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Wearable Sensor Technology for Healthcare

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Abstract: ***Healthcare and human activity monitoring has become the most important task in pervasive computing. The paper presents improvements for the present real time health monitoring systems in order to attain more accurate and quick results of the condition analysis of the person in contact with the sensors, the processed method makes sure that the process is efficient and also economically viable.***

Keywords: Sensors, Health monitoring, Real Time Analysis, LAN Application, Smart Grid, Wearable Technology, Wireless Sensors, Sensor Network, Internet of Things

1. Introduction

During the past decade, there has been an exceptional development of microelectronics and computer systems, enabling sensors and mobile devices with unprecedented characteristics. Their high computational power, small size, and low cost allow people to interact with the devices as part of their daily living. That was the genesis of Ubiquitous Sensing, an active research area with the main purpose of extracting knowledge from the data acquired by pervasive sensors. Particularly, the recognition of human activities has become a task of high interest within the field, especially for medical, military, and security applications. For instance, patients with diabetes, obesity, or heart disease are often required to follow a well defined exercise routine as part of their treatments. Therefore, recognizing activities such as walking, running, or cycling becomes quite useful to provide feedback to the caregiver about the patient's behavior.

Likewise, patients with dementia and other mental pathologies could be monitored to detect abnormal activities and thereby prevent undesirable consequences. In tactical scenarios, precise information on the soldiers' activities along with their locations and health conditions is highly beneficial for their performance and safety. Such information is also helpful to support decision making in both combat and training scenarios.

The first works on human activity recognition (HAR) date back to the late '90s. However, there are still many issues that motivate the development of new techniques to improve the accuracy under more realistic conditions. Some of these challenges are the selection of the attributes to be measured, the construction of a portable, unobtrusive, and inexpensive data acquisition system, the design of feature extraction and inference methods, the collection of data under realistic conditions, the flexibility to support new users without the need of re-training the system, and the implementation in mobile devices meeting energy and processing requirements.

The recognition of human activities has been approached in two different ways, namely using external and wearable sensors. In the former, the devices are fixed in predetermined points of interest, so the inference of activities entirely depends on the voluntary interaction of the users with the sensors. In the latter, the devices are attached to the user.

Intelligent homes are a typical example of external sensing. These systems are able to recognize fairly complex activities (e.g., eating, taking a shower, washing dishes, etc.), because they rely on data from a number of sensors placed in target objects which people are supposed to interact with (e.g., stove, faucet, washing machine, etc.).

Nonetheless, nothing can be done if the user is out of the reach of the sensors or they perform activities that do not require interaction with them. Additionally, the installation and maintenance of the sensors usually entail high costs.

It is now an everyday news [17] that the wearable electronics devices and technologies, such as heart rate monitors, smart watches, tracking devices (including Pill Cam) and smart glasses (Google glass), etc. are experiencing a period of rapid growth. Fitness devices are by far the most mature market, making up 97% of the projected value in 2013, though this will fall dramatically as smart watch and smart glasses categories develop and products with embedded sensors that track and analyse physical or other movements and activity. Future wearable technology reports that the wearable technologies will impact future medical technology, affecting our health and fitness decisions, redefining the doctor-patient relationship and reducing healthcare cost.

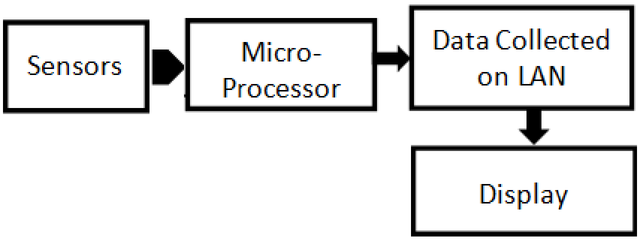

Figure 1: Block Diagram of Wireless Sensor for Healthcare

2. Sensors Used for Human Activity Monitoring

Here we will describe a few sensors used for human activity monitoring. Sensors are fundamental elements of the whole monitoring system and should measure the physiological parameters of interest accurately and reliably over a long duration. The rapid development of microelectronics, micromechanics, integrated optics and other related technologies has enabled the development of various kinds of smart sensors to sense and measure data more efficiently and faster, with lower energy consumption and less processing resources.

2.1
Body temperature sensor is the most basic sensor used which gives us information about the variation in the body temperature and can be used to detect the illness of the patient. This is extremely useful for determining the physiological condition and the activity classification (in coordination with other sensors).

2.2
The next most common physiological parameter is the heart rate of the person under monitoring. Heart rate is a precisely regulated variable, which plays a critical role in health and disease of human. There many methods available to measure heart rate of a person; Photoplethysmography (PPG) based technology sound based based on changes on brightness of person's face] and so on.

2.3
Accelerometers are very commonly used in monitoring of human activity and basically are used to measure acceleration along a sensitive axis and over a particular range of frequencies. They can be used for many purposes such as detection of fall movement and analysis of body motion or a subject's postural orientation.

2.4
Wearable ElectroCardiogram (ECG) sensors are also used for short-time assessment of cardiovascular diseases, especially for people with chronic heart problems. The ECG signal provides very useful information about the rate and regularity of the heart beats, which are used in diagnosis of cardiac disease.

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2.5
Health Monitoring
The basic architecture of the human activity monitoring system can be represented with the help of a block diagram; the simplest one is shown in Figure 1. Depending on the task of monitoring, different types of sensors are used. The raw data from sensors are collected by a processor. The data are processed and then displayed on a display.

3. The Method Proposed is as Follows

All the above mentioned sensors are embedded in a glove and the readings are taken at equal intervals.

The sensors give their output to the micro controller (node microcontroller). Which is an open source platform; it includes firmware which runs on the ESP82866 Wi-Fi SoC and hardware which is based on ESP-12 module.

The next step is to collect data, which is transmitted by the microcontroller and stored on a local area network (LAN). This LAN is made with the help of wireless sensor network. All the data is stored here and can be displayed on a monitor as per convenience.

We designed the method especially for collecting data in a hospital with minimum human intervention. This is done to reduce the chances of error.

The body data will be collected from all the patients and stored on the local area network.

4. Block Diagram for Data Collection in a Hospital

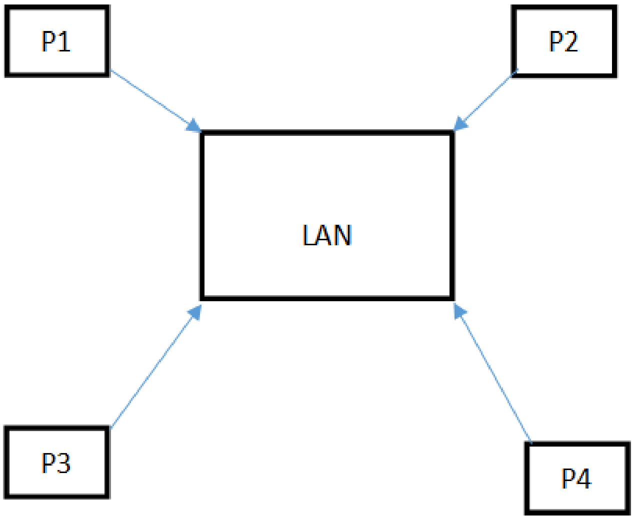

Figure 2: Wireless Network of Hospital for data Collection Connecting to a Central Hub.

5. Design Challenges of Wearable Sensors for Human Activity Monitoring

The research and scientific communities are working hard to design and develop smart wearable devices to be used for continuous monitoring of different human activities for twenty four hours and seven days a week. There are several challenges faced on design, development, fabrication, implementation and utilization cum continuous monitoring. While designing wearable devices there are always design challenges from the hardware and software constraints arising from the form- factor, light-weight and low energy operations, as well as there are safety requirements such as avoidance of physical injury. The physical impact of a sensor operation needs to be taken into consideration and can be addressed by appropriate design of multiple sensor components such as processor, radio, and optimization of data algorithm. While the sensors are placed on the body, the risk of thermal injury to tissue may also be considered and can be reduced by limiting the sensing frequency as well as wireless frequency, the computation power, and the radio duty cycle of the body worn sensor. A novel non-linear optimization framework has been presented to consider safety and sustainability requirements that depend on the human physiology and derive system level design parameters for wearable sensors application. In wireless wearable sensors different data sources generate time-varying traffic, the volume of which may be large resulting in intolerant latency. It is a huge challenge to ensure that the most significant data can always be delivered in a real-time fashion. Moreover, data transmission may suffer from deep fading and packets loss due to the dynamic on-body channel induced by movements and surrounding environment. So energy-efficient medium access control (MAC) is crucially needed to allocate transmission bandwidth and to ensure reliable transmission considering WBAN contexts, i.e., time-varying human and environment.

6. Conclusion

The paper has reviewed the reported literature on wearable sensors and devices for monitoring human activities. The human activity monitoring is a vibrant area of research and a lot of commercial development are reported. It is expected that many more light-weight, high-performance wearable devices will be available for monitoring a wide range of activities. The challenges faced by the current design will also be addressed in future devices. The development of light-weight physiological sensors will lead to comfortable wearable devices to monitor different ranges of activities of inhabitant

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