UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles

Wearability issues

Wearable devices and electronics present a unique interface of technology and humanity, thus producing unique challenges that need to account both for technological and human aspects of the problem. Human behavior may affect the operation of wearable as much as the technology advance. The following aspects may be considered as some of the challenges facing the field of wearables:

(a) Break-through applications of wearable electronics. From the dawn of history, the evolution of wearables is driven by the practicality, utility, and convenience they provide. The challenge of modern wearable electronics in discovering ubiquitous applications, as its future growth is contingent on emerging applications in health, wellness, and other personal needs. Novel applications of wearables may need to be supported by extensions of sensing and data analytics capabilities, thus presenting a compelling use case

(b) Minimization of user burden and integration with everyday wear items. The illustrations of wearable devices frequently include pictures of individuals instrumented at every possible location on the body, such as arms, legs, torso, etc. Practically, such a scenario represents an unrealistically high user burden and is unfeasible. A related challenge is the seamless integration of wearable electronics in everyday wear items, such as textiles clothing, footwear and accessories.

(c) Efficient and informative interpretation of data generated by wearable devices. Wearable devices may generate an abundance of data, for e.g., health-related sensor signals.The challenge lies in the interpretation of such data streams and connection with health outcomes, using sensor data to guide behavioral interventions and health education. Emerging methods of artificial intelligence carry a promise of solution to the problem of data analysis and interpretation.

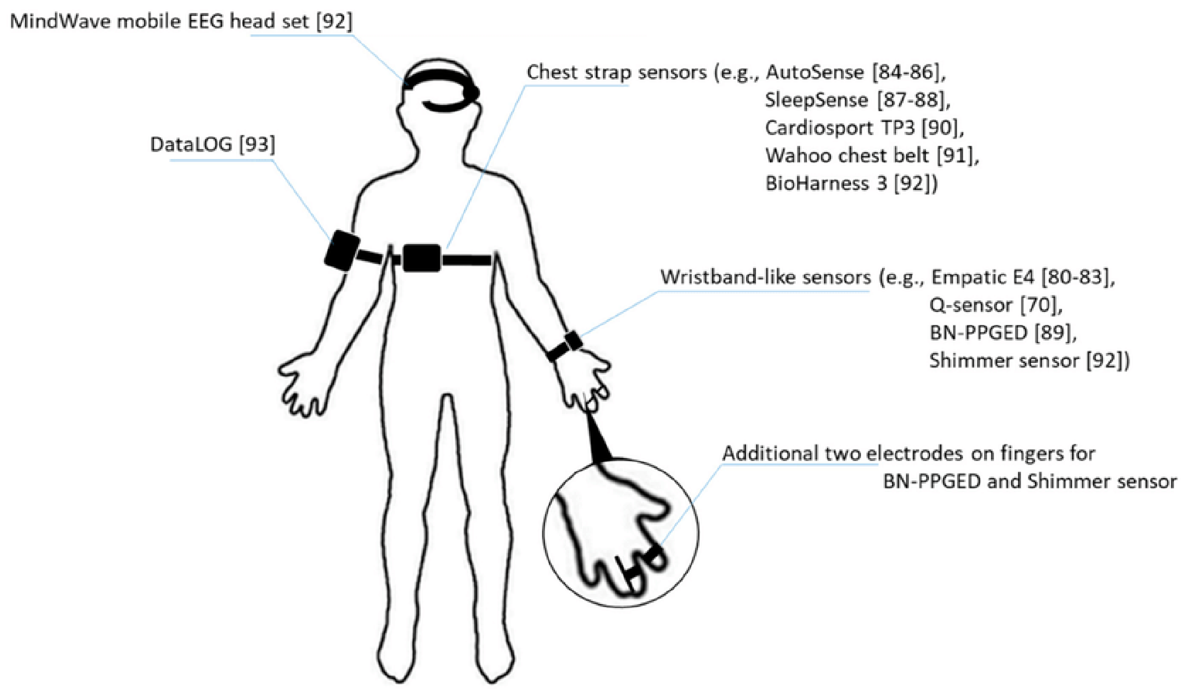
(d) Ultra-low power operation. A wearable device should ideally sustain a lifetime operation without or minimal user interference. In terms of power, this implies operation on a battery, energy harvested from the body, or a combination thereof. This requires low-power operation both for analog and digital electronics of a wearable. Wireless power delivery may be explored to seamlessly charge many devices without need to connect each individual device to a charging circuit (for e.g., charging all socks in a drawer), biofuel cells and supercapacitors may need to be utilized in the power subsystems.

(e) Flexible and stretchable electronics. Epidermal and body compliant electronic devices may be considered a subset of wearables with additional requirements of allowing shape changes in response to body movement, making such devices especially sensitive to motion artifacts, demanding high biocompatibility and adaptability to variation in human body shapes, sizes, and characteristics.

(f) Biocompatible communications. Communications from the body (to the outside world) and on the body (between multiple wearables) demand new solutions, as traditional radio methods experience challenges due to absorption by body tissue. The related challenges include development of efficient methods for communicating through or on the body, including the organization of wearables in body sensor networks and their integration into the Internet of Things Biodegradable Electronics. If wearable electronics are to become the true mainstream, the challenge of sustainable, ecologically viable manufacturing, and disposal needs to be addressed.

(h) Privacy and Security. By definition, a wearable is an electronic device that resides on or close to a person and is present in a variety of life situations. The challenges include protection of personal information, preventing the unauthorized use of wearables for biometric identification, and ownership of the data produced by wearables

physical shape and placement of sensor



The sensor such as 3-axis accelerometer can be used as body position sensor. This sensor provides information of patient's position i.e. standing, sitting, supine, inclined, left and right. Such accelerometer based sensor can easily be interfaced with any microcontroller boards such as arduino uno, arduino mega etc.

Design for wearable BSNs focuses on specific and important issues for developing wearable computing systems that take into account the physical shape of the sensors and their active relationship with the human form.
Design for wearability requires unobtrusive sensor node placement on the human body based on application-specific criteria.

Criteria for placement can vary with the needs of functionality and convenience. Functionality criteria constrains node placement to regions where relevant data can be sensed. The number of nodes required to capture all relevant data can vary based on the quality of information sensed at individual locations. Convenience criteria include:(1) physical interference with movement,(2) difficulty in removing and placing nodes,(3) social and fashion concerns,(4) frequency and difficulty of maintenance(charging and cleaning)
For example, in continuous healthcare monitoring, patients will be expected to charge the sensors or replace the batteries on a regular basis, as they do with cellphones and other electronics.However, the frequent need to charge and the bulk of the battery can frustrate the users, causing them to no longer wear the sensors. Furthermore, batteries are the heaviest component in the system. By decreasing power usage, the size and weight of each sensor node can decrease, thus increasing patient comfort and device wearability.

This makes energy usage a primary constraint in designing BSNs, limiting everything from data sensing rates and link bandwidth, to node size and weight. Thus, one of the important goals in designing BSNs is to minimize energy consumption while preserving an acceptable quality of service. Energy consumption can be decreased by lower sampling frequency, decreasing processing power, and simplifying signal processing.
Another effective technique is deactivating nodes thatare unnecessary for specific tasks.

Technical challenges - sensor design and signal aquisation

As engineers seek to develop new and innovative wearable diagnostics, many are focusing on smaller, more energy-efficient devices. In the process, respondents say they are fighting the kind of typical constraints that factor into many of today’s product development efforts, citing top among them the areas of cost (38%), durability (37%) and power management (35%).

There are other unique challenges in designing diagnostic wearables to be used by a patient, caregiver, or consumer in a non-medical setting. High user expectations around ease of use, the need for intuitive user interfaces and complete documentation, as well as the need to account for the vagaries of uncontrolled home care settings top the list of challenges cited by engineers.

Data collection and connectivity represent another area for concern. Nearly one third (30%) of respondents pointed to connectivity as a challenge. Over two thirds (82%) agree that there isn’t a lot of clarify about how to effectively capture and use the data or doing something medically effective with it once collected. Nearly all (94%) cited a need to for ownership of data security and privacy.