Life Time Maximization of Wireless Sensor Node by Event Based Detection: An Experimental Approach

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Summary
Lifetime maximization is the key element in the design of sensor-based network applications. The lifetime is a critical parameter for wireless sensor network (WSN) which is defined as the maximum time of delivering certain data to the base node before sensor node runs out of energy available with it initially. Extending lifetime of battery-operated devices is a key design issue that allows uninterrupted information exchange among distributed nodes in wireless networks. In this paper, we consider event detection method to maximize the life time of WSN. Event based detection has always been an important application in the practical deployment of WSN. Threshold based event detection method works well in our application. The energy consumption sources of the WSN are analyzed for the significant characteristics of a specific event. This analysis is utilized to observe the increase in life time of wireless sensor node.

Key words:
wireless sensor network, life time expansion,Power consumption, Event based detection.

1. Introduction

Our approach is aimed at the extremely resource-constrained devices known as motes; motes consist of a radio component, a microcontroller, an array of sensors and an energy source (e.g. battery)
Wireless sensor networks are designed to detect events or phenomena, collect and process data, and transmit sensed information to interested users [1-3]. After the initial deployment, sensor networks are left unattended for a long period of time.
In many scenarios, it seems infeasible to replace or recharge batteries of sensor nodes. Consequently, one of the most important objectives is to maximize lifetime. Many researchers are working on improving the lifetime of sensor networks and proposed various schemes to increase the lifetime of wireless sensor networks. These methods include cross-layer interaction [4], routing [5, 6], medium access control [7], scheduling [8] and data aggregation.
Data routing algorithm was proposed with an aim to maximize the lifetime among nodes in wireless sensor networks. Later, considerable research efforts have been devoted to maximize such lifetime, which is also referred to as network lifetime. A technique for network lifetime maximization by employing accumulative broadcast strategy was considered in [10]. The work in [11] considered provisioning additional energy on existing nodes and deploying relays to extend the network lifetime. In an event detection scenario, sensor nodes are deployed in to a target field to collect data. The sensor nodes can process the observed data if needed before transmitting the data to a fusion center, where a final decision is made about whether an event occurs or not.
Traditionally, there are three types of detection schemes: A centralized scheme requires sensor nodes to forward all information contained in the observations to the fusion center. A distributed scheme, on the other hand, allows each sensor node to make its own decision and then send out only its 1-bit decision to the fusion center. An in-between scheme also exits that each working senor node only selects important data to send to the fusion center. For all these schemes, in-network aggregation technology may be used to reduce the communication cost, and a possible final decision may be made at the fusion center based on the information provided by all the sensor nodes.
An event can be defined as an exceptional change in the environmental parameters such as temperature, pressure, humidity, etc. Thresholds like *temperature*>33 and *light*>50 are often used to detect the happening of some event. In this case, we presume that event has some significant characteristics that can be used as thresholds to distinguish between normal and abnormal environment parameters.
However, an event may occur in many other forms. An event can be a gradual and continuous change over time, or has no clear border with normal environment parameters. Sometimes we don't know in advance the event type we are looking for. We just hope that WSN node can report some interesting data to the sink node. Threshold based event detection method does not work well in these cases. In most real WSN deployments, sensor part of WSN node works periodically, and the consecutive sensor readings constitute a time series.
In our application of WSNs for environmental monitoring for large agricultural field and green house Parameters which required to be monitored in such application are mainly temperature and humidity. Temperature and humidity do not change instantly so continuous monitoring is not essential though it consume the more power. [13] .So

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to maximize the life time of the network it is essential two analyze the complete process and node remains in the slipping mode as long as the temperature is less than the threshold value. Based on this technology, we propose a method to detect specific events .In these papers cross bow nodes are used to elaborately model the physical process and sensor part of WSN node. The remainder of this paper is organized as follows: First, studies related to event detection in WSNs are surveyed in section [13]. This is followed by a section that explains how to find patterns in sensor data streams. In Section [IV], a suggested method for specific event detection is implemented.

2. Methodology

In the applications of WSN for monitoring large agricultural field monitoring is required to avoid critical condition of parameters like temperature and humidity. In such applications where continuous monitoring is not essential. Event based detection is very important to maximize the life of wire less sensor node. In [13], generally, radios can operate in four distinct modes of operation: transmit, receive, idle and sleep. An important influencing factor is that a significant amount of energy is dissipated as the radio's operating mode changes. As shown in Table 1, most radios operating in idle mode result in significantly high energy consumption, almost equal to the energy consumed in the Receive mode.
Considerable amount of power is save and improve Life time of wireless sensor network for specific application where continues monitoring is not essential

Table 1 Power Consumption for different Mode.

Radio mode	Power consumption (mW)
Transmit	14.88
Receive	12.50
Idle	12.36
Sleep	0.016

Table 2 gives the critical condition for Temp & Humidity monitoring for Jalbera crop.

Sensor	Normal condition	Critical condition	Worst condition
Temperature	**15°C to 18°C**	**U.L. =30° C L.L. =12° C**	**1.Temp.>30 °C 2.Temp.<12 °C**
Humidity	**Humidity >20%**	**Humidity =20%**	**Humidity< 20%**

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In our application of Green House monitoring of wire less sensor network where continues monitoring is not essential. The critical parameters for threshold parameters are identified (table no.2).
Nodes are deployed at the various part of the premises to monitor temperature of the house .Initially we select one parameter temperature as the event parameter threshold we set 30ºc. It is challenging to maintain temperature for temp in hot summer days. Nodes are deployed with star topology in the premises. On first day all sensors send the data through the day and monitor the temperature and corresponding value of the power consumption for the entire time span of 6 hours and node remains on transmit & receive mode for through the operation. The reading of the battery voltage is noted at the beginning and at the end of the monitoring. These experimental conditions are set to monitor the total power consumption for the entire operation i.e. for continues monitoring. For next module same set up is used for the event based monitoring. The same span of the time is considered for the event based monitoring. The battery voltage is noted at the beginning of the switch on the node. Data transmission of the node is based on the threshold value. Initially the temperature of the sensor is noted. In this module all five sensor are remain in transmit & receive mode when the sensor temp is less than the threshold value a. Nodes are remain in the sleep mode when temp is less than the thresh hold value . Unlike in the case of continues monitoring ion this case node are shift from active mode to sleep mode .lower thresh hold value does not consider in both case because in summer days minimum temp 25c. For the same span of the time at the end of module two battery voltage is noted and corresponding value of the of both the modules are compared.

3. Experimental Results

All the experiments in this section were run in cross bow mote view software and nodes were Mica 300.The nodes using sensor data which was fed to the base station or gateway.

3.1 Topology of Deployed Node

The majority of the experiments were run on the cross bow data set, which is a collection of approximately 40 thousand readings from sensor nodes collecting data of temperature, acoustic, light and voltage. On our experiments we have used all the readings from all the nodes. Due to space limitations, we will not discuss the outcome of every single experiment; instead we will present a few selected cases. In the Figure 1 (a), it shows the topology of the sensor nodes in the premises. Nodes

mica 300 is deployed at the various deployed points and data is continuously sent to the base node. This is the topology for the 1st module of the continuous monitoring.
In this Topology temperature of the sensor nodes are clearly mentioned the nodes in the fig 1(a) are the continuous monitoring nodes and are active throughout the operation .If temperature is greater than the threshold. Nodes connected with the green line are active nodes and nodes with the gray line are the sleeping node. From comparing the topology it Cleary indicates that all the nodes in first figure are active and in the later figure 1(b) nodes are in sleeping mode. When the temperature is less than threshold the nodes are in sleep mode. In continuous and active when the temperature greater than the threshold are active. In continuous monitoring gate way or base node receives continuous data from the all the deployed nodes and in later module it receives the data only when a critical condition arrives. For remaining interval it remains in sleeping mode and it conserves the power.

We divide our work in two modules with deployed nodes. First we experiment with the continuous module where we deployed the nodes with star topology and it remains active through out for a span of 7 hours. Initial value of battery voltage is noted at the beginning and nodes sent data continuously for 7 hours.

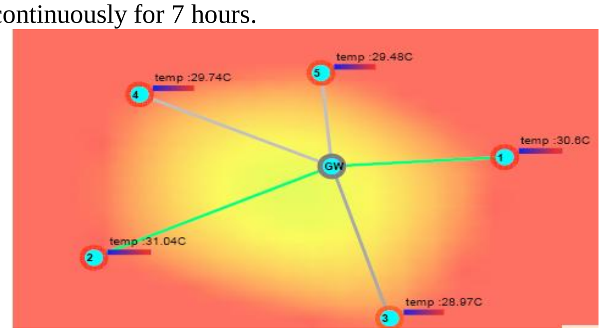


Fig.1 (a) Topology for continuous module

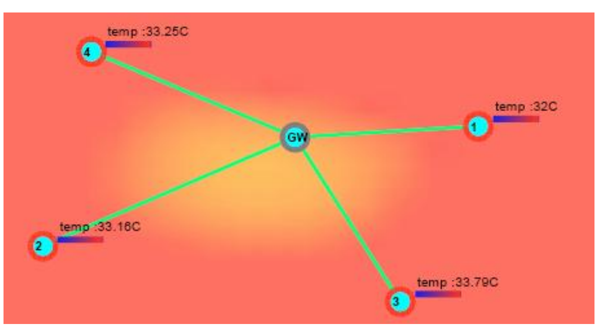


Fig.1 (b) Topology for Event based

We divide our work in two modules with deployed nodes. First we experiment with the continuous module where we deployed the nodes with star topology and it remains active through out for a span of 7 hours. Initial value of battery voltage is noted at the beginning and nodes sent data continuously for 7 hours.

3.2 Implementation with Conventional Method

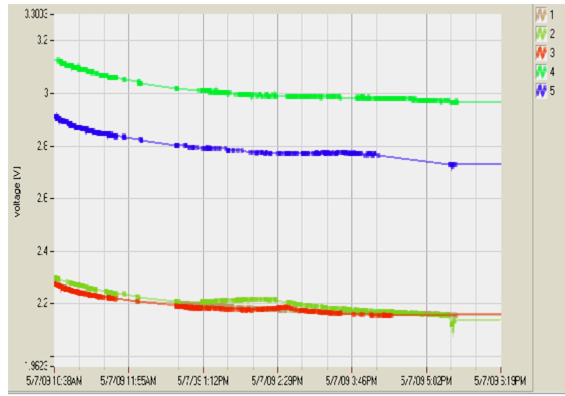
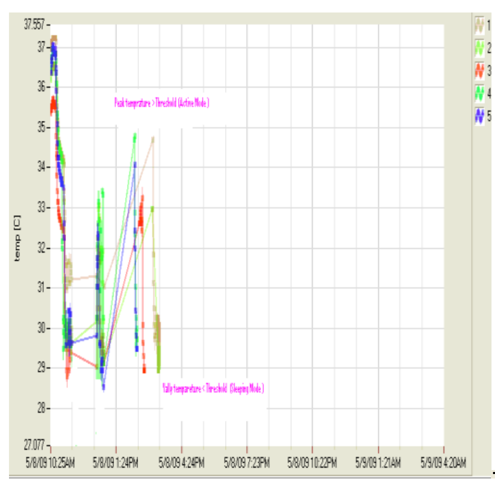


Fig2 Graph show voltage vs. Time for different nodes for continuous monitoring

Initial value of battery voltage is noted at the beginning and nodes sent data continuously for 7 hours. Nodes sent data without considering any threshold value through out the process. Fig (2) shows the graph, on the x axis time and on Y axis battery voltage is mentioned. Different colours in the graph indicate the data from the different nodes. Decay in the battery voltage is linear in nature and voltage is gradually decreasing as the power is consumed by the nodes**.**

3.3 Implementation with Event Based Detection

In these module for event based detection we deplyoed nodes at same topology as that in module one without changing any position of deployed nodes .



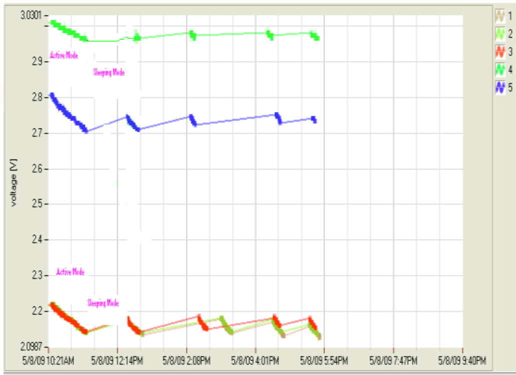


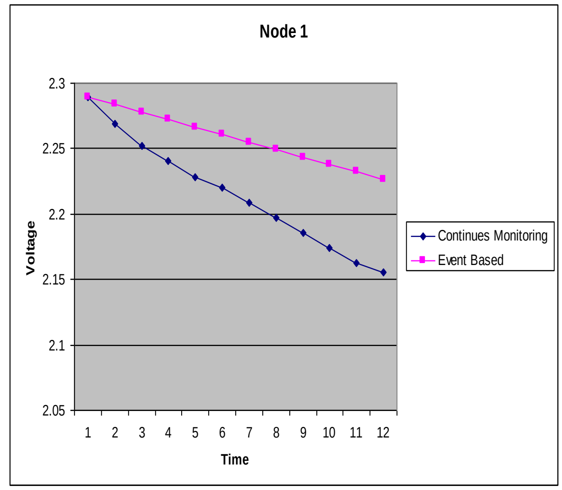
Fig3 (a) Graph shows temperature vs. Time for different nodes for Event based Monitoring Fig3 (b) Graph show voltage vs. Time for different nodes for Event based Monitoring

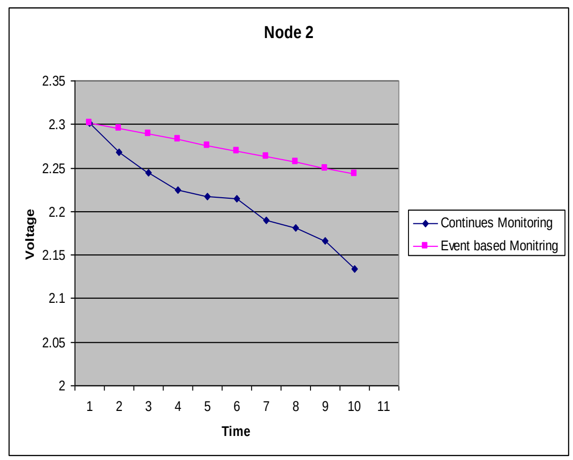
Deployed nodes sent signals only when the critical condition was detected . As shown in the fig.No.(2) Graph plot on x axis shows time and on y axis temprature of different sensor is mentioned . it is cleary mentioned in the garph when the temparetue less than the critical value ,nodes are remain in the sleeping mode and when the temprature is greater than the threshold value, nodes switch active mode .

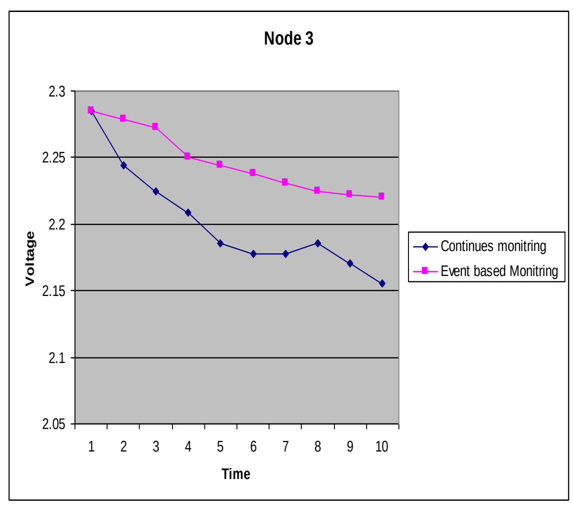
By comapring fig no. (3) and fig no.(4) we clearly indentify the active and slleeping time intervals of nodes. Data is sent by the nodes and time span of the module 2 is again of 7 Hours. All peak temprature indiacte the tempareture of the peak and Value of the nodes. This peak value force nodes to be active . when the temprature reaches to the threshold value nodes swithces from sleeping mode to active mode and vice versa.

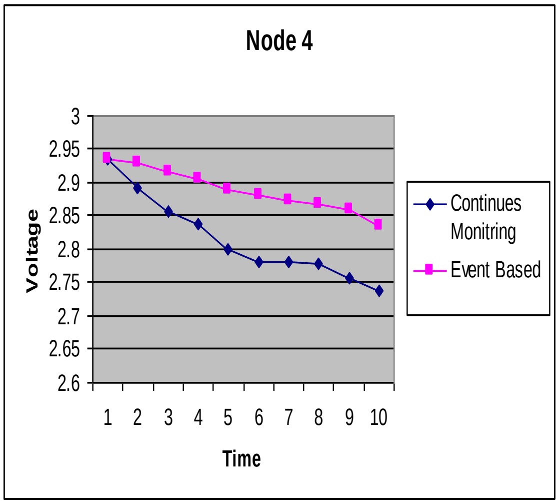
3.4 Comaprative Anlysis

Objective of this work is to note difference in power consumption between two approcehes. We comapre the power consumption by the node with continuous and event based monitoring. Power consumption analysis is based on the total voltage drop in the battery level. We use here the same battery for the analysis of power consumption and in the anlysis we differntiate between the the battery voltage level at the beginning of the module and at the end of each module . We compare the drop in the voltage level of the battery for node 1 to node 5. We noted the considerable amount of power saved in second module . If we compare the battery discharge level for same span of time for node 1 in continuous monitoring is 134 mV and by event detection is 63 mV ,for node 2 the discharge voltage 168.6 mV & 59mV,for node 3 130 mv & 64. 8 mV for node 5 discharge voltage is 197 mv and 98.64mV.









Comaprative analysis of all nodes and coressponding expansion in the life time is mentinoed in the table .Here we consider the battery life for a Dura cell with maximum power .

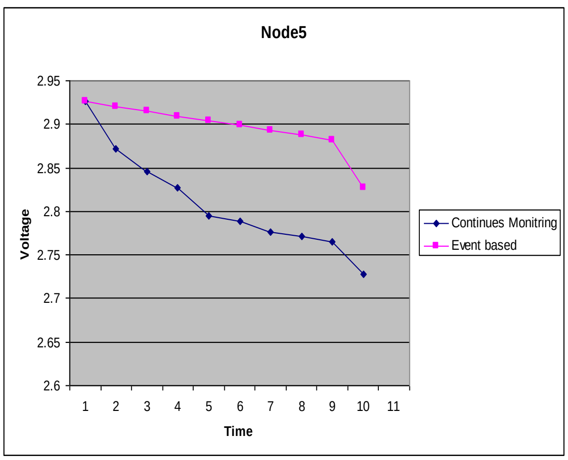


Fig.4(a- d) Voltage discharge Chractersitices of the Battery of different nodes .

Table 3 Performance Imporovement in Life Time of Node.

Node No.	Life Time with Continuous Monitoring	Life Time with Event Based Monitoring	Performance Improvement
1	29	38	29.98 %
2	30	38.4	28%
3	31	38.13	23%
4	27	32.61	21%
5	26	31.2	20%

4.1 Hardware and Software tools used

For the implementation of the platform, we used the following hardware and software tools:

4.1.1. Material used

The kit sensor network used for the implementation of the proposed platform, contains: 5 Sensor MicaZ and a base station MIB520

4.1.2. Software Tools

The realization of the experimentation platform requires an operating system, a sensor emulator and a programming language to implement the applications on the sensors:

- TinyOs is an operating system event-driven (event driven) designed for sensor networks. It is implemented entirely in NesC and respects an architecture based on a combination of components, to reduce the code size required for its implementation. TinyOs occupies a very low memory in its minimum distribution (512 bytes). Therefore, it is suitable for sensors with very limited memory resources. For as much, the components library of TinyOs is particularly complete since it contains network protocols, sensor drivers and tools for data acquisition.

- NesC is a component-oriented language designed to support the concepts of structuring and execution of TinyOs.

TinyOS provides tools to automatically generate message objects of package descriptions. Thus, instead of analyzing the formats of packet manually, the MIG tool establishes a Java interface to the message structure. Indeed, for a given sequence of bytes, the code generator MIG would analyze each field of the packet, visualize received packets and Produce new packets.

5.Conclusion

In this paper, we have outlined, studied and evaluated the problem of life time maximization to energy constraints. We are using threshold based method to detect specific event, we point out the fact that patterns always exist In WSN node measurement series. We introduce a method to find simple linear patterns and use it as an approach to maximize the life time of wire less sensor network. We use carefully designed simulation to evaluate the performance of this event based method, and the result is encouraging. This method is useful for the application where continuous monitoring is not essential. Further modification in the events parameter it will be useful in the border security .it need to be further improved that there exist some other kinds of events that take on complicated change rule. In future, we will consider some more event based methods to detect complex event, while always keep in mind that these methods should be affordable and energy-efficient.

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