Hermes Partnership workshop on

Nano Communication and Technology for Autonomous, Ultra Miniature, Ultra Low Power, Multi-Functional Wireless Systems

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Abstract of presentation of Lukasz Januszkiewicz

Title: The research on Body Area Networks for future health applications carried at Technical University of Lodz, Poland

Developments in electronic integrated circuits technology allows to design miniature, low power and functionally complex devices. It has resulted in the miniaturization of radio transceiver integrated circuits and given the possibility of embedding radio transceivers directly into garment (Body Area Networks). Therefore obtained so called textronic products have new functions attractive in medicine such as wireless physiological parameter sensing or remote alerting. Thus clothing can be enhanced with new features, which may improve living standard of both healthy and disabled people. Textronic products may also be embedded in protection clothing for persons working in extreme environmental conditions, for example in the presence of fire or toxic substances. The need for constant communication with persons who are in conditions of life hazard call for the application of suitable wireless systems in which it is desirable to integrate antennas with textile products.

To place a radio transmitting system in the garment the radio propagation in the body area should be investigated in terms of signal attenuation and the absorption of radio energy into the body. The radio equipment used in such a system will require the electronic elements to be made as flexible and as light as possible. Besides integrated circuits and batteries a vital role in the performance of radio transmitting system plays an antenna. Textile antenna is made of textile materials and techniques so it can be easily placed on or in the garment.

Nowadays the new applications of textiles and electronics rely on several technical disciplines more than ever before. It is not sufficient to do research isolated for each discipline, but it should be done for the whole system. This means that innovation will be driven both by development in particular technologies and new applications through systemic thinking.

Technical University of Lodz has the potential and integrates different technologies into one interdisciplinary platform. It takes advantage of textile technologies of flexible sensors and electrical connections that may be used in Body Area Networks. Flexible textile sensors in particular are a new emerging interdisciplinary field of research that combines the following scientific disciplines: textiles and manufacturing, material science, micro-nanotechnology, information and communication technology and biotechnology. Also radio communication technologies are developed to realize wireless data transmission in the direct vicinity of human body.

Our research groups work on several aspects of Body Area Networks. The Institute of Electronics is a part of Faculty of Electrical, Electronic, Computer and Control Engineering, which is a member to Polish Network of Excellence. Current R&D activities are conducted by the Communication Division and concentrate on: electromagnetic wave propagation modelling, design of antennas and antenna systems for wireless communication networks,

modelling and design of radio communication systems including ad-hoc, sensor, and personal networks, numerical simulation and measurement procedures in electromagnetic compatibility, signal and image processing for transmission in telecommunication networks (filtering, compression, coding), analysis and design of application specific integrated circuits (analog and digital).

Department of Fibre Physics and Textile Metrology is a part of Faculty of Material Technologies and Textile Design. The main area of research activity of the Department is textile metrology and technology of textile materials for special applications like biomaterials, protective equipment, filtration, construction and others. Department is also a partner of Polish Technological Platform of Textile Industry (PTPTI) and a Centre of Advanced Technologies of Human Friendly Textiles (PRO HUMANO TEX). Recent research is focused on fiber sensors and fiber materials of various electrical parameters.

In the presentation the main fields of investigation that are focused on body area networks are introduced. The textile antennas as well as BAN radio wave propagation aspects will be described.

In the recent years the growing interest in textile antennas can be observed. Textile antennas are made with the use of conducting and insulating textile materials or thin metal foil. The major advantage of using textile materials for antennas is the whippiness and light weight of the final product that can be easily integrated with clothing. Thus the main application of textiles antennas are personal radio communication systems that have to be located close to human body. Textile antenna used in such a system can be built into the structure of garment, being almost invisible to the user of the system, and having no influence on his comfort. Wearable antennas should preferably have an approximately omnidirectional radiation pattern and sufficient antenna gain to constrain power consumption and simultaneously provide the required radio coverage. Most designs of wearable antennas use conducting patches however the research group from TUL had different approach using wires embedded in nonwoven textile materials.

The human body has heterogeneous structure so the interaction of electromagnetic wave with it has very complex nature. The body consists of tissues that in average have the electrical parameters similar to the parameters of water, salt and sugar mixture thus the energy of high frequency electromagnetic wave is absorbed by the human body with various intensity (depending on the wave frequency and the part of the body). This effect is often analyzed with the use of computer simulations. The finite difference time domain method (FDTD) is capable of calculating the amount of energy absorbed by the human body. This method is used to analyze the interaction of the radio communication system with the human body (for health hazard assessment) and to simulate the parameters of textile antennas in their typical locations.