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Department Communications & Electronics – RFM²

Internship Subject 2024

Comparison of the influence of subject's morphology on Wireless Body Area Network propagation channels based on complex morphed inhomogeneous numerical phantoms and simplified homogeneous ones

Wireless Body Area Networks (WBANs) have been studied for about 20 years. They cover scenarios in which several sensors (or actuators) are placed on or near the human body in order to perform measurements (physiological for example) and to communicate between *on-body* nodes, implants and external nodes, or from on-body nodes to a distant access point. Various applications are concerned, notably in the domains of health, monitoring and surveillance, as well as in sport, multimedia, entertainment, data transfer, etc. Although much work has been already achieved, many questions remain open – from antennas to applicative layers –, but that of the propagation channel is still particularly concerned. Indeed the propagation mechanisms along or around the human body are very particular because the body is a very strong electromagnetic (EM) scatterer, and the sources of variability of the channel are particularly numerous. Various research teams have proposed models based on EM simulations or on comprehensive measurement campaigns with human subjects or with phantoms. Standard IEEE models were published in 2006 (802.15.4a) and more specifically for WBANs in 2009 (802.15016). Improved models have been proposed since, in particular accounting for the variability due to posture and movement. However, among the numerous sources of variability (radio link type, motion, movement, posture, morphology, antennas, etc.), the variability effects due to the surrounding environment, in particular in indoor premises, has not been yet comprehensively studied and modelled.

The work proposed in this internship will involve comparing the simulated path loss (PL) (with the *Sim4Life*® full-wave electromagnetic solver) for several on-body radio links (Hip-to-Chest, Hip-to-Wrist, etc.) with an inhomogeneous phantom of complex morphology (obtained from NMR imaging) and simpler homogeneous phantoms (which can be easily deformed with common image synthesis freeware such as Daz® or Blender®). This type of comparison is intended to validate, if possible quantitatively, the use of simplified homogeneous phantoms, which make it easy to generate statistical samples of "populations" with significant anthropometric variability (corpulence, overweight or even obesity, etc.), from which statistical models can be extracted. In fact, there are very few "realistic" morphed inhomogeneous numerical models available worldwide, as the scientific problem of image processing is complex and still the subject of ongoing research.

This work will be carried out as part of an ongoing PhD thesis.

This internship requires knowledge in radio communications, propagation, antennas, microwaves and at least basic knowledge of signal processing and statistics. Knowledge of Matlab (at least basic) would also be appreciated.

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