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Marianna Trebuňová; Viktória Mezencevová; Jozef Živčák

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# MEDICINE AND ENGINEERING – CONNECTION BIOLOGY, TECHNOLOGY AND INFORMATICS

**Marianna Trebuňová**
Technical University of Košice, Faculty of Mechanical Engineering, Department of Biomedical Engineering and Measurement, Letná 9, 042 00 Košice, Slovakia, marianna.trebunova@tuke.sk
**Viktória Mezencevová**
Technical University of Košice, Faculty of Mechanical Engineering, Department of Biomedical Engineering and Measurement, Letná 9, 042 00 Košice, Slovakia, viktoria.mezencevova@student.tuke.sk
**Jozef Živčák**
Technical University of Košice, Faculty of Mechanical Engineering, Department of Biomedical Engineering and Measurement, Letná 9, 042 00 Košice, Slovakia, jozef.zivcak@tuke.sk

***Keywords:*** bioengineering, biomimetics, loadable and implatable technologies
***Abstract:*** Biomedical engineering is a broad field that covers a wide range of medical disciplines. Increasingly, nature is linked to engineering and technology. There is a breakthrough in chemical engineering and nanotechnology. Current progressive information, sensors and wireless technologies opens new means of monitoring patients and interpreting patient health data. In this review article, we focus on the field of biomimetics and inform about new possibilities of using wearable implantable systems.

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## 1 Biomimetics

Engineers, scientists, and business people are increasingly turning toward nature for design inspiration. The field of biomimetics, the application of methods and systems, found in nature, to engineering and technology, has spawned a number of innovations far superior to what the human mind alone could have devised [1-2]. The reason is simple. Nature, through billions of years of trial and error, has produced effective solutions to innumerable complex real-world problems. The rigorous competition of natural selection means waste and efficiency are not tolerated in natural systems, unlike many of the technologies devised by humans. For example, gas-powered cars are only about 20 percent efficient, that is, only 20 percent of the thermal-energy content of the gasoline is converted into mechanical work.

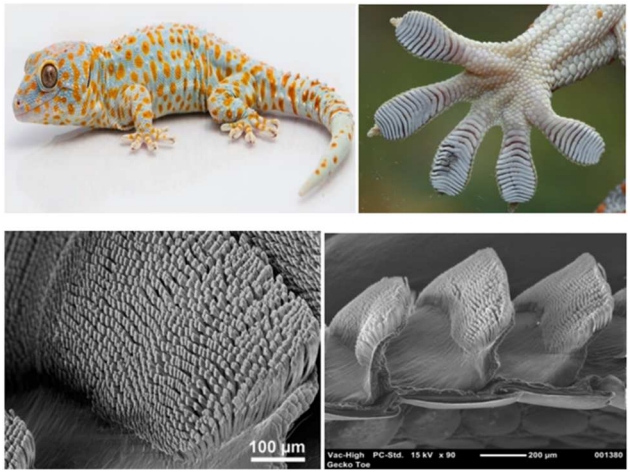

*Figure 1 Geckskin™ is a new super-adhesive based on the mechanics of gecko feet [3]*

Biomimetics, also known as Bionics (a term coined by an American air force officer in 1958), Biognosis, and Biomimicry, has been applied to a number of fields from political science to car design to computer science (cybernetics, swarm intelligence, artificial neurons and artificial neural networks are all derived from biomimetic principles). Generally there are three areas in biology after which technological solutions can be modeled [2]: 1.) Replicating natural manufacturing methods as in the production of chemical compounds by plants and animals. 2.) Mimicking mechanisms found in nature such as Velcro and "Gecko tape" (Figure 1) [3]. 3.) Imitating organizational principles from social behavior of organisms like ants, bees and microorganisms.

To capitalize on the wealth of designs and processes found in nature, Dr. Julian Vincent, the director of the Centre for Biomimetic and Natural Technologies at the University of Bath in England, and his colleagues have devised a "biological patents" database that will enable engineers to directly tap into nature's ingenuity bypassing the need to consult with biologists that they have come to rely upon for insight into nature's workings. According to the June 9th, 2005 issue of *The Economist*, "The idea is that this database will let anyone search through a wide range of biological mechanisms and properties to find natural solutions to technological problems." Currently, Dr. Vincent estimates that "at present there is only a 10% overlap between biology and technology in terms of the

mechanisms used" so there is a great deal of potential in this area.

The biological patents database takes a different approach to providing examples of natural biological technologies which fulfill the requirements of a particular engineering problem. As explained in The Economist, instead of searching by a plant or animal's name, an engineer would query the database with a keyword like propulsion" to get "a range of propulsion mechanisms used by jellyfish, frogs and crustaceans." There are other ways to use the database as well, including characterizing "an engineering problem in the form of a list of desirable features that the solution ought to have, and another list of undesirable features that it ought to avoid…. So, for example, searching for a means of defying gravity might produce a number of possible solutions taken from different flying creatures but described in engineering terms. 'If you want flight, you don't copy a bird, but you do copy the use of wings and aerofoils,' says Dr Vincent."While the system only contains about 2,500 "patents" at present, Dr.Vincent aims to significantly expand the collection to help engineers identify natural systems and behaviors that might be useful in their engineering challenges. There is great hope that biomimetics will help mankind develop technologies that both reduce our impact on the environment around us and improve our quality of life [4-6].

## 2 Loadable and Implatable Technologies

Current technological advances and trends support an increasing interest in finding new solutions and forms of healthcare provision. Innovative portable and wearable systems (Smart Wearable Systems) offer solutions for affordable and personalized services in good quality. The systems are used to monitor patients 24 hours a day, in their own home and surroundings, according to pre-established medical protocols.

For health monitoring, SWS can provide a wide range of wearable and implantable devices, including sensors, actuators, intelligent textiles, power supplies, wireless communications networks, processing units, multimedia devices, user interfaces, capture, data processing and support software and algorithms decision-making.These systems are capable of measuring life functions such as body and skin temperature, heart rate, arterial blood pressure, blood oxygen saturation, sensing surface tension, and generating an electrocardiogram, electroencephalogram and frequency of breathing. Measurements are transmitted through a wireless sensor network, either for a central hub, such as a Personal Digital Assistant (smartphone), or are sent directly to a health center. The physician can then manage patient management based on transferred data [1, 7].

### *2.1 Monitoring Parkinson*

Symptoms and progression of Parkinson's disease (Parkinson's Disease) vary widely from patient to patient. The severity of the symptoms in these patients may vary considerably between the doses of drugs during the day.Making a precise assessment of the patient's condition and adjusting treatment for his or her needs is of utmost importance to the doctor.Patients often confuse the tremor of Parkinson's disease with drug-induced dyskinesias, which causes autoreports to be unreliable [1]. Because of these diverse experiences, it is hard for scientists to capture a truly accurate picture of what it is like to live with a PD.Workable technology, including bioengineers, including intelligent phones and smart clocks, is a promising new approach that has the potential to see how and what kind of information is collected and shared from the patient to the researcher. Intel has developed a large data analysis platform using the Amazon Web Services (AWS) infrastructure to identify the data accessed by Parkinson's researchers across the globe.

In a research initiative that began in 2014, the Michael J. Fox Foundation (MJFF) has worked with Intel Corporation to collect, measure and evaluate Parkinson's disease symptoms using "smart" wearable PD technology. This open access model allows free access to data from people with PD directly to scientists, and can help analyze new traces and present a holistic picture of what it means to live with Parkinson's disease. The first set of data will be available to qualified researchers this summer [8]. Research data is on the AWS and is made available to Parkinson's physician and researcher worldwide, thanks to Intel's platform. Through analysis, the data can reveal new useful findings about life with Parkinson's disease [9].

Similar procedures could be used to detect 1) episodes by exacerbation´s COPD (chronic obstructive pulmonary disease), 2) changes of functional abilities in patients, which have got stroke and those who have undergone rehabilitation, 3) seizures in patients with epilepsy and other medical events in which the time is significant. He exact method of monitoring the patient and the type of data collected and transmitted would vary according of the disease concerned [1].

### *2.2 Smart tatoos*

Bioengineers from the University of Illinois - who work with colleagues in Singapore - have found out how to insert flat, flexible, extensible electronic sensors into a temporary tattoo that can resist wrinkling, bending and

twisting of the skin (Figure 2) [10]. These microelectronics, which are thinner than human hair and water-resistant, could be used to monitor the electrical signals produced by heart, brain and muscle without irritation (Figure 3).

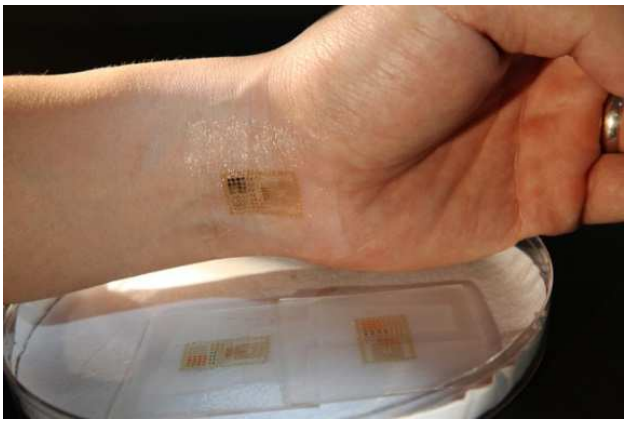

*Figure 2 Smart tatoos* [11]

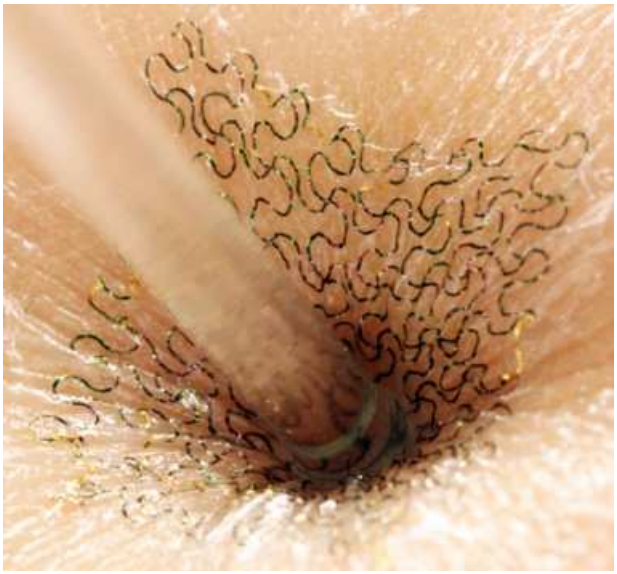

*Figure 3 The circuits' filamentary serpentine shape allows them to bend, twist, scrunch and stretch while maintaining functionality* [12]

Applications are extensive. Tattoos could be used to monitor heart arrhythmias, sleep disorders and cardiac activity in premature babies, stimulating muscles. Other detectors, transmitters and receivers could be attached to the tattoo. Currently, bioengineers are working on producing a small battery powered by solar cells or a wireless transmitter. They hope that one day they will be able to interpret chemical information from the skin [1, 13].

## Conclusions

Advances in sensor technology and innovations in wearable technology have provided a number of new devices ready to support innovation in medical and professional applications, including diagnostics, surgery, and remote patient monitoring in indoor and outdoor areas. Wireless medical devices provide new dimensions for these applications. Biosensors, combined with wireless devices, can remotely monitor a person's health at home or patient in the operating room in an "intelligent device" [7].

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