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APPLICATIONS OF DATA MINING BASED DBMS ARCHITECTURE FOR WIRELESS SENSOR NETWORK U HEALTHCARE SYSTEM

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ABSTRACT

Recent developments in low-power microelectronics and downsizing have led to the development and spread of wireless sensor networks. These networks can keep an eye on and adjust the ecosystem all by themselves. This chapter describes how WSNs and sensors fit into the larger picture of network design, and it contrasts WSNs with cellular networks and MANETs. To date, health problem diagnosis has only taken place at the server, not the actuator, for in-hospital or at-home patient monitoring. An effective routing mechanism and channel allocation at the MAC layer is required for data transmission from the sensor to the server. The U-healthcare application's algorithm paradigm and data collection model inform the routing protocol under consideration. This chapter describes the basic building blocks of a sensor network that can be used for virtually any purpose. Continuous monitoring of an environment or a patient's vital health parameters generates massive amounts of data. Since the server is outside of the sensor's 100-meter range and requires the use of the Wifi standard for sending real-time data streams, the use of this technology is a need. The use of WSNs in the U-healthcare sector is analysed and criticised. The chapter also includes discussion of the database management systems and microprocessor database support currently on the market. Complex operations on sensor data in the U-Healthcare domain are analysed in this study. Our research focuses on incorporating an outlier detection technique into a sensor device that routinely monitors blood sugar and blood pressure to ascertain whether or not the two together constitute a critical situation warranting an alert. Our research shows that a UDBMS has been built for deployment at the sensor, allowing for the dynamic creation and storage of databases as well as the execution of ad hoc queries at the sensor.

Key words:DBMS architecture, Wireless sensor network,U-healthcare system

1. INTRODUCTION

Recent developments in low-power microelectronics and downsizing have led to the development and spread of wireless sensor networks. These networks can keep an eye on and adjust the ecosystem all by themselves. This chapter describes how WSNs and sensors fit into the larger picture of network design, and it contrasts WSNs with cellular networks and MANETs.

1.1. WSN Architecture

Wireless sensor network components allow for wireless communication between application platforms on one end of the network and sensors or actuators on the other end of the network.

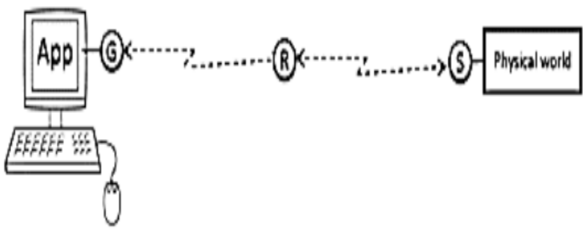


Figure 1: Basic Wireless Sensor Network components

As detailed in figure 1, at the application end gateways (G) perform protocol conversion to enable the wireless network to work well with other standard network protocol stack. A relay node (FFD) is a device, which is present between the leaf node and the gateway. Each relay node is a router, which is to extend the wireless network coverage. Leaf node (S) is a reduced function device (RFD) which is physical interface between the wireless sensor network and the sensor or actuator. Leaf node has two I/O connections to support the communication with analog or digital sensors. Sensor is a device, which interacts with the physical system under monitoring.

1.2 WSN vs. MANET (Adhoc Network) vs. Cellular Network

There are three types of wireless networks viz. infrastructure (Cellular) and infrastructure -less network (ad-hoc and WSN).

1.2.1. Infrastructure Network:

Cellular wireless networks such as GSM/CDMA are infrastructure type networks. Cellular network consists of central entity called base station and mobile devices as MSs (Mobile Subscribers). If one MS wants to communicate with other MS, communication is possible only via base station (BTS).

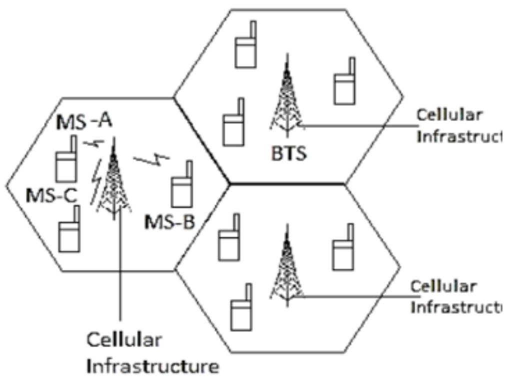


Figure 2: Cellular Network (Infrastructure Network)

Many MANET features are also present in WSNs, and vice versa, but these two networks are distinct in other important ways as well. The fundamental differences between the two network types account for some of these distinctions. In contrast to sensor networks, which are not designed to focus on human interaction but rather on interaction with the environment under monitoring, MANETs are designed to be close to humans because the nodes in the network are devices (such as laptop computers, PDAs, mobile radio terminals, etc.) that are intended for use by humans. Number of nodes in any sensor network is comparatively large and density of deployment is order of magnitude higher than that in the MANET.

2. LITERATURE REVIEW

This section focuses on various aspects and components of the wireless sensor network for Uhealthcare application. For patient monitoring in hospitals or at home, health problem diagnosis has only ever happened at the server, never at the actuator. For data to get from the sensor to the server, the MAC layer needs a good routing protocol and channel allocation. The routing protocol that is taken into account depends on the data collection model and, in turn, the algorithm paradigm that the Uhealthcare application uses. This chapter describes the common parts of a sensor network that can be used in any application.

2.1. UhealthCare Network Setup

Researchers are beginning to take an interest in wireless sensor networks because of its potential utility in a variety of fields, including target tracking, environmental monitoring, and others. A basic overview of the home and hospital system layouts is provided below. To build WSNs, only the first five OSI reference levels are used. Task management, mobility management, and power management are the three overlapping layers that help them out. Management of the network occurs across these three tiers. Wearable body sensors are used in healthcare applications to track and record data about the patient's vital signs and transmit that information to a gateway or access point that is also located on the patient's body. Data is transmitted from the access points and repeaters to the base station, which is then sent on to the hospital's main server or the doctor's personal digital assistant, mobile device, or desktop computer [1].

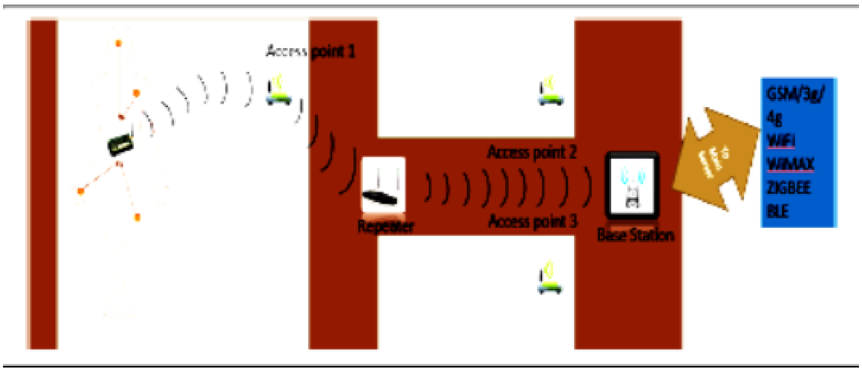


Figure 3: Home/hospital environment for WSN

Due to the increased density of sensor networks caused by shorter sensing distances, it is crucial to develop an effective medium access protocol while adhering to stringent power limits. Research on the various immunisation patterns seen in sensor network applications is necessary because these patterns can be used to extract and express the behaviour of the sensor network traffic that must be managed at the MAC layer. There are three discernible communication patterns in sensor networks. There's the broadcast, the converge cast, and the local rumour mill. A broadcast packet is not the same thing as a broadcast communication pattern. In the former situation, the data of packet is intended to be received by all nodes of the network, whereas in the latter case, the intended receivers are only those nodes within the communication range of the broadcasting node. In some conditions, sensors can exchange data with one another in a local network.

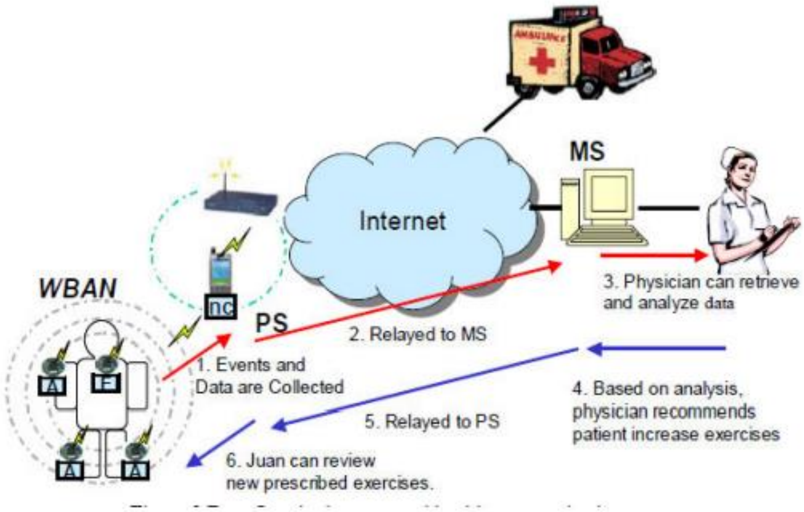


Figure 4: Data Flow in Health Monitoring System Network Architecture

A data fusion centre, base station, or cluster head could be the final destination. Communications between cluster leaders and their member sensors fall under the fourth type; in this case, the intended receivers need not be all neighbours in the cluster led by the leader. In order to accommodate the aforementioned use cases, the multicast communication pattern is specified, in which a sensor delivers a message to a subset of sensors inside a set or group. [2]

Figure 4 depicts the architecture that results in a WBAN that includes an electrocardiogram and tilt sensor combined into a single device (eActiS) and a dedicated personal server (PS). When receiving and processing ZigBee wireless data, each sensor node connects to the Tmote sky platform via USB. A laptop computer is all that's required to host the personal server. A medical server, designed to handle hundreds of users and staffed by experts in the field, is at the pinnacle of data processing. A user's body is covered in sensor nodes.

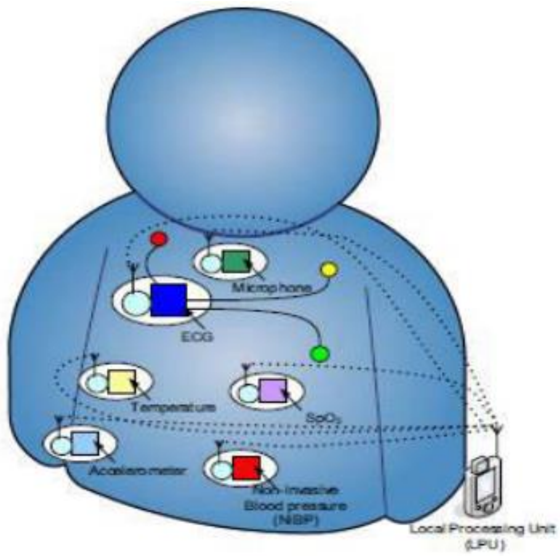


Figure 5: A Body Sensor Network Design

Figure 5 shows the BSN architecture, which incorporates a number of wireless biosensors into the BSN node, such as a 3-lead ECG, a 2-lead ECG strip, and a SpO2 sensor. In addition, a PDA-compatible flash BSN card is created for displaying and analysing sensor data. In addition to serving as a node in the BSN, PDAs also perform the role of a router between the network and the server. All acquired sensor data is sent to a centralised server over a Wi-Fi / GRPS network for long-term archival and lagged trend analysis [3].

The purpose of the Integrated Gateway is to enhance the transmission efficiency of the Figure 16 architecture. A CE includes an integrated gateway. This gateway takes readings from a variety of PHDs and transmits them to a remote MS in a standard data exchange format defined by ISO/IEEE 11073. Data collected by PHDs is sent in two different ways: immediately and seamlessly. When operating in the former manner, gateway readings are sent to an MS without delay. This mode kicks in if a reading is larger than a specified value, or if the data from all of the saved readings is combined into a single transmission. The MS receives the integrated message, which helps to lessen the load on the network. [4]

3. ENERGY EFFICIENT PROTOCOL IN WIRELESS SENSOR NETWORK: REACTIVE ONDEMAND ROUTING

In this research, we classify the many routing protocols documented in the literature into two main groups: network architecture and protocol functionality. SPIN and Directed Diffuse are the two most widely used routing protocols that are based on the topology of a network. Before sending data to the base station or the sink node, the SPIN protocol performs energy-saving metadata negotiation. Each node has to be aware about the one node neighbour. Unlike Directed Diffuse, SPIN protocol is suitable for environment monitoring. With Directed Diffuse, the aggregation tree is built at the base station or the sink node via a gradient setup for each node as interest flows from the base station or the sink node to the sensor. Despite advantages SPIN dost not guarentee the delivery of the data to the base station.

Our proposed protocols is achieving the energy optimization by reducing the number of packets transmitted to the server through nodes having routing table each with three routes along with their probability of efficiency.

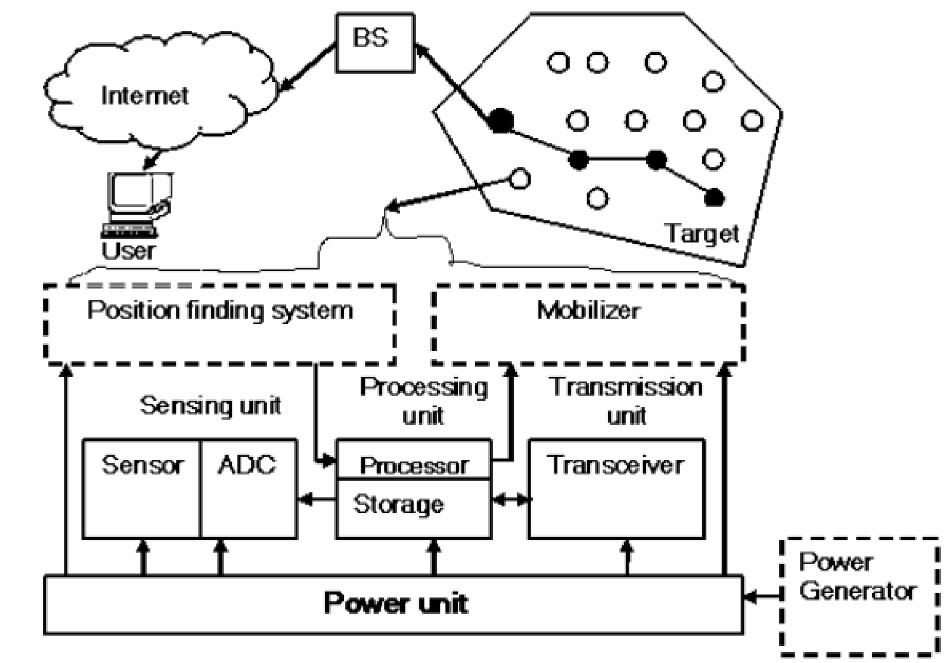


Figure 6: Sensor Network Infrastructure

With the advancement of electro - mechanical system technologies, embedded systems and wireless communication with low power consumption leads to the wireless sensors for sensing and information processing. Sensor nodes in a wireless sensor network are typically tiny in size and power consumption, and they communicate with one another via a wireless transmitter and receiver.

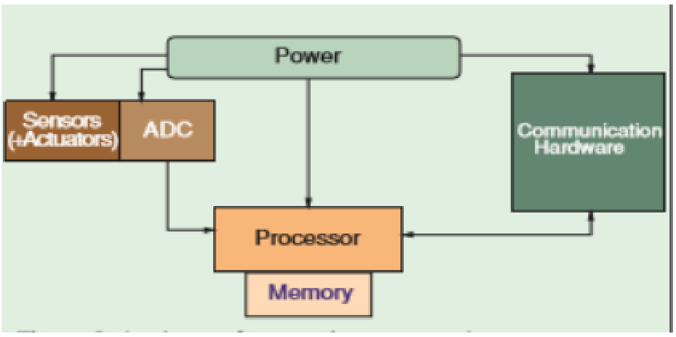


Figure 7: Architecture of a Sensor Node.

Using these nodes, the wireless sensor network collects the information regarding the monitored environment like weather, humidity etc. and sends the various messages to the base station, called sink node. Depending on the parameters being tracked, a sensor network could include seismic, thermal, electrical, acoustic, visual, radar, and many other types of sensors. Several fields find use for sensor networks. To list some common employments of sensor networks are:

• Military applications - battle-field surveillance, nuclear, biological or chemical attack detection.

• Environmental applications - as wild animal tracking, forest fire detection

• Health applications such as heart rate monitoring, automatic drug administration based on the prescription.

• Commercial applications such as highway traffic analysis and power consumption measurement for a building.

3.1 Problem Statement

Assumption for Reactive OnDemand routing are that sensor nodes do not move any more after deployment of WSN (Ming Liu Jiannong Cao, 2009). As the nodes can move, leave and re-join the wireless network at any time and any location, the above said assumption might not be true in the real applications. (NesrineOuferhat, 2006). Proposed Reactive OnDemand routing protocol is to monitor patient's home environment. WSN under consideration is homogeneous. This protocol improves the likelihood that data will be delivered from the sensor to the base station compared to SPIN but does not ensure such delivery.

4. METHOD FOR DATA COMMUNICATIONS (TO UPDATE LINK COST OR THE NODE FAILURE)

Depending on the data's purpose and whether or not the sender is aware of the recipient(s), one of three ways can be used to communicate messages in order to determine the best multi-hop path. The first method is called a broadcast and it is used when one node in a network has to send data to every other node in the network. When a node in the network sends out a broadcast packet, the goal is for every node in the network to receive it. Second, in cases where only a single sender and recipient need to exchange data, unicast is employed. The third approach is multicasting, which involves broadcasting to multiple listeners simultaneously. This multicast message may not be of interest at this time to any interested receivers. At any time, many nodes may be simultaneously delivering data to the same multicast address. Therefore, one can view of a multicast destination address as the logical destination of zero or more receivers.

4.1 Dynamic vs. Static Routing Protocols

Process of discovering, selecting and maintaining path from one node to another for the delivery of packets is called routing. Dynamic routing is the important factor for the best routes. When multiple routers are used in a network, dynamic routing functions optimally. They are extensible because other routes are calculated on the fly whenever the network's structure evolves. Routing changes are broadcasted in a dynamic network. There is a performance cost associated with this routing technique, since it requires more resources such as processing power, memory, and network bandwidth.

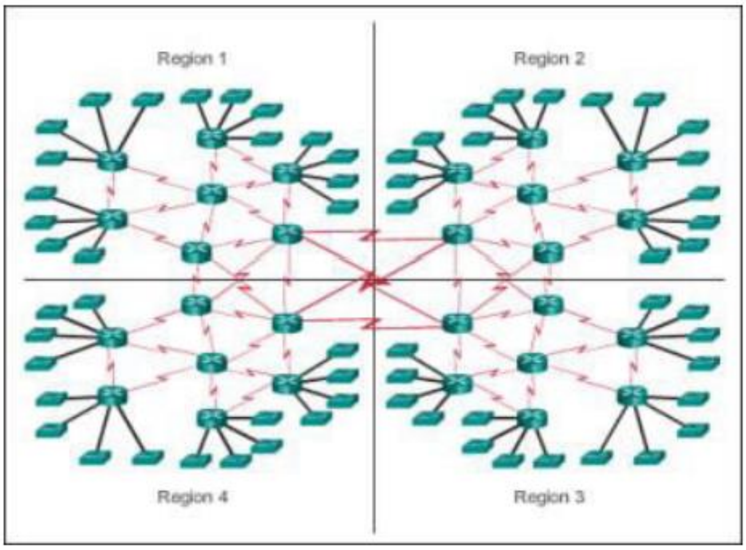


Figure 8: Dynamic routing scenario.

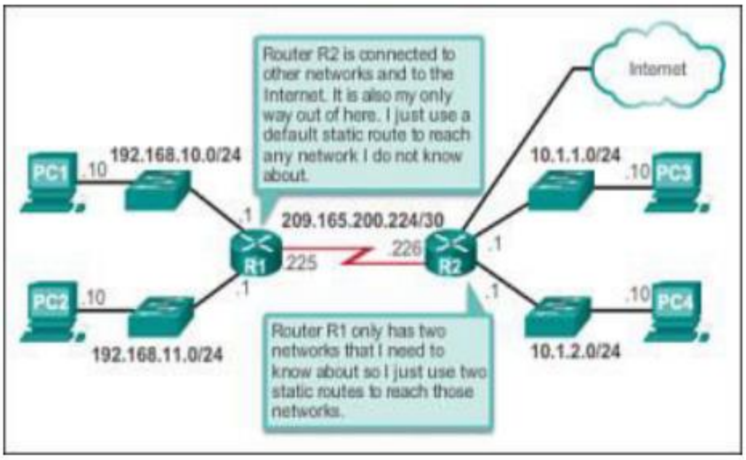


Figure 9: Static routing scenario

Since sensors' capacities are limited, flooding as a means of communication with the sink may be necessary. But if nodes get multiple copies of the same data transmission, an implosion is possible. MPRs, often known as gossiping, are the basis of one optimization technique. On the other hand, there is still some duplication of efforts. Routing protocols are a crucial addition to wireless sensor networks because of the limitations of earlier approaches. Numerous suggestions for routing algorithms for WSNs may be found in the associated literature; these are compared based on their convergence times.

5. FEASIBILITY OF COMPLEX OPERATIONS ON REAL TIME DATA STREAM AT ONSURFACE BODY SENSOR FOR UBIQUITOUS HEALTHCARE

Wireless body network consists of wearable / on-surface or implantable / in-body (pacemaker) sensors which are distributed on human body to monitor vital physiological parameters i.e. pulse rate, in-tissue glucose level, body temperature, blood pressure, and even more. This bi-directional body area network is ground for ubiquitous computing in HealthCare domain for in- hospital or at home patient monitoring. Data generated through the these sensors is accumulated into access point or the gateway, which in turn work as repeater to transmit data to doctor's PDA / desktop or the main server through the base station in timely manner before the information conveyed in data becomes obsolete. Raw data generated by these sensors is considerable. Doctors can make decision on the real time stream data communicated to their PDA. WBAN can monitor the impact of one or more than one vital signal on patient body thus can be an effective and efficient solution for early disease detection through long term patient monitoring.

5.1 Various UDBMS Options

Based on survey of the existing UDBMS they can be categorized by target device as follow.

Table 1: Categories of UDBMS as per their host devices

Target Devices		UDBMSs
Extremely Small Devices with Low Computing Power	Sensors	TinyDB, Antelope, LittleD
	Smartcards	PicoDBMS
Small Devices with High Computing Power	Cell Phones, PDAs, Car Navigators, and UMPCs	IBM DB2 Everyplace, Oracle 10g Lite, Oracle Berkeley DB, MS SQL Server CE, Odysseus/Mobile

5.2 Requirements of UDBMS

Keeping in mind the requirements of the resource constraint devices following are features required to be supported by UDBMS to be accommodated at senor device.

(i) Lightweight DBMSs: Table 5 shows memory and storage specifications of the sensor devices. Since the energy performance of devices varies from one device to the next but is still somewhat low in comparison to FFD, it is essential that a UDBMS be designed with this in consideration.

(ii) Selective convergence Sensors and smart cards, for example, would be able to function adequately with only the most fundamental of features, such as the SELECT SQL query. Instead, DBMS can enable complex features like data synchronisation between sensor node and base station on high-performance devices like PDAs. A user needs geographical functionalities, for instance, to use a GIS programme on his personal digital assistant. Selective convergence in UDBMS requires a foundation in micro lithic design as opposed to monolithic.

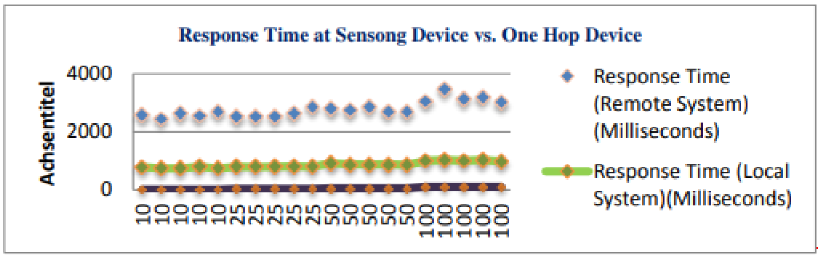
(iii) Data synchronization Since the batteries in ubiquitous devices run out quickly and the devices themselves are always in motion, it is impossible for them to maintain a constant connection to the server. Furthermore, gadgets that are everywhere are limited in their ability to store massive amounts of data. Users can then store the massive amounts of data generated by the sensor on the server, leaving the omnipresent device with only the data that it needs. By syncing their data with the server, multiple sensor nodes in this setup can pool resources and coordinate their efforts. Thus, a UDBMS must have a feature to merge disparate data sets into a single, coherent one. This requires the support to data synchronization concept for UDBMS.

(iv) Self-management In a UDBMS, there is no dedicated database administrator (DBA) to oversee database operations. Therefore, it is necessary for tasks like indexing, backup, and restore to be carried out automatically.

(v) Complex Operations Complex processes like data mining and outlier disclosure are required by modern database systems but are outside the scope of SQL. The operations performed by a UDBMS should be robust. In order to examine connections between the provided document and the stored documents, sensor applications require complicated search processes. We may require cutting-edge software for patient management in a U-healthcare setting. U-health ensures convenient access to quality healthcare around the clock and around the world. In a u-health care setting, patients have sensors attached to them to create a body sensor network, which then collects and sends health data to doctors' portable digital assistants.

6. RESULT ANALYSIS

Huge amount of sensor measurement gives rise to the concept of Big Data. Pulling the sensor measurements from the senor for pattern analysis has given rise to the concept of "Internet Of Things". It is time and energy consuming to transmit every measurement of sensor to the sink or the server node. We might apply some aggregate functions at the time of sensor measurement collection at every epoch. If we can hold the raw data at sensor itself for algorithm to implement complex operations at the seniors then energy required to transmit all the measurements could be saved, time delay between the occurrence of an event notified by the sensor measurements and its notification to the sensor controller could be reduced to least.



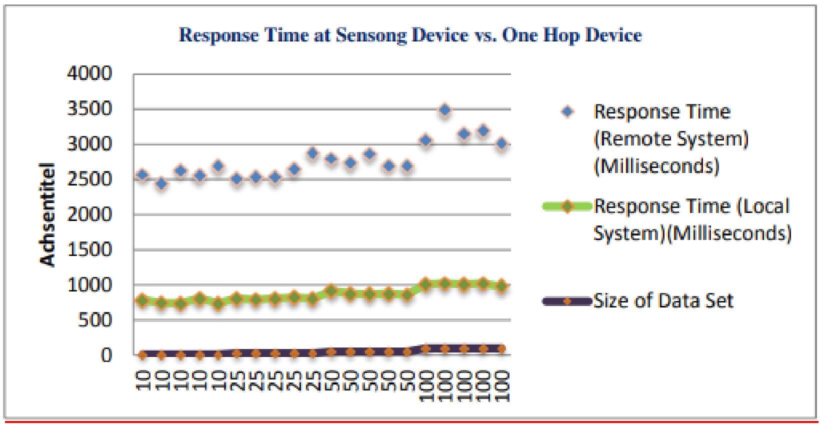
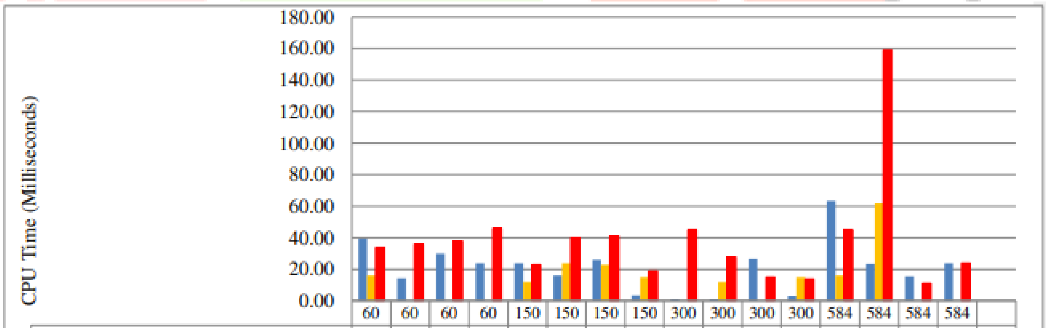
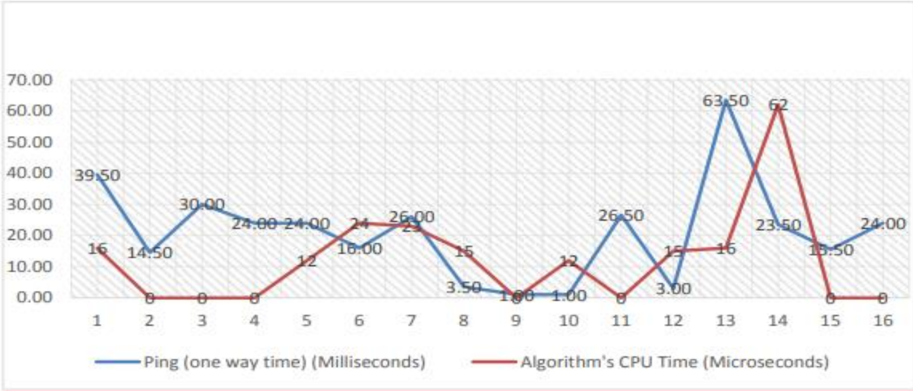


Figure 10: Response time comparison of the algorithm on local and remote machine

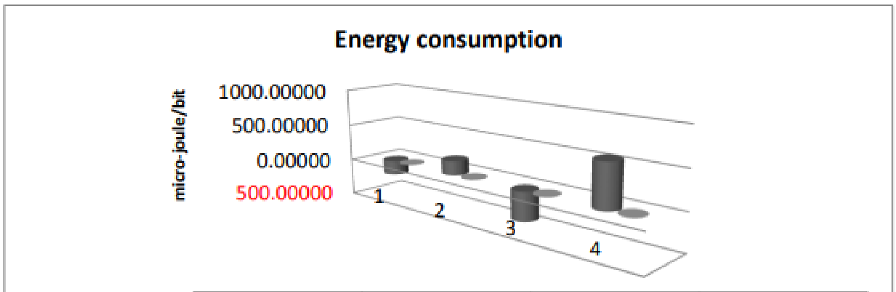
This experiment reveals the benefit to execute odd measure detection at the sensor device rather than at nearby resource constraint device. Deployment of outlier disclosure algorithm at sensor device gives 37% to 45% in terms of time.



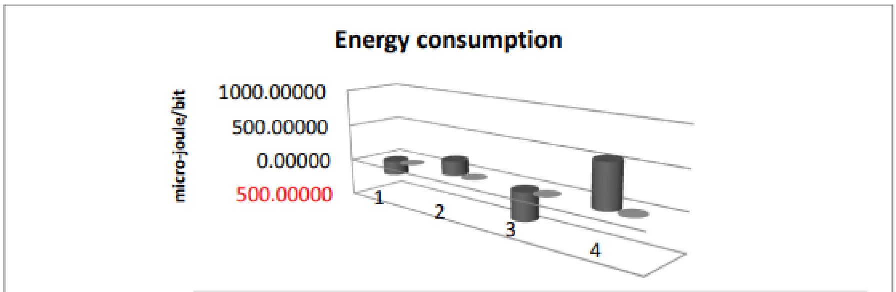
	60	60	60	60	150	150	150	150	300	300	300	300	584	584	584	584
Ping (one way time) (Milliseconds)	39.50	14.50	30.00	24.00	24.00	16.00	26.00	3.50	1.00	1.00	26.50	3.00	63.50	23.50	15.50	24.00
Algorithm's CPU Time (Microseconds)	16	0	0	0	12	24	23	15	0	12	0	15	16	62	0	0
Algorithm's Todal Duration (Microseconds)	34	36	38	46	23	40	41	19	45	28	15	14	45	159	11	24



ICMP header has fixed length of 32 bits. Study reveals that even transmission of 32 bits of data takes 1 milliseconds of time compared to minimum-recorded nonzero CPU execution time i.e. 12 microseconds. It show 83% gain in algorithm execution at the machines where data originates.



	1	2	3	4
Zigbee	192.03470	192.03470	384.06940	576.10410
Low Bluetooth	0.15805	0.15805	0.31610	0.47415



	1	2	3	4
Zigbee	192.03470	192.03470	384.06940	576.10410
Low Bluetooth	0.15805	0.15805	0.31610	0.47415

Inference

Rapid growth in the field of wireless technology, body area network, personal area network and miniaturization in device has led to continuous health monitoring of moving patient, which further can result, into emergence of technology driven enhancement in contemporary healthcare practices. Can we have an Intelligent Applications in HealthCare (with knowledge base and inference engine) which can work on real time data stream initiating at sensor. For that, we need to think of an application, which can analyse sensed data stream, based on the rules specified time to time as its knowledgebase to take decisions with in definite latency or delay.

CONCLUSION

This is elementary work done to address the possibility and feasibility for an application in UhealthCare domain, which could be tagged as an initiative in the path to intelligent application. This application follows supervised learning model where supervisor being the medical expert. Algorithm cannot provide explanation to the reasoning process to the decision taken to combat the criticality originated. Such Intelligent application demand the use of complex operation on real time sensor stream data. Here the odd measure has to be explored and decision is based on the odd measure whenever it has turned up. For these applications, the speed of execution of complex operations has to be in synchronization with the event or stimuli generated. Simply the basic requirement for such application could be that data stream generation rate should be always less than and never faster than speed of data analysis process to find odd measure.

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