Miniature Wireless Implants for Diagnosis and Therapy

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Wireless technologies bring promising solutions for patient acceptance and cost issues in healthcare. Portable electronic devices have made a significant impact on our society, and wearable and implantable devices around or inside body that can wirelessly communicate with them to form personal body networks have become feasible. Recent advances in micro- and nano-technologies further offer interfacing functionalities to human tissues add practicality to clinical realization. These technological progresses bring new capabilities to implants for communication between body and machine, sensing bodily functions, and modulation of tissues.

Advantages from miniaturization and low power consumption in such electronics enable novel applications in medicine and biological studies. Quantitative measurement and documentation of behavior, physiological and biochemical parameters present more accurate assessment of the patients. Electronic data also provide real-time alerts for acute conditions and continuing analysis for health monitoring. Direct modification of cells, tissues, or organs by electrical signals makes it possible to manage chronic diseases with closed loop mechanisms mimicking adaptive functions of human body. With wireless communication, implants can be implemented for freely behaving animals or patients without constrains, discomfort or limits in mobility. This increases diagnosis accuracy in realistic environments as well as permits remote synthesis of physiological functions and delivery of therapeutic treatment. Personal wireless communication network allows closed-loop control of bodily functions with patient's own cognition of comfort and needs. The ubiquitous access to physiological information in electronic formats allows caregivers to comprehend patient's conditions with measureable numbers and statistical records.

This presentation discusses the development of wireless micro devices in body area network systems for clinical applications. The systems are based on batteryless wireless implants with enhancements by miniature electrochemical sensors, nanoparticle modified surfaces, microelectromechanical system (MEMS) and RF communication. Several diagnosis and therapeutic treatment examples utilizing implantable wireless devices including a closed-loop system for pain recognition and inhibition, a gastro-esophageal reflux episode monitoring system and an endoscopically implantable stomach stimulator will be discussed. These applications address the implementation and cost issues in healthcare, and enable new medicines to improve human welfare and assist better living.