Efficient Database Management System For Wireless Sensor Network

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Abstract

An effective database management system has been put forward in this work to tackle the problem in remote monitoring using Wireless Sensor Network Object Oriented Analysis and Design method employed as classes was evolved to create objects in the employed program used. An algorithm was developed with a corresponding flowchart to realize the design, the work also came up with a dynamic graph plotter, as this offers an adaptive monitoring facility for data stored in the Database. Sensor Node query was implemented and result of transmitted data was filtered for a particular node.

Keywords

WS; Database; Query; Java; Oracle; C-Sharp

Introduction

Wireless Sensor Networks are composed of a set of (tiny) devices (hereafter called sensors), which are microsystems, each comprising a processor, a memory, a set of sensors, and a low-range, low-bandwidth radio transceiver. Sensors are powered by on board batteries thus their energy efficiency is critical in most applications. Applications of sensor networks include, amongst others, environment sampling, disaster areas monitoring, and health monitoring. This system allows interaction with a wireless sensor network as a traditional database management system. In a traditional database system queries are used to search for data contained in a persistent storage repository. In a wireless sensor network, the data base consists of the environmental data that can be measured and acquired by the transducers available on the sensor nodes. Queries instruct nodes on the management, filtering, and processing of the data acquired from the environment. The wireless sensor network and the software running on the nodes are the means that allow data to be acquired when needed from the environment, exactly in the way that a traditional database software allows data to be accessed on disks. In a wireless sensor network data is stored somewhere: environmental [4] data acquired by sensors of the nodes when needed, in accordance with the query that the network is being processing. A new data is available every time when a transducer is activated. [Ajit Warrier et.al]

The high speeds of data transfer in wireless communication media have unlocked the doors for the development many applications like health care, military, security and disaster management. The wireless data transmit rates combined with web enabled computer system, is opening new fields on Internet services. Wireless sensor networks are made up of large number of sensor nodes. The sensor nodes which are densely deployed either inside a phenomenon or very close to it. The location of nodes need not be pre-determined or engineered. Recently developed nodes can be directly connected to the internet. The examined data needs to be stored for later analysis. Object-oriented databases for data storage have significant benefits to the applications that exercise complex object models, high concurrency requirements and large data sets. [BES (1998). Baltimore]

The database approach is generally used for WSNs. It offers an easy-to-use interface and allows the user to query to the sensors to take out the data of interest. [5] have implemented an inquisitional query processing system. [Burns, R., Terzis, A., and Franklin, M]

We make the case for a sensor network model where each node runs a database management system (DBMS), providing a rich query interface to the flash storage of the node. [Cerpa, A., Elson, J., Estrin, D., Girod, L., Hamilton, M., and Zhao, J]

With potentially very large databases on every node, efficient querying mechanisms that can operate over large data sets are needed. One major problem in Wireless Sensor Network is data collection, since the system is a distributed network system many sensors will be involved in carrying out the task collecting and transmitting data, we hereby propose a solution to problem by coming up with Efficient Database Management System For Wireless Sensor Network.

Database Management System

We come up with an intelligent database system written in netbeans JAVA precisely, which collects the entire information on a table shown in figure 2, in which the JAVA Program is written such that it can be linked with ORACLE Database. The reason for coming up with ORACLE Database is to explore the additional online file sharing facility. The ORACLE Database will automatically generate a web address called Universal Resource Locator (URL). And with the username and password the database can be assessed from all part of the world as long as you are given the permission by logging with the right username and password. ORACLE Database also provides aesthetic, as the Graphic User Interface provides an interactive interface. It also has the capability to provide an instant history for past transaction and automated update.[Cerpa, A., Wong, J. L., Kuang, L., Potkonjak, M., and Estrin, D. (2005)]

Adaptive Monitoring

The packet collected by the database will be plotted on a dynamic graph plotter for adaptive monitoring, is developed and advanced by means of a Graphical Liquid Crystal Display(GLCD), which will further make the system smart. We have two output interfaces, Computer and Graphical liquid Crystal Display shown in figure 8 and 9.

Sensor Data Network Architectures

The sensor networks deployed thus far can be roughly divided into three classes: data collection networks, data logging networks, and data mule networks. Data collection networks are the prototypical sensor network architecture in which all nodes transmit their sensor readings to one or more data sinks, using a best-effort data collection protocol .

Data collection networks may support data aggregation, even though this has proved difficult to use in practice. The approach is a special case of the data collection architecture. In this work, the data stream from the sensor network is abstracted from a database query interface that controls how data is collected from the network. Queries are posed in an SQL-like language through a gateway node, which sends instructions to the network nodes about how they should send their current sensor readings. The gateway node can also issue data aggregation within the network. In a data logging network, all sensors log all sensed data to secondary storage, from which it later is retrieved in bulk. [Crossbow Inc. (2007)]

Periodically, the data was retrieved using from a bulk data transfer protocol [16]. Data logging networks are used when it is necessary to retrieve the complete data set, which is the case in many scientific deployments [Crossbow Inc. (2007). MICA Motes].

The reason for tagging the caption "Efficient Database Management System For Wireless Sensor Network" is basically because of the facility the Wireless Sensor database software provides. The sensor data base is always updated and the history of day by day event is made available by this facility. The output in figures 2 ans 8 which represents the Database output in Java and ORACLE.

Implementating Database

Since JAVA is an object oriented program the analysis and design offer one the opportunity to create classes., Class is a set of the entities which have same set of attributes and methods. An object must be a member of a class as an instance of that class. The class is like to an abstract data type. This class may also be primitive, e.g. Boolean, integer, string. [Deshpande, A., Guestrin, C., Madden, S., Hellerstein, J. M., and Hong, W. (2004)]

Class hierarchy and inheritance: Inheritances derive a new class which is called subclass from an existing class, called superclass. The subclass inherits all the attributes and methods of the superclass, also having additional attributes and methods , and we try to make this practical in our design by first developing an algorithm after the synthesis of the program.

In designing the Database Algorithm , the nested loop method was adopted as both inner and outer loop method was explored., in creating the Sensor Headers which also bear their names, and in the Algorithm ,the program was made to read the outer loop which represents the Sensor node, after which their respective inner loop is executed by the gain of data from individual sensor nodes.

[Duda, R., Hart, P., and Stork, D. (2001)]

An outer and inner nodes is arranged, which will accommodate all data captured in the field

Database Algorithm

We develop an algorithm to synthesis the program for the Database.

The Algorithm was started by reading the sensor node header that is temperature and CO for Sensor 1,2,3,…. , the count(i) = 1 first row/outer loop is the first sensor node to be read, and T = 1, J = 1 stand for the inner loop, which represents the data transmitted at time T = 1 While J = 1 standing for the first data in the first column..

For the program to pick the next data the following statement will be executed (T = T + 1), while J = J + 1 , When the time gets to its maximum, the program moves to the next sensor to get data by executing the outer loop count(i) = count(i) + 1. , by which it will move to the next row to pick the next Sensor.

A **DATABASE ALGORITHM**

Start
Count(i) = 1
Read temperature sensor node
Read CO Sensor node
T = 1
J = 1
Read Time
Get Data
T = T+1
J = J + 1
T >= M
J >= M
Print and store to Database Data transmitted by temperature/CO Sensor node
Cout(i) = I + 1
I >= n
Return to origin

We design and develop a concept for Distributed remote monitoring parameter analysis..All the motes have unique Address ID to identify the mote. The mote can handle different data related to the gas or temperature. The data is being stored in database and the required information can be retrieved in the Software monitoring system. In order to simplify the system we have divided the whole data into category i.e. offline data and online data. The online data are those types of data which can be monitored continuously with sensor motes, for example, temperature, and Carbon monoxide. The off line has to do with the data logged and stored in the database.And can be called on when the nodes are not working [H. Karl and A. Wiling 2005]

The diagram in figure 1 shows the flowchart used in realizing the Algorithm for Database Design, and the inner and outer loop shown here, in which the outer loop represents the Sensor nodes , while the inner loop

represent the Packet collected from the field as the case may be, the outer loop count I representing the Sensors nodes, while the inner loop J and T Packets of Data Transmitted.

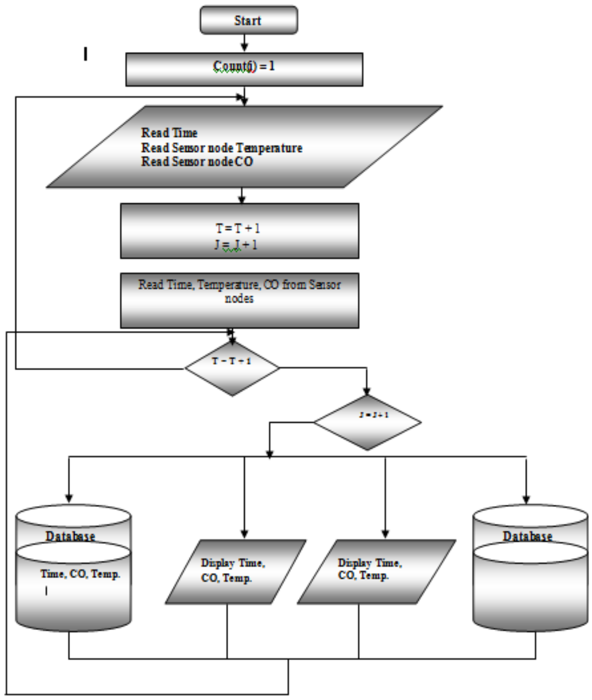


FIG. 1 FLOWCHART OF DATABASE SYSTEM IMPLEMENTATION

Implementing Software Interface

The interface in figure 3 is a JAVA interface using the netbeans, and the software interface was created to accommodate data transmitted from various sensor nodes.

For each node the packets are received and transmitted , when outer loop count i=1 the first sensor is read and later the inner loop count J=1, in which T=1 is picked to read all the data and later stored in the Database.

The output in figure 2 represents the Database output in Java and ORACLE.

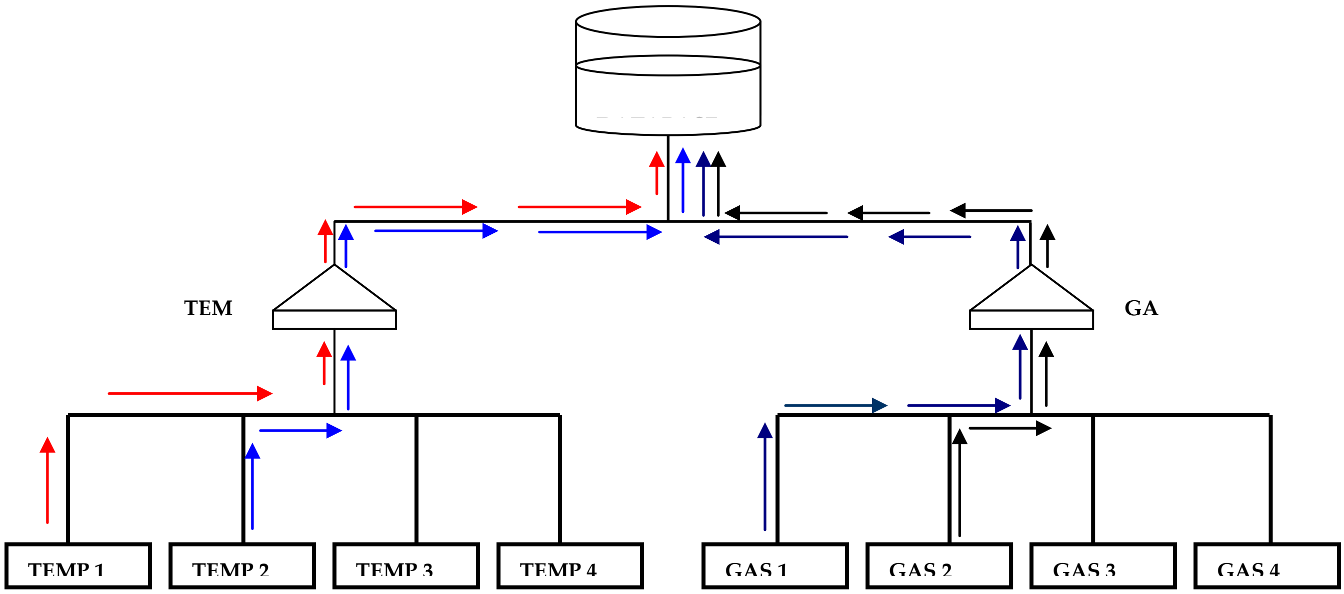


FIG. 2 QUERYING SENSOR NODE DATABASE

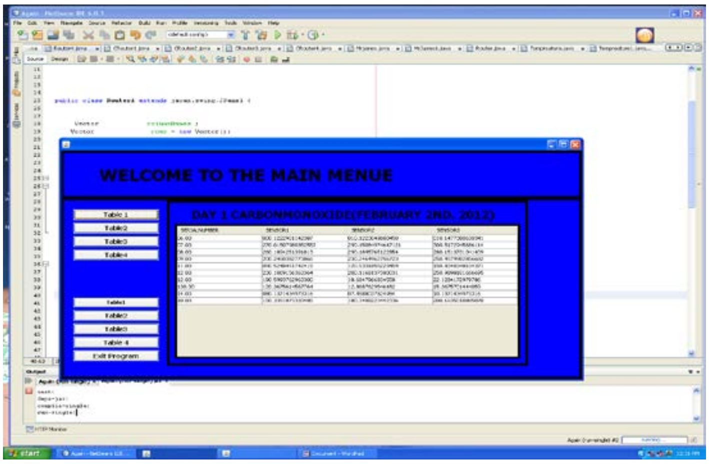


FIG. 3 JAVA DATABASE CARBONMONOXIDE DAY

We implement sensor node query in figure 2 in which the arrows represent filtering information from Database for a particular sensor node. Different locations also noted. [T.Chiras, M.Paterakis and P.Koutsakis]

Data will be captured via the database interface and sent to that part in the storage , the program is made to first access the Ports then in the JAVA Program the Object Oriented Program Characteristic plays a very big role as various classes are created to cover this. [K. Akkaya and M. Younis]

Querying Sensor Node Database

Here the whole data captured in the table will be displayed on a table.

MySQL the database for ORACLE Software, it can be called upon to all data received in the Database, The MySQL client program, also known as the MySQL monitor is an interface that allows the user to connect to the MySQL server, create and modify databases, and execute queries and view their

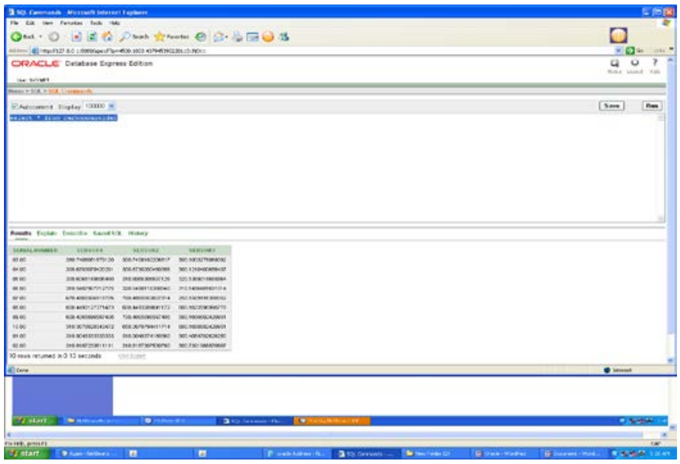


FIG. 4 ORACLE INTERFACE DATA BASE INTERFACE

results. This program is started by executing the command MYSQL at the shell prompt. [12,13,14]

After the base station software has formatted the data appropriately, it is sent to the MySQL database. This database can be located on any remote computer and accessed via the Internet, or on the base station itself. The database consists of a single table, 'alerts', which contains the information for every event generated by the wireless sensor network. Recorded data includes a timestamp of the event, event type, and any corresponding sensor data. [Habib F. Rashvand , Jose M. Alcaraz 2012]

Querying the Database

We query the Database for selected Sensor nodes for both temperature and Sensor nodes with the following command.

MY SQL COMMANDS

Select Sensor3 from Carbonmonoxide

Select Sensor3 from Temperature

Select Sensor1 from Carbonmonoxide

Select Sensor1 from Temperature

Select Sensor2 from Carbonmonoxide

Select Sensor2 from Temperature

Select Time from Temperature

The command selects data from various Sensor nodes for both Carbon monoxide and Temperature.

Figure 5 shows ways of querying both time against temperature In sensor 1

The command is Select Time from Temperature

We develop a formula to implementing the query for the sensors, and the following terms are used to develop the formulas

ST_1 = Sensor node one monitoring Temperature

$\sum_{i=1}^{n} ST_2$ = All Sensor monitoring temperature.

DB = Database

Equation 1and 2 will help tracing the sensor node amongst other sensors node in the network, and the equation will help extracting information on Sensor node ST_1 from $\sum_{i=1}^{n} ST_i$

Amongst Sensor nodes covering temperature which is further extracted from the Database DB.

$$\frac{ST_1}{\dfrac{\sum_{i=1}^{n} ST_i}{DB}} + \frac{ST_2}{\dfrac{\sum_{i=1}^{n} ST_i}{DB}} \quad \ldots.1$$

$$\frac{ST_1}{\dfrac{\sum_{i=1}^{n} ST_1 + ST_2 + ST_3 + \ldots\ldots\ldots ST_{n-2,} ST_{n-1,} ST_n}{DB}} \quad \ldots\ldots\ldots 2$$

The equation 1 above represent the querying implementation of two temperature Sensor nodes one and two, in addition the Sensor node will query and extract data from rom database for node one and two respectively. The Diagram in figure 4 implements queries for two nodes for both temperature and gas.

The equation in equation 2 is a general representation for the implementation of the queries.

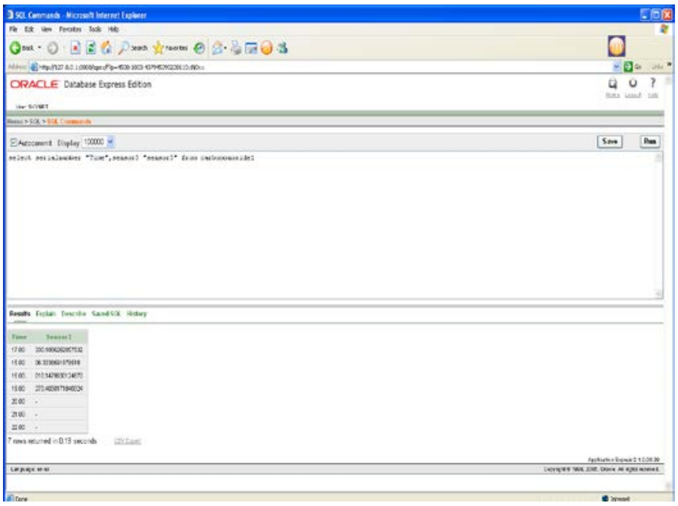


FIG. 5 ORACLE QUERY INTERRFACE

A practical output implementation of the querying is shown in the figure 5

Implementing Dynamic Graph Plotter for Adaptive Monitoring

In implementing the dynamic graph plotter it was draw out as in figure 6, V = Variable measured

$$\begin{array}{ll}
(V_{11}\, t_{11}), (V_{12}\, t_{12}), (V_{13}\, t_{13}) \ldots\ldots\ldots\ldots\ldots & (V_{1n}\, t_{1n}) \\
(V_{21}\, t_{21}), (V_{22}\, t_{22}), (V_{23}\, t_{13}) \ldots\ldots\ldots\ldots\ldots & (V_{2n}\, t_{2n}) \\
(V_{31}\, t_{31}), (V_{32}\, t_{32}), (V_{33}\, t_{33}) \ldots\ldots\ldots\ldots\ldots & (V_{3n}\, t_{3n}) \\
\vdots & \vdots \\
(V_{m1}\, t_{m1}), (V_{m2}\, t_{m2}), (V_{m3}\, t_{m3}) \ldots\ldots\ldots\ldots & (V_{mn}\, t_{mn})
\end{array}$$

FIG .6 GRAPH TEMPLATE MATRIX

T = time at which the variable has been measured and, the point on the graph template that makes up the matrix is (V,t), in figure 7 was evolved from figure six but this time (V,T) has been substituted by small circle points when a data is transmitted into the value in terms of (V,t) which becomes active by changing from white to red. A stream of event is then generated sequentially for a period of time as shown in figure 8.

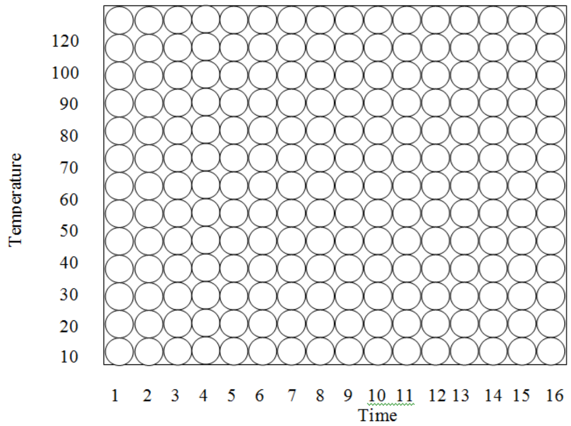
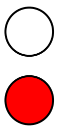


FIG. 7 GRAPH TEMPLATE MATRIX WITH DOTTED POOINTS



= inactive Point

= Active point

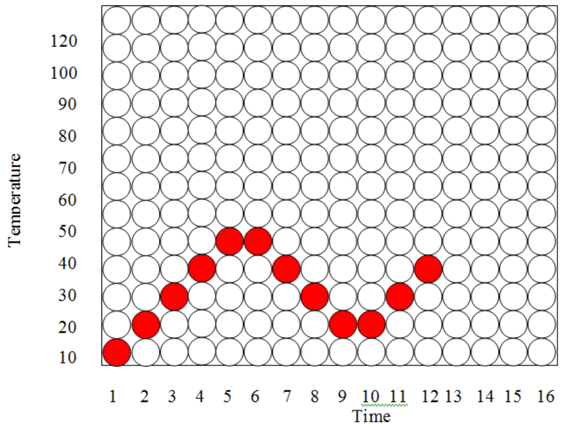


FIG. 8 GRAPH PLOTTING IMPLEMENTATION

FIG. 9 C SHARP VERSION OF TEMPERATURE PLOTTER 2

FIG 10 C SHARP VERSION OF TEMPERATURE PLOTTER 2

The result of the of transmitted data is seen in practical software interface USING C-Sharp program in figure 9 , As it can be seen from the interface That the Port name chosen for this work is COM 4 , and Baud rate is 38400, the start log commences the logging process while the Stop log discontinues the process, and view log take one to the Database where all Data are kept, TP stands for temperature, while GS represent Gas, SS stand for signal strength and NL stand for node location. [L.M.C. Arboleda and N. Nasser,]

We also advanced our work by incorporating a Graphical Liquid Crystal Display (GLCD) shown in figure 11., in which a hand held device is to enhance flexibility and smartness.

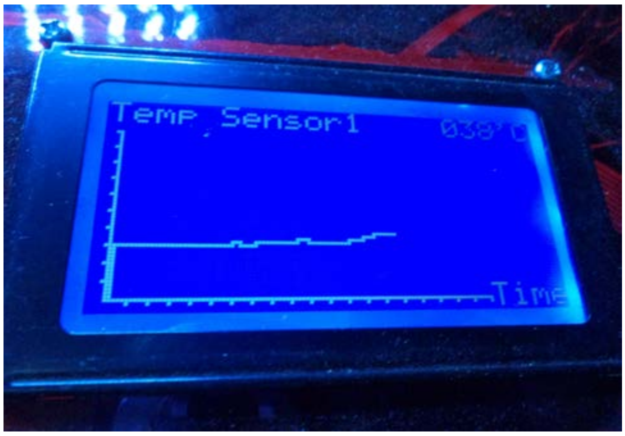


FIG. 11 GRAPHICAL LIQUID CRYSTAL DISPLAY(1)

Conclusion

It is concluded based on submission that spatially distributed network system like Wireless Sendor network involves monitoring many sensor nodes, and Sensor Nodes can be effectively monitored and capture event without room for redundancy. This is made possible due to the presence of an effective Database mechanism that can store and display data, which can can also call back events history , with all options to query the database. The ORACLE database also gave room for sharing files and resources over the internet, by automatically generating its URL. Monitoring process is also smart since the method of monitoring is adaptive to the Graph plotter.

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