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SEMANTIC SENSOR NETWORK

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SEMANTIC SENSOR NETWORK

Smartphone devices have emerged as a powerful computational device equipped with multi sensors performing different operations. These sensors embedded in the mobile phones help gather information for the benefit of the user. Examples are the locations and temperature sensors that help track the users' current location and also give the current temperature of the site respectively. Large amounts of data are generated during these processes and there is the need to manage these data. This paper presents a review of findings from different articles and journals on current and future sensors. It also focuses on how the generated data are managed using semantic technology. Sensors play a vital role in various aspects ofmodern life such as: health, transport, environment.

KEYWORDS:

semantic sensors, sensor network, smartphone, sensor, sensor node, querry sensor network, data management sensor network.

FOREWARD

Greatest thanks goes to Almighty Allah for giving me the knowledge, understanding, and strength to complete this thesis. I would like to thank my families, friends for their support and encouragement to the success of this thesis. I would also like to thank Patric Granholm who also happen to be my supervisor for his advice, suggestion and support for the success of this thesis.I finally would like to thank Poppy Skarli for her guidelines, time and support that helped me to conclude my studies.

2014, Turku
Karim Abdul Issakar

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1 INTRODUCTION

A sensor network consists of many sensor nodes meant to monitor conditions at different locations. The tremendous growth of sensor in smart phones keeps increasing day by day and will see tremendous growth in the near future. The success of smart phones is leading to an increased use of sensors in smart phones to help provide new features and services to end-users. Today's sensors do not serve as the key computing and communication means of choice but they help to provide services such as: GPS, temperature, pressure, motion, vibration, gyroscope, microphone and camera to the end user of the embedded sensor technologies. These sensors collectively enable new applications across a wide variety of sectors such as health care, environment, social networks and safety (Lane et al. 2010). The two important issues when it comes to sensor network are data management and query processing. Data management has to do with how the information collected within the network is managed and query processing has to do with how these data are assessed by applications by providing logging, storage and auditing facilities for analysis. It is for these reasons why semantics was introduced into sensor networks to aid data management.

This thesis is a literature review of semantic sensor network and it focuses on data management in sensor networks. It also compares various sensors in smartphones and their operation. The first chapters will focus on the theoretical background information on sensor networks. The subsequent chapters will be dealing with detailed information on data management in sensor network, some important services that sensor networks provide to the end user, types of sensors and sectors that are making great use of the current trend in sensor network within smart phones. Sensors have come to stay and their usage will increase as our needs and demands change.

2 THEORETICAL BACKGROUND

2.1 Sensor

A sensor is a device, which responds to an input quantity by generating a functionally related output usually in the form of an electrical or optical signal. The development of sensors to meet this need is referred to as sensor technology and is applicable in almost every industry. Every sensor should be capable of receiving and responding to signals such as touch, sound, motion/movement, or light depending on where it is used. In addition, sensors sensitivity indicates the level at which the output changes when the measured quantity changes. They should be capable of changing the input parameters regardless of what direction the parameter changes whether there is an increase or decrease in value. However, some sensors do not return the same value for both directions when changed. Sensors made to measure very small changes must have very high sensitivity and they should be designed to have a small effect on what they measure. Sensors can be classified into two types: active and passive sensors based on the power or energy supply required by the sensors. Active sensors are the type of sensors that require power supply. Examples include LiDAR (Light detection and ranging), a photoconductive cell. In surveillance, a detection device that emits energy is capable of being detected by itself. Passive Sensors do not require power supply. They obtain their power from the device they are connected to. Examples are radiometers, film photography.

Current and future application of sensor will be classified differently as technology keeps improving. They will be classified based on the places they are used. They can, for example, be classified as:

- Biosensors, which are based on electrochemical technology. Biosensors combine biological components with physicochemical detection and are mostly used for testing, medical care device, water testing and biological warfare agent detection.

- Accelerometers are based on micro-electromechanical sensor technology. They are mostly used in patient monitoring which includes pacemakers and vehicle dynamic systems.
- Image Sensors are based on CMOS (Complementary Metal Oxide Semiconductor) technology. They are used in consumer electronics, biometrics, traffic and security surveillance and PC imaging.
- Motion Detectors are also based on infrared, ultrasonic, and microwave/radar technology. They are used in videogames and simulations, light activation and security detection (EngineersGarage 2012).

2.1.1 Sensor Network

A sensor network can basically be described as a group of specialized transducers with a communications infrastructure intended to monitor and record conditions at diverse locations. Sensor networks are build with nodes, there can be few or hundreds or thousands of them where each node is connected to one or several sensors. Every sensor node includes a function of a traditional network terminal and a router. They are also capable of detecting failure and intelligently restructuring routing within the network when there is failure in any one of it. Apparently, the closest nodes to the base station are used more heavily than the others, and due to that, they mostly develop some problems like hardware error or battery exhaustion because they are always in used (Gehrke & Madden 2004).

Some of the commonly monitored parameters of sensors are temperature or pressure, humidity, target tracking or border surveillance, wind direction and speed, GPS, accelerometer, illumination intensity, vibration intensity, sound intensity, power-line voltage, chemical concentrations. Sensors could be used to measure the weakness in building structures, or in vehicles and airplanes. They are also used in factories in order to monitor toxic or hazardous material.

2.1.2 Sensor Network Architecture

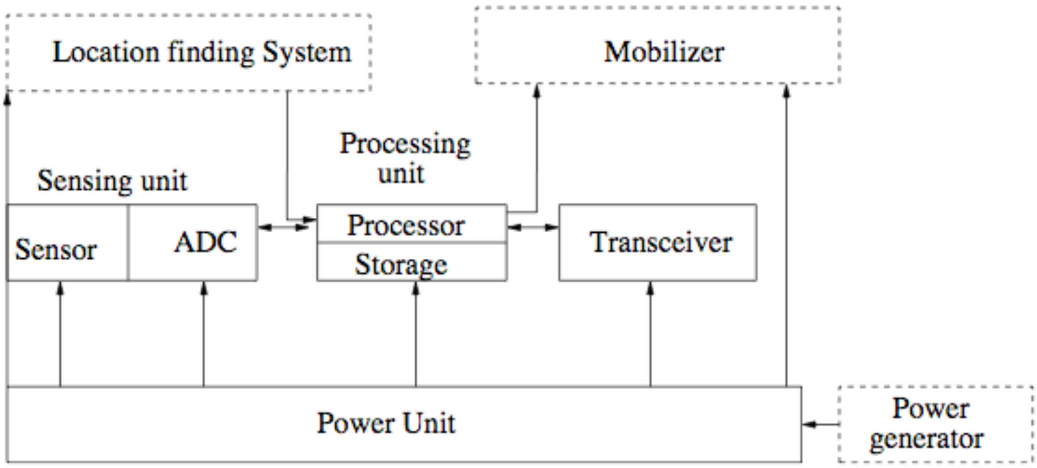

Figure 1. Architecture/basic component of a Sensor Node (Chandra et al. 2000)

Sensor nodes basically consist of 4 main modules, namely, the power supply module, the sensor module, the processor module and the wireless communication module. The power supply module supplies power to the sensor nodes. Communication mostly between neighboring nodes consumed quite a lot of energy compared to the data sensing and processing. Usually, micro-batteries capacitors are used. A sensor module consists of the sensors and Analog to Digital Converter (ADC). Sensors are designed to collect the information then transform the physical quantities into an electric signal. The ADC then changes the analog/electric signal generated by the sensor into a digital signal and then sends it to the processor. Large numbers of different sensors are available today and the most popular among them are able to sense light, sound, speed, angle, position, acceleration, pressure, temperature, proximity, electric or magnetic fields, chemicals, and even weather-related signals. The sensor module must be accurate to the supported application demand and consume less energy (Zafeiropoulos et al. 2009). The processor module performs a simple operation on the receiver digital signal and then stores the data into the memory. Its operation is mostly supported by on-chip memory modules. It also controls the operation of sensor nodes after processing its own data that is received. The wireless communication module is used for sending and receiving data. The information sent to the base station contains the MAC and network addresses of the sensors for easy identification. This is because every sensor has a unique MAC address. It uses either of the two most popular media, which are Radio Frequency (RF) i.e., where the unlicensed industrial, scientific and medical (ISM) spectrum band is freely available worldwide, or the Optical or Infrared (IR) i.e., where line of sight between communication is highly required and makes communication extremely sensitive to atmospheric conditions.

2.1.3 Sensor Node Requirement

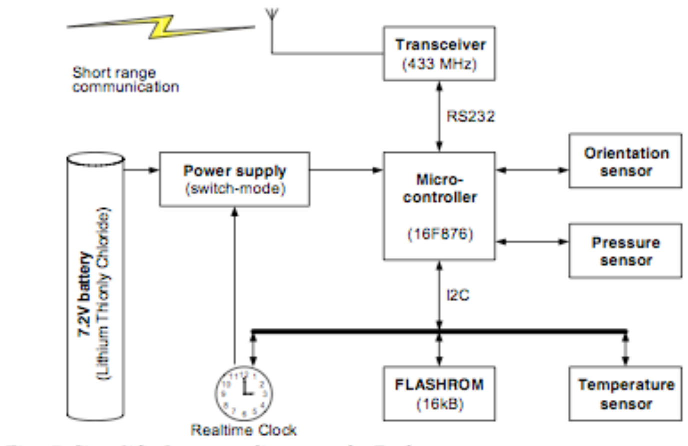

Figure 2. Simplified system diagram of a probe (Martinez et al. 2004)

Sensors are enclosed in sealed plastic cylindrical capsules each having a 100psi pressure sensor, two dual-axis micro-electromechanical system (MEMS) tilt sensor and a temperature sensor. The readings of the sensors are stored in Flash Rom by the PIC microcontroller and communicate to the base station through an Omni directional antenna. Two of the PIC microcontrollers can be used to enable failsafe control and remote reprogramming. Data are stored in 16k ring-buffer during wet summer and deployment period to tolerate 6-month isolation because of the expected communication problems (Martinez et al. 2004).

Sensor nodes have these basic requirements: before they are installed, they should be of low cost so that many units can be produced and also have low power for long-term operation. Again, they should be automated and maintenance free and have Non-intrusive-low environmental disturbance and be of low pollution.

Moreover, sensor nodes can be used in different ways; examples are they can be used for continued sensing, event detection, location sensing, event ID, local control actuators, etc. The nodes in the remote area acquire data by command from the base station or by nodes sensing one or more inputs. Smartphones can be used as a good sensor node for communication. The main function of wireless sensing node is to minimize the power consumed by the system. The concept of micro-sensing and wireless connection of these nodes makes it possible for it to be applied in many areas like military, environmental, health, home and other commercial applications (Akyildiz et al. 2001).

2.1.4 Sensor Node Communication

Sensor nodes are deployed to be sensed and controlled. Each sensor node is capable of communicating with each other. Generally, sensor nodes can only transmit data to a limited distance because of the limited memory, power and computational ability (Chandra et al. 2000).

Sensor nodes communicate through light, infrared, or radio transmission. The most used medium to communicate is through Radio Transmission with ISM (industrial, Scientific and Medical) band used in most networks. ISM is used because it is unlicensed, which means that users are free to use them without registering them or paying. Multihops are normally used to reduce the power consumption of sensor network. This is because they are immune to shadowing which makes them an attractive solution in a sensor network (Aboelaze & Aloul

2005). Sensor networks require different communication protocols because they are a special class of ad-hoc mobile networks. In the design of a sensor network, the key issues that affect the communication between various sensor nodes are Data Centric Paradigm, Location Based, Real Time, Scalability, Fault tolerance and Resource Constraints (Chandra et al. 2000). One main reason why Data Centric Paradigm is taken into consideration for routing protocols is that every network uses an IP address to route data and the data are communicated through router which contains two or more addressed nodes. Messages are not sent directly to individual nodes but rather sent to location or areas based on the data content.

Location Based is another issue that affects the design of sensor network because; sensor networks do not have permanent IDs assigned to them. The reason for this is because of their memory and processing capabilities and also the sheer volume of sensor networks existing globally. Any query is assigned to a location rather than a particular IP address or ID. When the query is assigned, the local nodes execute it individually and the rest are aggregated.

Further Real Time is absolutely necessary to be guaranteed for data transfer and communication in a sensor network. This is because they are deployed in environmental activities with real time event. A typical example is when a sensor network is deployed in a nuclear plant to detect radioactive leakage. If it cannot be guarantee to detect leakage within a certain interval, then the safety system will not be alerted and this may result a catastrophe. Another factor to be considered is the Scalability, which maintains the communication protocol of sensor network in a minimum global state and should be able to incur as little control overhead as possible when a sensor network is designed to be scalable. Similarly, Fault Tolerance is essential. The most common faults in sensor nodes are environmental noise or obstacle, wear and tear, power depletion, and physical destruction. The protocol must be designed in a way that, it is self-stabilized and can perform properly in the event of failure of many nodes. Another factor to be considered is Resource Constraints. In communication layer, power conservation is very important in a sensor network. Radio transmission consumes much energy and because a sensor network uses small batteries to operate, this makes power conservation a key factor in sensor network. The efficiency of the energy depends on the available power in the nodes or the energy required for the transmission in the link along the routes. The selection of the efficiency route can be done either by selecting a route which has the maximum available power among all nodes, or by selecting the route that consumes minimum energy to transmit data from the node to the destination in the route, or by selecting the minimum Hop route, or by selecting a route in which the minimum power is larger than the minimum powers of the other routes.

2.2 Sensor Configuration

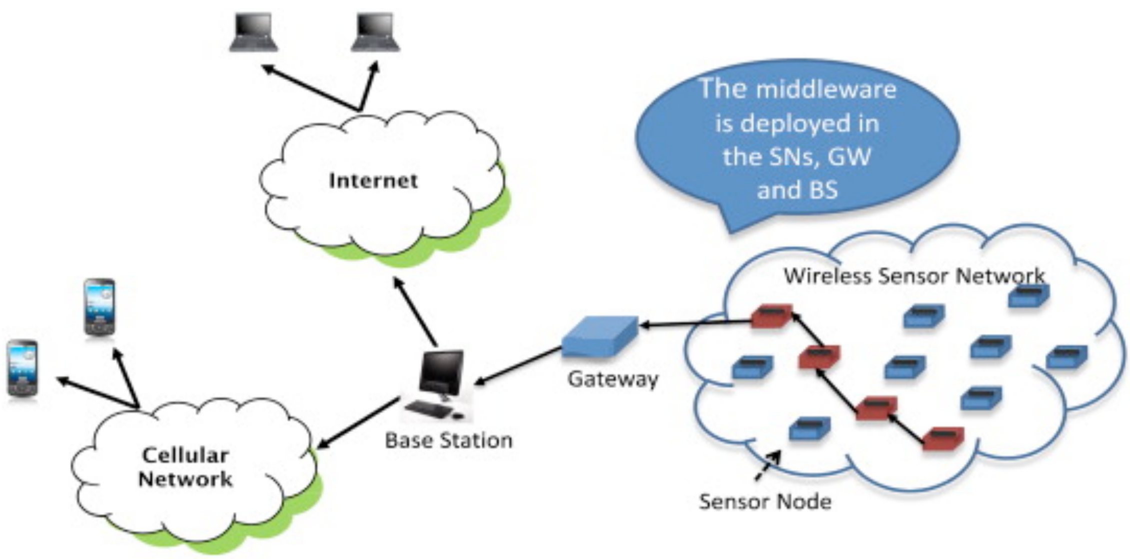

Figure 3. Wireless Sensor Network Configuration (Mobile Networking 2012)

Figure 3 above shows a wireless sensor network consisting of a large number of sensor nodes. Sensor nodes usually use a multihop routing protocol to communicate with nodes that are separate. The individual sensor nodes are normally also connected to each other in their area through wireless network (Chandra et al. 2000). Sensor nodes and network are usually mounted in an area where they are not easily accessible. They are resistible to open air environment and can be expose to sun, wind, or rain. Depending on the type and quality of sensor used, it is always recommended to use sensor nodes which are mostly strong, robust, very difficult to damage even when distrusted by human or animal. They should also be adaptable to harsh environmental conditions. Before every sensor has been used, the first measure is to know the average value so that it can be determined when higher than the pre-defined threshold. The signals of all sensor nodes located in different locations are configured to pass through a gateway before going to the base station and then to the required location. Sensor data received and sent from the sensors have to be secured from being cracked and one should always be careful in obtaining fake monitoring information. In that case, the hardware and software of the sensor network should be robust and fault tolerant. Accurate results can be obtained by fusing data from several sensors.

2.3 Importance of Sensor Network in Mobile Phones

Sensors have developed since the first generation. In the first generation, most devices had sensors very few if not any sensors in electronic devices or machines. As technology increase, analog device are fading out and digital device are beginning to increase with all electronic remote from sensors. The third generation mostly uses smart sensors in almost every device. Mr. McGuire once said in the movie ‘ The graduate’ that ‘’ There is a great future in plastics and it is worth investing in’’. This sentence in today’s world will be referred to as Sensors. Everything that comes with the word ‘smart’ in front of it has several sensors. For example, ‘smart lighting’ mostly refers to sensors for home lightening that can be controlled from smartphones. In smart parking, sensors are normally used in monitoring parking spaces for availability. In smart toilets, an application on a smartphone can be used to regulate the cleaning and flashing, opening and closing of the toilet lid. The sensor on the smart toilet together with the application on the smartphone calculates the time spent and the amount of water to be used to clean the toilet. The toilet uses Bluetooth to communicate with smartphone application and all features include flushing, lifting the seat and cleaning. The application on the smartphone can also be used to track user's bowel movement to track one's health system.

Sensors connected to our mobile devices are becoming more important in other areas of our lives as well. Most modern home security nowadays uses wireless sensors on doors, windows for surveillance, which can be armed or disarmed using a mobile application. Due to the tremendous advantage of sensors, they are used by most manufacturers and scientists to make work much easier and simple. Some cars have about 50 or more assorted sensors to monitor everything, from temperature to the tire pressure, rain, voice command, parkin, traffic control, etc. (Bajarin 2013). Sensor networks have been used for vehicle traffic monitoring since ages. Most of the traffic intersections have either overhead or some buried sensors to detect incoming vehicles and control the traffic light by giving priority to the incoming vehicles. Fixed street video cameras are also used to monitor road segments with heavy traffic. The videos from the camera are, therefore, sent to the operator at the central locations or base station.

3 SENSOR APPLICATION USING SMARTPHONES

3.1 Why Smartphones

Smartphones are more than just a cell phone. They include calendars, reminders, list, apps etc and can help one to stay organized and in control of a busy schedule. They provide instant access to the web and help one stay in touch through text messages, email, social and media and at the same time phone conversation. They also allow users to synchronize with their desktop computer, meaning that users can store, view and work on documents directly in their hand and at the same time respond and receive emails as they arrive in the inbox. There are few features one has to take into account when choosing a smartphone. The first one is the design. A smartphone should be light in weight and have a touch that boasts excellent resolution and is large enough to watch video, make video calls, surf through the web and much more with easy access. A smartphone should also include multimedia features, which include, email, calendar, digital player and at least a 5-megapixel camera for taking pictures and capturing videos. Moreover, call features and quality are some of the features mostly important in a smartphone. A very basic or advanced smartphone comes with calling options such as three-way calling, call hold, call timer, call waiting, caller ID and speaker phone option.

The battery life and memory of every smartphone is one key feature because of the active sensors and application running all the time. A high rated smartphone battery should at least last throughout the day even with heavy call and feature usage. There are some additional features in smartphones which include Wi-Fi, Bluetooth, maps and GPS, tethering, and ability to run on at least 3G networks, third-party or browser based programs. The third party application is a key component as it allows users to customize their smartphone to support their lifestyle. In addition a Basic smartphone comes with at least some sort of audio video recording function technology. Every smartphone even those with lower end of spectrum and features come with some sort of audio video recording Technology. (ModernizeTelecom 2012)

3.2 Smartphones and Sensors

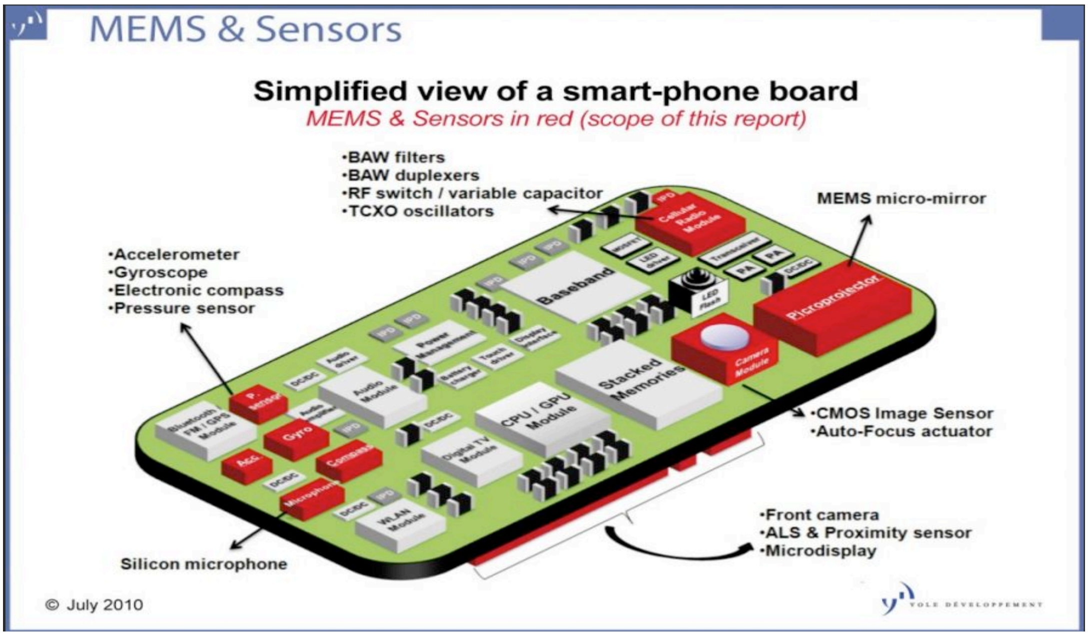

Figure 4. Communication of smartphones and Internet (Chatterjee 2011)

Every smartphone has the ability not only to make and receive calls, text messages, and voice mails, but also to be able to access the Internet. Smartphones have a built-in browser, depending on the manufacturer of the phone. Recently, most developers have begun to improve their versions of software which will be run on smartphone operating systems to allow users to choose what internet browser they are more comfortable with. Smartphones run on various types of operating system. Some have Windows mobile installed in them, Apple Iphone run on iOS, Blackberry phones run on Blackberry OS designed by Research in Motion (RIM), and HP running on Web OS.

Smartphones are pretty smart with all the features and sensors included in them but they still have a long way to go. Smartphones are not able to track air pressure, humidity and temperature even though tall these applications are very useful. Recently, Samsung have managed to include air pressure, humidity and temperature in their phones, the Galaxy S4 and Galaxy Note 3. The Iphone 5S is also recently pioneering the use of motion coprocessor (a low- power chip that collects and process signals from all the sensors in mobile device). Sensor industries are working hard to include more and more sensors in smartphone to make life easier for us.

The increasing success in smartphones is leading to an increasing amount of micro-electromechanical systems (MEMS) and sensors in mobile phones which provide new features or services to end users and intend to reduce the cost and provide hardware performance. Smartphones come with different embedded sensors depending on the manufacturer but the basic and more commonly used ones are the ambient light sensor, proximity sensor, GPS, accelerometer, gyroscope, and compass.

Ambient lights extends battery life in smartphones, laptops, and tablets and also adjusts the display backlight which improves user experience and power savings by optimizing the displays to the environment. When the brightness of a smartphone is set to automatic, it detects the amount of light present and automatically adjusts the brightness for clearer view. Smartphone displays can take about 50 percent of the total phone power which has a major impact on the phones running time on battery. Smartphones come with manual and auto adjust function, which help users to adjust the ambient light manually or set it to automatic.

The proximity sensor enables the light to turn off when speaking on the phone. The sensor detects how close the screen is to the body when there is an active call. It allows the screen to turn off when the phone comes closer to the ears and turns on when moved away from the ear to save power and also unwanted touch input. It also pauses whatever activity is running on the smarphone (playing music or video, browsing the web) to allow the user to pick the phone call. When the phone is moved away from the ears after the call, it resumes its previous activity. The sensor is in most cases located at the top of the smartphone near the front camera. The GPS is a navigation tracking with a map in the background showing where the user has been and also allows routes to be pre-programmed to give a line or direction the user can follow on the smartphone. GPS satellites circle the earth twice in a precise orbit and then transmit signal information to the earth. The GPS receivers then take the information and use triangulation to calculate the user's exact position (Asad-Uj-Jaman 2011). Smartphones normally use Assisted GPS (A-GPS). This is because the A-GPS accesses the intermediary server when it finds it difficult to connect directly to the satellite. The smartphone first get in touch with a cell phone tower, which help the device to get a fix on a satellite. A-GPS help make the location of a cell phone available even without network during an emergency call. (Anton 2010)

The accelerometer basically measures the force of acceleration in smartphones whether caused by gravity or by movement. The accelerometer sensor allows a smartphone to switch from landscape to portrait modes and vice versa based on the way the phone is handled, i.e., up, down, sideways or the angle at which it is being held. The movement and the tilt are noted by the sensor on the smartphone and can determine the way the screen is being held. Then, the accelometer automatically adjusts the visual output to make it appropriate to the direction of the screen. A typical accelerometer sensor has specifications such as analogue/digital, output range, sensitivity, and bandwidth and amplitude stability. The gyroscope is used in smartphones to measure, or maintain directly the orientation of a device, unlike the accelerometer, which measures the linear acceleration of the device. Developers use smartphone acceleration measurement together with gyroscope measurements to create applications that can sense motion on six-axes, i.e., up and down, left and right, forward and backwards, as well as the rolls and also pitch and yaw rotation. The two together make smartphones more sensitive, responsive and powerful for gaming and other applications. (Allan 2010)

3.3 Health

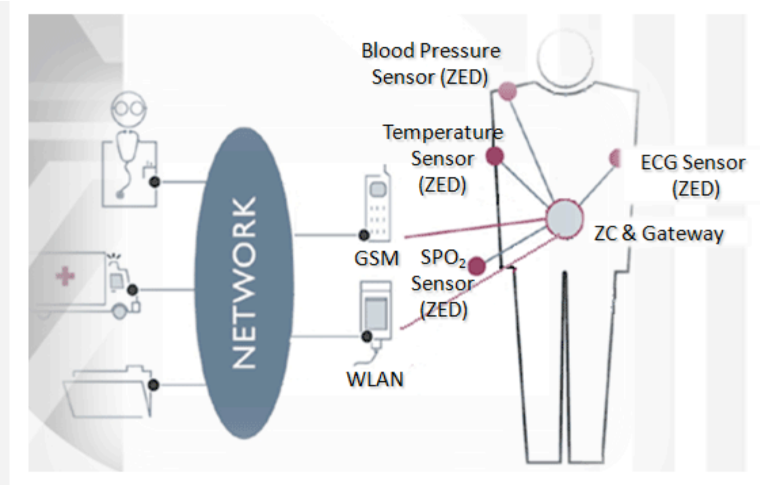

Figure 5. Application of sensors in health care (Holst Center 2009)

In hospital and other medical facilities including home treatment, sensors are used in healthcare electronic devices and equipment to sense and monitor temperature, pressure, chemicals, positions, therapeutics, monitoring patience, drug discovery and delivery, biological levels of patients and drug for applications in diagnostics (marketsandmarkets 2012).

Sensors operate differently depending on where they are installed and the tasks assigned to do. Sensors have become part of human life. In some modern health care center, sensors are used to check heart rate, blood pressure, sugar level or the physical activity and patience physiological data. They are also installed in drug storage, vaccine storage, and blood bank storage to check the level of temperature since these places are greatly affected if the temperature changes. All sensors can be connected to an app on a smartphone or a tablet or a base station which receives a signal when there is a change in temperature in one of the areas.

Sensors enable smartphones to have the ability to collect continuous sensor data that can greatly change the way health and wellness are assessed as well as how care and treatment are delivered. Most information recently for personnel health care comes from self-report surveys and frequent consultation of doctor. As technology advances, health care has developed applications on smartphones to help treat depression. A dialy survey is schedule for required patience and the patiences are encouraged to track his/her behavior with a daily survey or questionnaires on a smartphone. Both the doctor and the patient can observe the small changes in the patient's day-to-day life and this help the doctor to choose more specialized treatment for the patient (marketsandmarkets 2012).

3.4 Temperature

Temperature sensors are used in different types of application, such as medical devices, HVAC environmental control, chemical handling and automation (e.g., air intake, coolant, cylinder head temperature). They are use to measure the hotness/coldness of a device to ensure that the process is either staying within a certain range of value, or providing safe use of that application or meeting a mandatory condition when dealing with extreme heat or hazard or inaccessible measuring points.

Temperature sensors come in different types. They all have different characteristics depending on their actual application. The two main basic types of temperature sensors are contact sensors and non-contact sensors.

Contact sensors have physical contact with the object they measure. They use conduction to monitor changes in temperature and can be used to detect solids, liquids or gas over a wide range of temperature. Examples of contact sensors are thermocouple and thermistor. Non-contact sensors measure the thermal radiation a heat source releases to determine its temperature. They detect liquids and gasses that emit radiant energy as heat rises and cold settles to the bottom in convection currents. They are also used to detect the radiant energy being transmitted from an object in the form of infrared radiation.

The contact and non-contact temperature sensors are sub-divided into three groups of sensors. They are electro-mechanical, resistive and electronic (Storr 2012).

3.5 Enviromental Sensor

Figure 6. The application of sensors in vineyards (Miao 2005)

Sensor networks in the environment are not that strict compared to the battlefield because there is no much interruption to the environment. Sensors used in the environment are mostly used to detect the magnitude of various ambient conditions such as air quality, humidity, gas concentration, and light intensity. They are also used for weather forecasting, wildlife and pollution detection, agricultural purposes/research, traffic control, and habitat monitoring etc. They detects the magnitude of various ambient conditions such as air, quality, humidity, gas concentration and light intensity.

In forestry, sensor nodes can be installed to detect when a fire starts and ends. The nodes contain sensors to measure temperature, humidity, and gases produced by trees or vegetation. With the help of wireless sensor networks, the fire brigade can determine when a fire starts and ends. An integrated sensor network can also be combined with ground sensors to monitor local moisture levels, wind speed and direction, together with satellite and metrological forecasting to enable determine fire risk levels in targeted regions as well as sending vital information on the fire direction. This type of network assists authorities to organize co-ordinate disaster response to help save lives and properties by providing warnings to high-risk areas (Miao 2005).

4 DATA MANAGEMENT SENSOR NETWORK

4.1 Query Sensor Network

The few factors to take into consideration when processing a query in a sensor network is the construction of an executive plan with the help of a query optimizer to minimize the given cost function. Traditional performance in a database system of a sensor network depends on two factors. The first factor is the throughput, which is the average number of queries processed per unit time. This depends on the total work performed in the system to evaluate the query. The second factor is the response time, which is the time needed by the system to produce all answered record to the query. When the query is run for a long time, the query will run on a given time interval with varying records to a query.

In addition, two metrics correspond to the performance goal of a device database system, namely,

a. Resource Usage: This is the total energy consumed by the device when executing a query. The unit is express in joules.
b. Reaction time: This deals with the interval between the time called on a device, returns a value and then the time corresponding answer is produced on the front-end. The unit is expressed in seconds. (Bonnet et al. 2000)

4.1.2 Sensor Network Protocol Stack

A sensor network uses layered architecture in communication and the sensor nodes and sink use the protocol stack to combine power and routing awareness, integrate data with networking protocols, communicate power efficiency through the wireless medium and promotes corporative efforts in sensor nodes. In order to prolong the lifetime of a sensor network, the sensor nodes must collaborate with each other for effective work

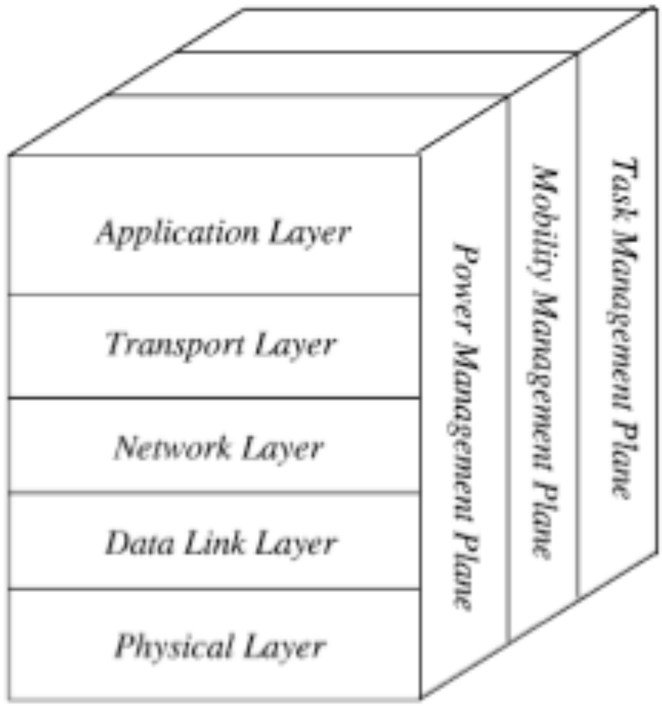

Figure 7. Sensor Network Protocol Stack (Akyildiz et al. 2001)

A sensor network protocol stack consists of the application layer, the transport layer, the network layer, the data link layer and the physical layer in addition to the power management plane, the mobility management plane, and the task management plane (Akyildiz et al. 2001).

Application Layer: Different types of application software can be built on the application layer depending on the sensing task. The application layer is responsible for collecting data, managing and processing the data through the application software for reliable results. Again, it ensures smooth flow of information to the lower layers and presents the final output. It contains the security protocols in Sensor Network (SPINS) to provide the output with data authentication replay protection, semantic security and low overhead.

Transport Layer: The transport layer is used to establish communication between the Internet and other external networks. Communication between the user and sink node is by UDP or TCP and is done through the Internet or satellite. Because each sensor has a limited memory, the communication between the sink and sensor node may be purely by UDP type protocol.

Network Protocol: Every wireless sensor network uses an ID-based protocol and data centric protocols for the routing mechanism. To create a secure routing protocol for WSN by using encryption and decryption techniques, each node acts as a router. The network layer of a sensor network is designed according to the following principles. The power efficiency is always important to be considered in sensor network. It uses the LEACH and PEGASIS to save energy consumption to improve the life of sensors. Further, sensor networks should be mostly data centric and use data aggregation which is useful only when it does not delay the collaborative effort of the sensor nodes. Again, an ideal sensor network should have attribute base addressing and location awareness.

The network layer is also responsible for finding the best path for efficient routing and the route with the maximum total available power is much preferred. It also routes data from node to node, node to base station, node to cluster head and vice versa.

Data Link Layer: The data link layer is responsible for error detection, multiplexing of data stream, data frame detection, medium access and error control, prevention of collision of packets, repeated transmission etc. It also ensures point-to-point and point-to-multi point connections in a sensor network communication.

Physical Layer: The main purpose of the physical layer is to establish connection, data rate/transmission, modulation, data encryption, signal detection and frequency generation. It is also responsible for increasing the reliability by reducing path loss effects and shadowing.

Apart from these protocol layers described above, the power management plane, the mobility management plane, and the task management plane help the sensor nodes to coordinate with the sensing task and also lower the overall power consumption of the protocol. In addition, they also monitor the power movement and task distribution among the sensor nodes.

Power Management Plane: As the name implies, it manages how sensor nodes use its power and prevents duplicate messages. Again, it helps other sensor nodes by broadcasting messages to signify that the power level is low and cannot participate in routing messages. The remaining power will then be reserved for sensing.

Mobility Management Plane: Sensor nodes have to keep track of who their neighbors are and the sensing path to balance their power and task usage. The mobility management plane is responsible for detecting and registering all the movement of the sensor nodes.

Task Management Plane: Not all sensor nodes are required to perform sensing tasks in a region at the same time. The purpose of the task management plane is to balance and schedule the sensing task in the region.

4. 2 Data Storage

Sensor nodes do not have a computational capability or energy sufficiency like the data base management system. They produce an infinite stream of data that cannot be processed and analyzed by common data base management because of its large number of node produced. When designing a robust data management and to ensure a proper functionality of the sensor network, one has to take the following into consideration: file frequency failures of the sensor nodes, unreliable radio communication, and then the trade off between low energy consumption and network efficiency. Methods for low energy consumption are really important in sensor network and, therefore, have to be taken into account when storing data.

Data from a sensor network can be stored either by collecting all data on a central infrastructure (external method) or storing the data from the nodes locally (local method) i.e., every node stores only self-generated data, or storing a certain category of data to a predefined node, i.e., a routing algorithm is needed in order to answer a query or perform aggregation (data-centric method). Among these methods, the most expensive is the external method. This is because it has a high energy cost to transmit data from each sensor nodes to the central infrastructure. The data-centric is the cheapest since it focuses on minimizing the cost of communication between sensor nodes as a result of its routing algorithm. It uses the geographical hash table method and can work with balance between communication efficiency and energy consumption. Choosing a data storage strategy can be affected by the way the queries are answered, data flowing among sensor nodes and then the ability of sensor web to respond to questions from both the previous and present data (Bonnet et al. 2000).

4.3 Generic Architecture for Sensor Network

Generic architecture is applied to a different category of sensor networks and deployed applications. A review carried out by Zafeiropoulos, et al. on the deployed application concludes that the majority of the proposed approaches have limitation regarding the size of the sensor network, the amount of data transfer, and the support of distributive sensor deployments and lack of semantic data representation (Zafeiropoulos et al. 2009). The mass increase in deployment of sensor networks and its ability for remote communication and management of sensor resources is always doubtful if these approaches are scaled.

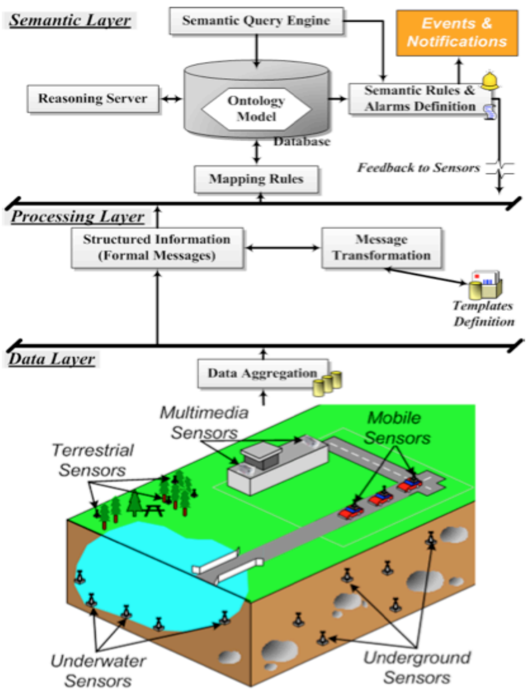

Figure 8: Architecture of sensor network (Zafeiropoulos et al. 2009).

Figure 9 above describes the module scheme for easy deployment application and management of larger scale sensor networks which consist of heterogeneous data sources. It consists of three layers, namely, the data layer for data discovery (collection and aggregation), the processing layer for integration and processing of the aggregated data, and the semantic layer for addition of in-text annotation and ontological descriptions. Each layer can work independently, and the specific decision about the implementation and strategies made by the one layer do no affect the other layer. The architecture on different topology and data aggregation techniques help the administrator in selecting the most suitable topology and aggregation scheme to optimize the consumption of energy and bandwidth utilization.

Data Layer: This collects and aggregates raw data from the sensor data discovery in a central entity. It reduces communication cost and thereby extending the lifetime of sensor network. It also builds the most successful data management technique. The total energy consumption, bandwidth utilization and delay for transporting the collected information from the simple nodes to the sink node are based on optimal aggregation. Data can be gathered in the data layer either by following the structured or the structure-free approach.

Structured approach: This is approach is taken when the sensor nodes follow a specific strategy or order to forward the data to the sink nodes. Because they follow a specific strategy, they are very sensitive to delay imposed from intermediate nodes, the frequency of the data transmission and the size of the network.

Structure-free approach: This approach does not follow any specific strategy and routing decision to forward data to the sink nodes. This is because the nodes do not clearly know where they go and cannot wait for data from any particular node before forwarding their own data. This approach is normally used in dynamic environment and in ad-hoc sensor networks where nodes continuously join and leave the network.

Security in raw data aggregation is mostly important due to the fact that the sensor network often stores, processes, and interacts with sensitive data in hostile and unattended environments. Authorized persons alone should access the information in transmitted data in sensitive location.

Processing Layer: The raw nature of sensory data from the data layer is interpreted by several XML-based models in order to make it meaningful for end users and not to acquire any special sensor software when distributed to the other device (e.g., PDAs). This is because the data cannot provide a high-level information extraction due to the raw nature of the sensory data. Information gathered from the processing layer is sent to the upper semantic layer, then it is encapsulated before being sent for further machine processing.

Semantic Layer: In the semantic layer, the mapping rule collects data from the XML and stores them in the ontology model in the form of class individuals. The messages from the processing layer are mapped to the ontology model. The semantic layer can either be part of the system or not, but the benefits provided by it always justify its existence regardless of the additional computational burden.

5 CONCLUSION

The world nowadays is transforming into a computing platform with the widespread use of sensor, actuators and mobile devices. Sensors and sensor networks have become part of us now whether being noticed or unnoticed as they make life very simple and easy. The number of smartphones is rapidly increasing, as people tend to use them more than even their computer since they serve many purposes and can be used for many tasks. Based on this, manufacturers include in smartphones different sensors that are needed in our daily life. They also try to make the smartphones as small as possible for easily handling. As time goes on, smartphones will gain more and more usefulness in people's life, which means that there will be more advancement to simplify daily task we undertake.

Sensor networks consist of a large number of sensor nodes. They are used in many applications such as heath applications, for sensing and monitoring temperature, drug discovery and delivery. For military applications, they are used for surveillance and target tracking. In industrial applications, they are also used for detecting hazardous chemicals and monitoring the work efficiency of machines. Again in environmental application, they are used for early fire warning in the forest and seismic data collection (Aboelaze & Aloul 2005). Sensors are utilized/deployed/ installed in a wide range to monitor various activities and send related data to smartphones, PCs or tablets. They make life easier and simple by combining many applications as one and also by increasingly impacting the world around us. Anything that comes with smart in front of it has a sensor included and can perform many functions depending on how it is designed.

In the future, new technology will tend to replace the existing technology when there are economic advantages. Wireless sensors will tend to replace wired sensors, and that there will be no wiring, which will reduce costs, and there will also be more flexible deployments. New software technologies are developed in smartphones to sense, learn, visualize, and share information about ourselves, friends, communities, the way we live and the world we live in. Sensor network has a brighter future as the availability of sensors and new technologies can lead to new and existing applications and will also have the potential to revolutionize human computers.

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