Next Generation Wireless Communications: Telehealth

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Personal wireless communications technology has evolved significantly since its introduction in the 1970s. Cellular telephones have advanced from pure voice communication devices to data communication devices and are evolving into computing devices with a current focus on data management and entertainment applications. As cellular phones become indistinguishable from small computers, the focus on advancing the technology has shifted from increasing spectral efficiency – the number of bits per second per Hertz, which measures how much information can be reliably transmitted – to improving the computing aspects of the device. As wireless communications continue to advance, there is a new focus on new domains of use. Herein, we focus on a particular evolution of wireless communications, telehealth, and define some of the research problems associated with making telehealth viable.

At inception, cellular telephony was in the domain of privileged. However, the penetration of mobile phones even in populations with lower socio-economic status is substantially higher than any other compute or communication device. Today, more than 80% of the world's population is within the reach of a cell tower with nearly 4 billion mobile phones in use. Such expansive mobile phone penetration and coverage creates new opportunities to exploit mobile phone technology for prevention and treatment efforts of health conditions in difficult to reach, at-risk and underserved individuals worldwide. Due to this fact, wireless body area networks (WBANs) are employing mobile phone technology as the centerpiece for both continuous non-intrusive monitoring of metabolic health and exercise habits, and intervention delivery.

In particular, WBANs are well-suited for detecting and identifying the physical activity of an individual. In this presentation, we first introduce the architecture and elements of our WBAN for the collection and processing of a variety of biometric signals from multiple sensors. This is a large-scale project exploiting an interdisciplinary approach. Our current application of interest is in the treatment of pediatric obesity in inner-city minority populations. However, we are currently exploring applications of the system to the rehabilitation of stroke patients, intervention design for Parkinson's disease, stress and depression assessment, as well as a possible indirect measure for mild cognitive impairment.

A short to medium term challenge for the practical deployment of such WBAN systems is the fact that current cellular telephones have not been optimized for use as fusion centers for the analysis of biometric data. Thus, new methods and algorithms are necessary to maximize the energy efficiency and thus prolog the battery life of these cellular-centric WBAN systems. Energy efficiency must be improved at all layers of the system from data collection to data processing to mobile phone system operation. To this end, we have explored a variety of solutions including: improved detection algorithms for assessing the physical state of an individual, optimizing resource allocation and the scheduling of sensors, and exploiting novel methods for dealing with missing or erroneous sensor measurements. Our prior approaches will be reviewed and some open research problems will be highlighted.