INNOVATION ARTICLES
THE IDEA SUBMISSION PORTAL FROM MEDTRONIC

BODY AREA NETWORKS (BAN)

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The era of the solitary mute medical device is over, displaced by fast networks of wireless sensors implanted in the body or worn externally. These so called body area networks (BANs) can monitor and treat health parameters and feed data to the outside world. BANs form the foundations of the booming eHealth revolution and are attracting a new generation of telecommunications engineers into the medical device arena. Here, Laura Galluccio, Assistant Professor in the Electrical, Electronics and Computer Engineering Department, University of Catania in Italy, explains how her research could radically improve communication in BANs involving implanted devices.

NETWORKING IN THE BODY

BANs monitoring factors like blood pressure or blood glucose send data outside the body to a sink, located for example on a wristwatch "which can collect and partially process this information and even send it to a medical centre remotely located," explains Galluccio. To date, BANs have used electromagnetic RF waves, but Galluccio warns that "this can have drawbacks because of overheating of tissues" which can lead to cell death. The complexity of transmitting RF signals through body tissue also means "it is quite difficult [to] communicate between a sensor located inside your body towards a sink that is a few centimetres away" since RF waves don't' travel well through human tissues.

Galluccio believes ultrasound is a better choice for implanted devices (1). "The body is more than 65% water, and in water, ultrasounds propagate very well," explains Galluccio, "For example, submarines or underwater communications are based on the use of ultrasound." Ultrasonic communications at frequencies just above the limit of human hearing "are well known for being used in medicine in the 60s with no bad effects. So, they are safe waves," says Galluccio, adding that ultrasound avoids the problem of over-heating tissues.

Galluccio, along with collaborators S. Palazzo at the University of Catania and T. Melodia and G. E. Santagati at the University at Buffalo, New York, USA, has tested ultrasound communication in a synthetic kidney training phantom, more commonly used to train physicians in interventional techniques (2). "We would like to test in animals but there are some ethical aspects that should be considered," says Galluccio, "When we are sure that the effects are not dangerous we will move into this second step and test on animals."

A patent is pending for this technology in the first steps towards commercialization. "We have an institutional office that partially helps us with patent registration," says Galluccio, "but our US colleagues have a specific office that takes care of everything, so we are well driven by them."

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INDUSTRY-WIDE CHALLENGES

Even if ultrasonic communication transforms the BAN landscape, the industry needs to overcome several hurdles before BANs can achieve their potential.

Firstly, Galluccio notes that if ultrasonic BAN communication takes off, spectrum regulation for the ultrasonic communications might be required to avoid interference of other telecommunication devices working on the same frequencies.

Security of sensitive health data is another big issue that the industry is working to solve. "There are ongoing studies to introduce solutions to preserve security and privacy," says Galluccio.

Reimbursement of devices using BANs could pose initial difficulties until costs are brought down. "In the long-term, this kind of technology should be very low cost," says Galluccio, noting that energy harvesting technology could make devices self-sustaining in the future.

COLLABORATION AND A DESIRE TO HELP

At university, Galluccio was torn between studying engineering and medicine. Engineering won out, but her career has since been focused on doing "something that can be helpful to people - to improve their lifestyle or medical care. I've always had this passion for studying these medical topics." This has influenced Galluccio's collaborations with medical professionals. "Research involves multi-disciplinary points of view. You have to talk to people that know the diseases and how the organs communicate with each other," she says, "Then, I try to see if there is a physical layer solution or a networking solution or a protocol that can be set to allow the devices to communicate."

THE KEYS TO SUCCESS

For Galluccio, the key to successful medical innovation comes from applying your particular skill set to solve a challenge. Her advice for potential innovators is to "think about a medical aspect that is interesting to them. Start by thinking about a very specific problem and trying to see if you have a background that can be useful, or that can be used at large to solve a small problem. That is just a seed towards the solution of a bigger one."

This fulfils the social goal of research according to Galluccio. "Research itself does not make any sense. It should be focused to work something that is helpful for others," she says.

REFERENCES

[1] Challenges and Implications of Using Ultrasonic Communications in Intra body Area Networks, 2012 IEEE WONS Galluccio L, Melodia T, Palazzo S, Santagati G

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