TNO | Knowledge for business

Powerful, intelligent micro-systems determine your future

Faster, cheaper, smaller and more functionality. TNO generates, develops and applies specific knowledge in the field of microsystem technology.

Microsensor application in ground water monitoring.

A world full of intelligent microsensors, all around us but concealed, out of view, in clothing, equipment or other products. In other words, pervasive computing. These highly miniaturised systems, known as microsystems, interact constantly with users, by transmitting data up and down, depending on personal requirements.

Microsystems comprise a combination of electronic and non-electronic processes (like chemistry, mechanics, physics and/or optics) and are only a few mm^3 in size. These systems are able to detect, process, decide and communicate (wireless).

Quite unconsciously a whole range of microsystems has begun to permeate our daily lives. Perhaps the simplest example of an existing miniaturised, autonomous and wireless communication system is the RF-ID identification tag. It is a product that is used widely for a variety of applications, like security checks and intelligent labels. Other well-known applications include the airbag sensor (automotive), inkjet printer heads, pressure sensors and micro-actuators as well as micro-valves for the medical sector. Microsystems can be used for virtually every kind of industrial application.

Other developments in the field of micro-systems are:

- Medical applications: people can be constantly monitored using a "body network" of wireless sensors, and medical specialists can make or adjust their diagnosis from a distance.
- Improving production processes: intelligent sensors monitor and control production processes autonomously.
- Product innovation: the functionality of products can be significantly improved by the incorporation of intelligent sensors.
- Security: by linking up to a network of wireless microsystems, decisions can be taken autonomously in the future in warning situations.
- Environment observation systems: intelligent "noses" can quickly and automatically detect contamination of, for example, water and air.
- Food industry: developments have already reached the point at which the shelf life of food can be monitored using

IT-E 029e 04-04-2005

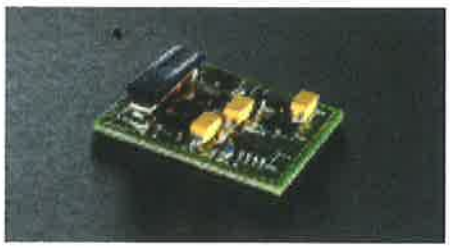
electronic systems. It is also possible for intelligent packaging to automatically set the method of preparation in kitchen equipment like ovens and microwaves.
- Automotive: the car of the future will be even more extensively equipped with intelligent sensors than it is now.

Critical technological succes factors for autonomous microsystems which TNO Science and Industry is working on:

1. Power dissipation

In view of the increasing degree of miniaturisation, the battery is slowly becoming the largest and heaviest component of miniaturised systems. This means that the optimal combination of factors (small battery size, low weight and long lifetime or minimal battery recharging time) is a constant challenge.

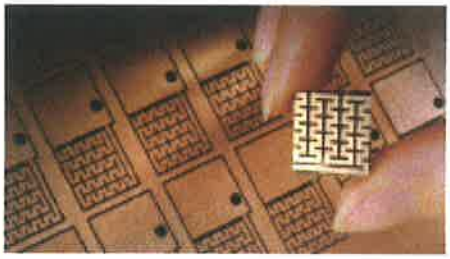
Optimisation demands a lot of development from the battery technology side as well as from alternative energy sources like the human body itself (body motion or body heat energy), kinetic terrestrial energy and solar energy. Other key factors include energy consumption, load management, standby and peak consumption, maximum discharge of current and communication protocols.



Microsystem for inductive energy management.

2. RF communication

The wireless communication of miniaturised systems is becoming increasingly important. Developments in the area of wireless information transfer reveal an inverse correlation: a decrease in the required power and an increase in the data rate.



Antenna for RF communication.

The 64 GHz band allows the apparent disparity in this technology trend to be harmonised. Reducing the size of the antenna (in favour of microsensors) poses a real challenge to the mechanical manufacturability of the antenna structure because the tolerances have to become even smaller. One advantage of this short wavelength is that the antenna is easier to integrate into the housing of portable and wearable products. To achieve this, new techniques are used (including phased array antennas) to bundle the energy that has to be sent as efficiently as possible.

3. Packaging techniques

Packaging technology determines in part how well microsystems function. The technology takes care of the interconnection, heat conduction and mechanical strength of these systems. In addition to footprint reduction, various kinds of 3D packages are used. When the surfaces are the same, the functionality can be stacked and this creates additional space for both the electronics and optical, mechanical or fluid components. The key packaging requirements – that materials and processes become cheaper as well as smaller and lighter – will remain.

Footprint reduction using stacked microsystems.

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TNO Science and Industry has knowledge and expertise in the field of microsystem technology, in terms of both development and application.