Vital Functions Monitored With Wearable And Implantable Devices

EurekAlert

Physiological signals can nowadays be easily monitored with measurement devices implanted inside a living body. The object - animal or human - is barely aware of the presence of the implant. An example of a device implantable in humans is the pacemaker that has long since become standard treatment for heart patients. Researcher **Jarno Riistama** from Tampere University of Technology (TUT) believes that the next tech-savvy generation represents a potential customer base for new applications in the field.

They might be interested in monitoring their personal health with implantable electrocardiogram (EKG) devices. The device could also be used as a diagnostic tool in emergencies, because it gives medical personnel instant access to the patient's EKG data.

Implants for humans and cattle

TUT has developed implantable EKG devices since 2003. The devices have been employed, among others, to monitor the mental and physical well-being of cattle. Once implanted, the device transmits signals that are used to infer the cow's stress levels and to analyze how the animal reacts to different living conditions.

Departments from the University of Helsinki and the MTT Agrifood Research Finland have also participated in the research.

The use of implantable EKG devices has yielded promising results, but further research and development is still necessary, says Riistama.

Riistama believes that implantable measurement devices intended for human use may become commercially available in a decade's time. The approval process and tests required to conduct measurements on humans take time and there is no room for failure.

The technology holds definite commercial potential. Increased industrialization will begin to take its toll and people are likely to suffer more health problems and be more health conscious in the future.

Disposable measuring device for hospitals

Alongside the implantable measurement device, researchers from Tampere University of Technology have developed an instrument that measures vital functions, such as EKG, directly from the skin surface. Riistama sees untapped market potential for such a simple, ultra-light device that can be mass-produced for a couple of cents apiece.

The measurement strips are affordable and they can be developed into disposable variants to be used in a hospital environment. The signals transmitted by the strip are comparable to those produced by existing measurement devices, such as pulse counters. The signal is received wirelessly, which eliminates the need for bothersome cables.

The surface measurement device created by Professor **Jukka Lekkala** is further developed at TUT to increase the fault-tolerance of signal reception. Once the application is completed, it will have the potential to penetrate the global market. The device will enable minimally invasive, continuous measurements. It could be used, for example, to measure employee well-being in the workplace and to analyze athletic performance by integrating a receiving antenna into an athlete's shirt.

The main advantages of the device over currently available pulse counters are that the sensors are hygienic and considerably more convenient to use, says Riistama.

Electrodes are key to measuring vital functions

Measuring the current distribution created by vital functions is based on creating a galvanic contact between the object and the electrode of the measurement device. Measurements may be conducted on human and animal subjects as well as cells. Heart functions, for example, are monitored by an EKG. Electrodes are usually made of some highly conductive metal, but they can also be made of other conductive materials, such as doped silicon.

Several factors may interfere with the measurement of vital functions, for example, the contact between electrode and object in surface measurement devices and the reaction between electrode and tissue in implantable devices. If the electrode shifts, it may disturb the signal.

In sports applications it is almost inevitable that the electrode does not remain completely fixed in place, so the material must be such as to minimize the effects of signal disturbance, states Riistama.

If the electrode is implanted, it stays in its proper position but the material plays a more important role than in conventional electrodes.

The device may remain implanted for a number of years, so it is important that the tissue reaction to the surface material and electrodes is kept at a minimum.

Riistama's doctoral dissertation, which he successfully defended at TUT in May 2010, focused on wearable and implantable measurement devices and related applications. He discovered new electrode materials that quickly minimize signal disturbance caused by the movement of the electrode, which could lead to an inaccurate reading. The materials are especially well suited for applications in which the electrode is likely to shift out of position.

The characteristics of electrodes made of surgical steel proved highly competitive compared to conventional silver/silver chloride electrodes. The main benefits of using steel, however, are that it's tissue-friendly and easier to manufacture than silver electrodes, says Riistama.

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