International Journal of Pure and Applied Mathematics
Volume 118 No. 24 2018
ISSN: 1314-3395 (on-line version)
url: http://www.acadpubl.eu/hub/
Special Issue
http://www.acadpubl.eu/hub/

An Overview of Sensor Types for Telemedicine Application

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May 22, 2018

Abstract

Sensors and the network of sensors play a vital role in wide number of real-time systems. Depending upon the application and area of investigation, the type and range of sensor varies. There are surplus varieties of sensors available in the industries which are specific in their application. The sensors that are designed for detection and measurement of various physiological parameters such as temperature, blood pressure, gas, heartbeat, etc., are useful in biological monitoring process. These sensors or actuators are fruitful in tracking patients physiological factor under interest along with the location of the patient.

***Key Words*:**Sensors, health care at home, physiological parameters.

1 INTRODUCTION

The constant evolution of wireless technologies and the miniaturization of devices have led to the massive usage and development of Wireless Sensor Networks (WSNs), which potentially affects all aspects of our lives around the world health care through home automation and energy management, to military services and many other applications [1]. WSNs are networks of small sensing devices collaborating with each other to collect, work on it and converse information about some physical phenomena over wireless channels [24]. In addition, a data-centric approach is used and a WSN is seen as a shared-out system comprising of many autonomously cooperating nodes at the application level [3]. Nodes are grouped to form a cluster. Each cluster can have individual or several sinks. In general, the data is sent hop by hop to the designated sink which can then forward it to an external gateway in order to be stored and managed either in a dedicated cloud or in distant monitoring and administration centers. There are many characteristics and constraints associated with a WSN [2]. One of the main constraints is the topology changes of such network where hundreds to thousands of sensors and actuators are placed arbitrarily in the sensing fields. [5] These nodes are either stationary or moving, which leads to highly dynamic and multiple scale networks being prone to frequent failures [2]. WSNs are thus self-organizing networks where nodes frequently change their positions and/or geo-locations, and states (e.g. active or sleep mode). Moreover, as supplementary sensors may be deployed or altered at any instant, the need for a dynamic network reconfiguration seems to be essential in these networks. Low power and low energy are also two other main constraints of WSNs.

2 SENSORS/ ACTUATORS & THEIR TYPES

Sensors are micro-electronic devices generally equipped with limited and irreplaceable source of energy like batteries. They also have restricted energy source, power, memory and processing capabilities. In many cases, deployed nodes are in un-attempted and certain areas in the network. In addition, the installation and maintenance of WSNs are considered. Network should be secured [20].

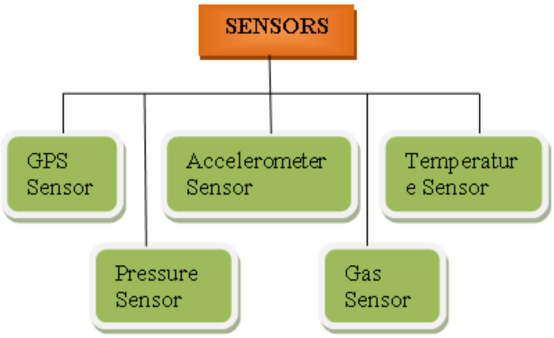

Fig.1. Classification of sensors

a. GPS SENSOR The remote management is the main secured part of the sensor network characteristics. An important issue to be considered in these networks is their heterogeneity in terms of lump models and profiles, data gathered (e.g. sensing ranges, formats, coding schemes and metadata), communication protocols and/or grounding and applications [2]. Within the same WSN, each node coming from diverse manufacturers may tender special processing functionalities and may need various resources depending on its role (node, actuator or sink). [6] Furthermore, the required data speed and data form may differ from one application to another. Where some scenarios need periodic data transmission, others are based on event driven or on requests from a gateway [11].

In Body Area Networks (BANs), instantaneous observation and alarms, as well as consistency and utmost security levels are also mandatory. Additionally, the lifetime and Quality of Service (QoS) also vary from one WSN to another. All these fore-mentioned interoperability and heterogeneity issues complicate WSNs interworking and thus make actually impossible the generic interactions with any kind of sensors at the management, monitoring and application levels (e.g. generically reuse and share of their data within different applications).In order to provide solutions to afore-mentioned heterogeneously used and interoperability issues, we must in particular assign an explicit and common semantic to every terminology used, i.e. introduce and specify an open data model offered for WSNs [21]. Since this open data model has to include in particular the grounding information of the WSN nodes, it will thus make easy WSNs interworking. Using the formal definition extracted from ontologys are tools for specifying the semantics of terminology system in a well-defined and unambiguous manner [7][11].

Ontology can then be used to make official the WSN contributed open data model by introducing a common vocabulary, associated with well-defined semantics, for data (sensed, monitoring, control, alarm) and information sharing between different components, applications and services in WSNs. we present, formalize and prevalidate an original semantic open data model dedicated for sensor and data common description [13]. This model is proposed for managing any sort of sensors/actuators and their associated data, thus providing a solution to interoperability and heterogeneity management key issues in WSNs.

The foremost reason behind this semantic ontology is also to provide associated standardized information management enablers allowing: the discovery of nodes and clusters, the effective data collection and aggregation, and the dynamic monitoring and control for WSN [14]. Reviewing the literature on WSNs ontologys we notice that some ontologys are dedicated to the portrayal of sensors attributes and examination, while others bring in characteristics that depict the data.

Fig.2. GPS Sensor (Courtesy: google.co.in/ telemedicine GPS sensor images)

b. PRESSURE SENSOR

A pressure sensor network is formed by a set of miniature smart sensor devices. The adhoc pattern is used for the deployment of the sensing particle, in measuring some quantity of interest, and in sending this to a designated base station node. Sensor nodes have

limited. Irreplaceable power units are used in the sensing device. The power consumption in the network is radio transmission where maximum energy is consumed in the node to node communication, the energy consumed is irresistible and the desirable interaction is done [24].
This is because the numbers of packets in the system network computations reduce the packet transport load and thus increase the lifetime of the network. We focus on the distributed computation approach for sensor information processing. When successive results for several sampled values need to be computed, separate pipelined computations are performed for each vector of sampled values. Thus, we do not exploit block computation [15]. We assume a centralized optimal scheduler, which schedules the maximal independent sets of links in the network [22]. Thus, there are no collisions in the model. The pressure level of the person under observation can be continuously or frequently monitored and examined.

Fig.3. Pressure Sensor (Courtesy: google.co.in/ telemedicine Pressure sensor images)

c. ACCELEROMETER SENSOR ADL means Activity of Daily Living and factually the activity from day by day living. In the early days, the activity measurement system using accelerometer measures in one direction at one element. This method has an advantage that easy and quantitative measurement is possible using one sensor [16]. But that is so simple method that precise activity assessment for various posture classifications in daily living is impossible. For the study about the correlation between the humans movement and energy consumption, the method that measures 3 direction action information using 3-axis accelerometer sensor is utilized. This technique is better than using several sensors, but the classification for various humans movement is still impossible.

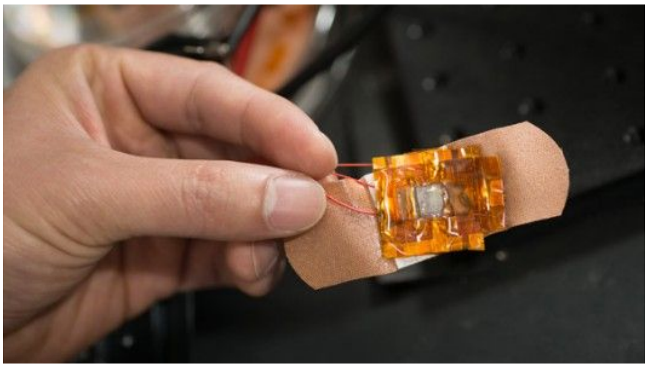

Fig.4. Accelerometer Sensor (Courtesy: google.co.in/ telemedicine Accelerometer sensor images)

d. GAS SENSOR

Based on the human experiments, a set of pressure data from the human stomach using the first step of the joint algorithm is presented. The pressure data were constantly changing, and the gastric emptying time (GET) was 157.2 minutes. The slope and gamma versus embedding dimension m. In Step 2 of the joint algorithm, the phase space was reconstructed. Considering the average displacement method, the optimal delay time td versus the embedding dimension m of the pressure data has been provided. Because the gamma value remained approximately constant when the embedding dimension was greater than 10, the maximum value of the embedding dimensions m. The sampling interval was 1.2 seconds. Although the amplitudes of the separated signals lacked scientific definitions, these separated signals can be analyzed with the spectral analysis method [23]. Specifically, the de-mixing matrix. Because the frequency components that were caused by breathing, movement, and contractions of the abdominal muscles were 10.00 15.00cpm, identifying and separating these signals must be a top priority. Based on the ICA algorithm, the pressure variations were separated [12]. The main frequencies existed markedly from 10 to 18 cycles per minute (cpm). Meanwhile, these frequencies varied steadily over time. Otherwise, the separated signal and were relatively complicated signals that were mixed by 3cpm and 1018cpm components. The frequency of the separated signal that was caused by the electrogastrogram (EGG) was centralized at 3cpm, which demonstrated that the frequency.

Fig.5. Gas Sensor (Courtesy: google.co.in/ telemedicine Gas sensor images)

e. TEMPERATURE SENSOR

Temperature can influence the performance of the pressure sensor; calibration data from the pressure sensor when the temperature varied from 35C to 41C. When temperature was constant and pressure changed from 90 kPa to 120 kPa, the voltage output of the pressure sensor was linear [18]. Based on the surface mesh model of the calibration data, the wireless capsule can accurately measure the temperature and pressure of the human GI tract. The measuring range, maximum error, and linearity of the pressure sensor were 90 to 120 kPa, 0.15 kPa, and 0.3%FS, respectively. However, due to the PGA (1/4), 128 times) and ADC (18 bits) in the ASIC, the digital resolution of the pressure sensor reached 546 bits/kPa. Notably, the power consumption was only 1.92mW. Based on the schematic design, the function modules inside the wireless capsule prototype were implemented. The wireless capsule measuring 11mm 26mm. Batteries, pH sensor, pressure sensor, ASIC, and RF transceiver were the main components of the wireless capsule. The PCB of the ASIC is with a peripheral circuit and the RF transceiver with a peripheral circuit, the pH-ISFET chip, temperature sensor, and absolute pressure sensor element. Using the wireless capsule and portable data recorder, human experiments were completed, and data from the human GI tract were obtained [19]. Using pressure data from the human stomach, analyses with PSR and ICA algorithms were conducted.

Fig.6. Temperature Sensor (Courtesy: google.co.in/ telemedicine Temperature sensor images)

Table.1. Summary of sensors for telemedicine application

Sensor type	Application in which used	Benefits	Inference
GPS	Body Area Network.	Patient location can be tracked.	More power consumed.
Pressure	Blood Pressure monitoring	Non- Invasive and highly accurate.	Problem due to motion artifacts and misplacing of sensor.
Accelerometer	Monitors human movement and energy consumption by activity of daily living	Easy and Quantitative measurement is possible even with only one sensor.	precise activity assessment for various postures in daily living impossible.
Gas	Used with electrogastrogram to sense the GI fluid gas concentration.	Detects various gases present in the stomach with high sensitivity and low noise.	Cooling requirement and long term instability.
Temperature	Measures the body & GI tract temperature.	Small package and can operate with low voltage	Least stable and least repeatable

3 CONCLUSION

The endless types of sensors that are coming under the above discussed categories are much helpful in the systems that involve remote patient monitoring process. This enables us to provide the needful persons with proper medication immediately whenever there is an emergency situation at the place of residence or work [25].These sensors can also be deployed inside the human body and pasted as tattoos. In such conditions the patient under observation was free to move (dynamic). Apart from the above mentioned sensors there were also many sensors that are useful to telemedicine application.

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