

Intelligent training with a fitness shirt and an E-bike

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Fabric manufacturers are experiencing a revolution: If clothing previously offered protection against the cold, rain, and snow, the trend now is toward intelligent, proactive, high-tech textiles like self-cleaning jackets, gloves that recognize toxins, and ski anoraks with integrated navigational devices to make life easier for those wearing them. Most

clever clothing is only at the prototype stage. It is by no means off-the-rack yet. Soon the FitnessSHIRT from the Fraunhofer Institute for Integrated Circuits IIS in Erlangen, Germany, will be ready for the mass market. It continuously measures physiological signals such as breathing, pulse, and changes in heart rate – metrics of adaptability and stress load. The intelligent sports shirt is expected to be available sometime in the next year, as an investor is already onboard.

Conductive textile electrodes integrated into the shirt's material capture the wearer's cardio activity. In addition, an elastic band around the upper body senses the motion of the chest during breathing. A removable electronic unit attached with snaps digitizes the raw data and calculates additional parameters like [pulse rate](#) or breath rate with the help of algorithms. The data are transmitted via radio link to a smartphone or optionally to a PC, where they are evaluated further and can be stored. These parameters form the basis for judging vital functions like stress, performance, exertion, or relaxation.

"The FitnessSHIRT can be employed a number of ways. It offers completely new options for the pursuit of sports, leisure activities, and wellness, as well as options for the medical branch," says Christian Hofmann, an engineer at IIS. For example, it could act as a training partner to provide seniors or rehabilitation patients with feedback on their vital signs during exercises or bicycling, and protect them from overexertion. Athletes will also benefit: for one thing, the SHIRT is more comfortable to wear than a chest strap. For another, the integrated sensors deliver more detailed information. Besides pulse and respiration, accelerometers sense the movement of the user and carry out an analysis. "If the pulse rate is high, for example, while the breath rate and the exercise activity is low, it could be a sign of possible heart problems," according to Hofmann.

The developers of the MENTORbike are also persuaded by the high

degree of comfort when worn and the possibilities for performance diagnostics. MENTORbike is a new type of training device consisting of a pedelec, a smartphone, and an intelligent user service site on the Internet. The project partners, led by BitifEye Digital Test Solutions, want to use the pedelec in combination with the FitnessSHIRT from IIS in future. The [shirt](#) will have a wireless connection via smartphone to the pedelec and the user service site on the internet, where the data can be viewed, analyzed, and documented. The [smartphone](#) mounted on the bicycle handlebars collects the vital parameters it receives like pulse and breath rate as well as the physical data, for instance the energy expended and the speed, analyzes them, and cuts in the electric motor as needed.

"If the pulse rate exceeds a maximum value of 150, for example, the rider is supported by the motor taking some of the load. If the pulse rate falls below a value of 80 beats per minute, the [electric motor](#) is throttled back and the pedal loading increased again. The motor output adapts automatically to the fitness of the cyclist," explains Markus Gratzfeld, an engineer with BitifEye. In this way, users are assured of an optimal level of training at all times, with neither over- nor under-exertion. Rehabilitation patients, especially persons with cardiovascular disease, could monitor their performance limits better, exercise more confidently, and increase their range of movement.

Researchers from IIS will demonstrate how the MENTORbike will work in conjunction with the FitnessSHIRT live at the Medica 2013 Trade Fair in Düsseldorf in the Fraunhofer Joint Booth (Halle 10, Booth F05), 20-23 November. Scientists want to make differential analysis of cardiac function possible with their FitnessSHIRT in the future and also monitor the heart for arrhythmia. Experts are presently developing the suitable algorithms. A medical-quality ECG might then be captured by the clever clothing for purposes of cardiac analysis. Physicians would be able to use the SHIRT for long-term ECGs.

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