can accurately detect the circumstances at points of contact between machines and humans and the surrounding environment. With a low volume of information, it is difficult to remove all uncertainty, even with intelligent processing of the information. However, if the quantity and quality of information is improved using MEMS devices to acquire more data, safety and reliability of machines can be improved.

Here, I will describe some concrete uses for MEMS devices.

Tactile Sensing

In settings where humans and machines coexist, humans sometimes touch or ride on the machines. By sensing the state of forces exerted when industrial robots and humans work together to assemble parts, or by detecting whether a passenger riding in a personal mobility vehicle is sitting in the seat and is in contact with the backrest, such machines can be precisely controlled, properly accelerated and decelerated, and used without incident on stairways and elevators. We may be able to predict when a vehicle could slip on a road surface by detecting the frictional forces and coefficient of friction between the tires and road surface. It can be said that MEMS provides us with new functions by enabling us for the first time to detect forces that humans and machines exert on each other and the distribution of force vectors produced through contact between humans and machines.

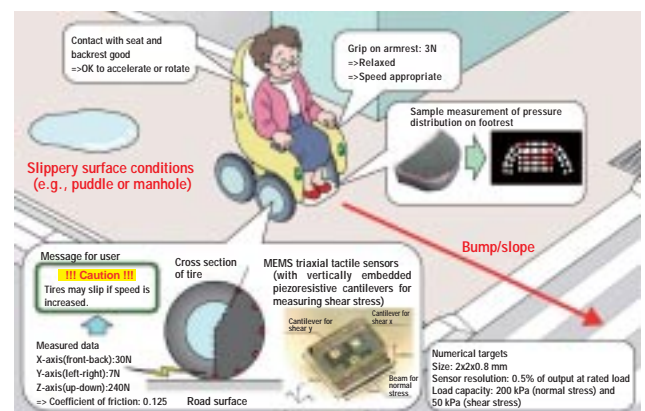
Increasing Sensitivity and Reducing Drift in Physical Sensors

Industrial robots, service robots, and personal mobility vehicles are constructed by assembling together rigid bodies. Encoders attached to the joints of the rigid bodies detect the angle of rotation between bodies in order to calculate the position and orientation of the links. Links are usually heavy in order to preserve rigidity, making the overall robot stiff and heavy. However, through the combined use of accelerometers and gyrosensors, the states of the links and robot fingers can be accurately learned, even when the links are flexible, making it possible to produce much lighter robots. Therefore, a new challenge facing R&D in robotics is to maintain the sensitivity of existing MEMS accelerometers and to reduce drift in gyrosensors.

Environmental Awareness

Measurements using light are effective in robots, automobiles, and personal mobility vehicles for detecting the state of objects in the vicinity. Currently laser rangefinders are being used to determine the distance to an object by emitting a laser pulse and measuring the time that the pulse takes to reflect off the target and return. However, in order for laser rangefinders to gain popularity, they must come down in both size and price.

As illustrated in the above examples, MEMS excels at adding new functionality, improving the performance of existing devices, and making things smaller, lighter, and less expensive, and MEMS devices are indispensable for operating machines in the same settings as humans. When listening to the Year-end Grand Song Festival on New Year's Eve, I heard the group AKB48 sing a song that included the lyrics "Are we dreaming?" and "Don't open someone else's map" and thought that I would like to pursue the dream in the former and the originality in the latter while researching MEMS devices in 2011.



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