ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, Vol 9(17), DOI: 10.17485/ijst/2016/v9i17/93101, May 2016 ISSN (Online) : 0974-5645

Hashing Technique Data Optimization for Low Power Consumption in Wireless Sensor Network

Vankayalapati Sahiti*, **K. Raghava Rao and K. R. R. Mohan Rao**

Department of ECM, K L University, Vaddeswaram, Guntur – 522502, Andhra Pradesh, India; sahithi.vankayalpati@gmail.com, raghavarao@kluniversity.in, mohanrao5423@kluniversity.in

Abstract

With the advent of technology MEMS came surpassing and led to the design of very small sensor nodes. This led to the creation of wireless sensor nodes. **Background:** Wireless Sensor Networks are entrancing to researchers due to their wide range of ever-growing application potential in every area and have been adapted in order to implement many applications such as habitat monitoring, military surveillance, precision agriculture. One of the major design challenges in Wireless Sensor Networks is power consumption. **Analysis:** It is crucial in various functions to position sensor nodes in an efficient way in order to monitor the event squarely and deliver the data to sink node. Uneven power consumption by nodes leads to the creation of energy holes, which means that data can never be delivered to the sink on that path. **Findings:** The sensor nodes located near to the sink node as the precedence, as there are the first ones to get effected due to this power consumption patterns and in 99 percent of the cases the first and the second rings are the places where an energy hole is first created. The main aim of this paper is to develop an algorithm using hashing technique which reduces the power consumption and energy harvesting is done optimally by avoiding duplication of packets in static network. **Improvements:** The power consumption improvement ratio and the life elongation of the network were simulated using Network simulator tool using the hashing technique and avoiding duplication of packets.

Keywords: Avoiding Duplication, Energy Harvesting, Energy Holes Problem, Hashing Technique, Wireless Sensor Nodes

1. Introduction

Wireless sensor nodes are sovereign devices equipped with heavily integrated sensing, processing and communication capabilities. When these nodes are networked together in an ad-hoc, they form a sensor network. The nodes gather data through their sensing equipment and next they process it in the node itself, meaning a packet is formed and forwards the information to the sink node. As a node has limited transmission range, the forwarding task mostly involves hop by hop transmission. A Wireless Sensor Network is composed of many sensor nodes among which the node receiving data from all the other nodes is called the sink node. These nodes are connected by a wireless network. The sensing data are transferred to the sink node through neighbor nodes. Calculation in the sensor node requires very little electric power in a Wireless Sensor Network, but communication among nodes requires much electric power.

Communication in the sense transmission of the data from the nodes located at different places to the sink node or in other terms called as the base station. The nodes that are close to the sink node deplete their energy faster in comparison with the nodes that are located away from the sink node, this is due to the fact that all the sensed data from the network is passed on to the sink node via the nodes which are very close to it. So their batteries get exhausted very easily.

Unlike other networks which are wireless, it is generally difficult or not practical to charge or replace exhausted batteries after deployment. As long as the on-board power supply is exhausted, the sensor node

* Author for correspondence

is a dead node. Saving power prolongs the life time of a node and also the life time of the network as a whole. Hence, one of primary design goals is to conserve power consumption and to improve the serviceable life of nodes as long as possible.

This is the main aim of present research paper to elongate the life time of a WSN network. An immediate question may arise about what is the life time of the network? It is defined as the time till which the first sensor node is exhausted or till the task for which these networks were defined is accomplished. Whichever occurs first is taken in to account.

1.1 Assumptions

There are some assumptions that are made in the paper which are as stated below, the first being the Wireless Sensor Network we are going to consider for our research is a static network meaning the sensor nodes once deployed in a location are maintained in that location till the end of their life time i.e. there is no movement. The wireless nodes are grouped based on the basis of corona based node deployment. The sensor nodes are spread out in a different passion along a considered geo-graphical region. According to the corona based assumption a particular sink node is considered and rings are determined at a distance of particular radius "r" from the sink node which is called the first corona[1] upon placing a multiplication factor to the radius parameter different corona's are defined away from the sink node.

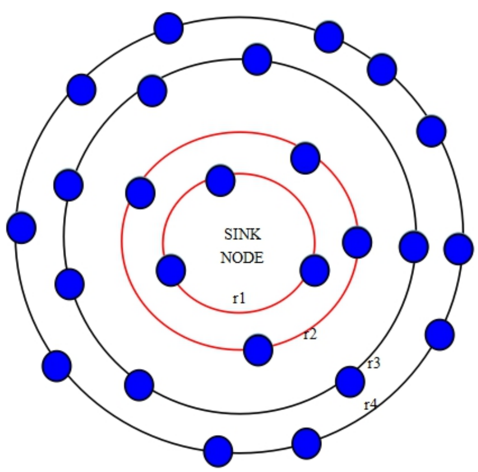

Figure 1. Corona based deployment of wireless sensor nodes.

Figure 1 depicts the typical deployment of a static Wireless Sensor Network with a sink node at the centralized position and the four rings differentiate the nodes based upon their distance from the sink node. The first and the second ring are highlighted with red to differentiate that the major activity of routing is done through the nodes in those two rings.

2. Methodologies

The existing methods for this particular problem and the introduction of the proposed method are described in the below sub-sections.

2.1 Existing Method

There were many research methodologies developed in the past decade upon reducing the power consumption of the WSN networks. One among those is felt efficient by the present author and further development for that procedure was in order to make the system flawless and more energy efficient.

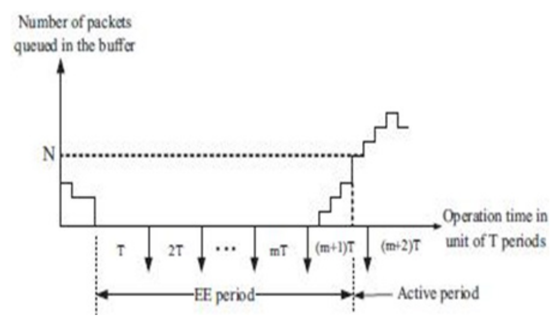

Figure 2. N policy representation.

Figure 2 depicts that irrespective of the time period that has elapsed, the cut off is considered only when N packets are accumulated. Cut off here is nothing but the energy efficient period and after that cut off it is the active period.

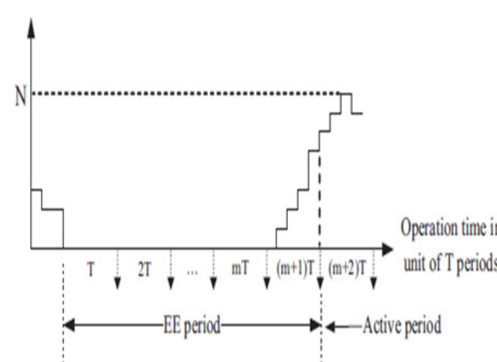

Figure 3. T policy representation.

Figure 3 depicts that irrespective of the number of packets accumulated, the cut off is considered only when (m+1) T time period is elapsed. Cut off here is nothing but the energy efficient period and after that cut off it is the active period.

Among all the energy harvesting techniques one involves the usage of min (N,T)[2] policy the queuing of packets according to that policy is shown in Figure 2 of N policy and Figure 3 of T policy according the M/G/1 queuing technique[3] where the packets arrive according to Gaussian arrival principle. First let us consider a Wireless Sensor Network which is communicating the packet information i.e. sensed packets based on the Gaussian arrival. The mean arrival rate is defined by λ. In general taking means whenever a sensor node receives a packet or the node in the outer corona as show in the above diagram generates a packet then it has to route it to the sink node via the nodes present in between. So when a sensor node has a packet with it, node tries to contend the medium in order to send the packet. As the result, whenever a packet is received or generated the transmitting medium is contended irrespective of whether the transmitting medium is busy or whether it is free. And also another observation is that for a node to transmit it needs to present itself in active mode otherwise it is present in the sleep mode, the power consumption process can be discussed in two fold here which is, one node active state consumes more power and two for the switching between active state to sleep mode also more power is consumed which is a lot of power wastage. Due to this process happening every time there is a lot of power wastage.

To minimize the power wastage a queue based scheme was used. Process happening this queue based scheme is that it reduces the number of times the node tries to contend a medium till it accumulates the threshold packets 'N', which shows as clear fact that the no. of times a node contends a medium is reduced.

This process is further conceptually expanded by discussing the Min (N, T) policy. On the first note let us note that min (N, T) policy is a queuing technique. The service of packets to the other node is done following either one of the below techniques.

- In the N policy packet transmission at a node is started only when N no. of packets are accumulated at the node, until which the node is in sleeping state and after the packets are accumulated the node switches is mode to active state and starts transmitting by contending the medium figure shown in Figure 2.
- In the T policy packet transmission from a node is started only when a threshold time period (m+1) is elapsed which when happens the node switches its state from sleep mode (Energy efficient) to active mode and contends the medium and starts transmission figure shown in Figure 3.

The switching of node from sleep mode to active mode is done based upon which ever condition happens the first i.e. whenever N packets are accumulated or when time period (m+1) has been elapsed.

2.2 Problem Introduction

In the above mentioned existing method we have discussed the implementation of the Min (N, T) policy[2] where the packets are transmitted following the principle but be forgot one fact here that is duplication of packets. In practical applications the data generated at a node in the first ring is hopped in to the second ring and so on in order for the data to reach the sink node which is the actual process. Nodes in the ring 1 broadcast the data to the nodes in the ring 2 due to which same packets are received by multiple nodes in the ring 2. This process can be defined as duplication, where multiple packets containing the same data are broadcast throughout the network which increases the load on network and also is the power consumption increased. So when a distributed hash function is implemented using a SHA-1 technique of hash then we can avoid duplication. Not only that the size of the packet is reduced from the arbitrary length to the to 160 bit size which reduces the processing time.

2.3 What is a Hash Function

A hash function[4] is a simple technique that can be used to match the data of arbitrary size to a fixed length which causes the compression of data. The hash function known as SHA1 is a hashing algorithm which maps the data of almost arbitrary length to strings of 160 bits. The MD-5 and SHA-1 are the majorly used hash functions in WSN networks. Out of which SHA-1 serves our purpose the more. The execution time of the SHA-1[5] hash function takes very much less execution time, about 0.1355 seconds which is one tenth of a second in real time application[6] when related to the other hash functions, which means that the operation time of a node in active mode is reduced. Due to the above mentioned factor the system operation time will be reduced which results in the less power consumption. Introduction to the implementation of hash technique is as stated below:

2.4 Proposed Method

In the below hashing algorithm, the node in the first ring agree with which node it wants to unicast its data with in the second ring which is very much nearby it. The same happens in all the nodes in corresponding rings till the packet is routed to the sink node. The order to pass on the information from node in rings is constructed in a predefined fashion and that is how a construction of hash table takes place.

2.5 Hash Syntax

Syntax of how a packet is routed between nodes in two different rings:

Key _ hash (*data packet*)

Route (*node _ Id(identification number)*, *put*, *key*, *value*)

Route (*node _ Id(identification number)*, *get*, *key*,*value*)

In this method, every node in the network is given an ID through hash function algorithm[7]. Each node has a routing table and it can forward information to destination node through the routing table. Based on the above process, the single node shares information with a node in the corresponding ring which it is meant to share as the result duplication is avoided which doesn't give a chance for multiple similar packets generation.

```
algorithm SHA1(M)    // |M| < 2^64
    V ← SHF1( 5A827999 || 6ED9EBA1 || 8F1BBCDC || CA62C1D6 , M )
return V

algorithm SHF1(K,M)    // |K| = 128 and |M| < 2^64
    y ← shapad(M)
    Parse y as M_1 || M_2 || ··· || M_n where |M_i| = 512 (1 ≤ i ≤ n)
    V ← 67452301 || EFCDAB89 || 98BADCFE || 10325476 || C3D2E1F0
    for i = 1,...,n do
        V ← shf1(K, M_i || V)
return V

algorithm shapad(M)    // |M| < 2^64
    d ← (447 − |M|) mod 512
    Let ℓ be the 64-bit binary representation of |M|
    y ← M || 1 || 0^d || ℓ    // |y| is a multiple of 512
return y

algorithm shf1(K, B || V)    // |K| = 128, |B| = 512 and |V| = 160
    Parse B as W_0 || W_1 || ··· || W_15 where |W_i| = 32 (0 ≤ i ≤ 15)
    Parse V as V_0 || V_1 || ··· || V_4 where |V_i| = 32 (0 ≤ i ≤ 4)
    Parse K as K_0 || K_1 || K_2 || K_3 where |K_i| = 32 (0 ≤ i ≤ 3)
    for t = 16 to 79 do
        W_t ← ROTL^1(W_{t−3} ⊕ W_{t−8} ⊕ W_{t−14} ⊕ W_{t−16})
    A ← V_0 ; B ← V_1 ; C ← V_2 ; D ← V_3 ; E ← V_4
    for t = 0 to 19 do
        L_t ← K_0 ; L_{t+20} ← K_1 ; L_{t+40} ← K_2 ; L_{t+60} ← K_3
    for t = 0 to 79 do
        if (0 ≤ t ≤ 19) then f ← (B ∧ C) ∨ ((¬B) ∧ D)
        if (20 ≤ t ≤ 39 OR 60 ≤ t ≤ 79) then f ← B ⊕ C ⊕ D
        if (40 ≤ t ≤ 59) then f ← (B ∧ C) ∨ (B ∧ D) ∨ (C ∧ D)
        temp ← ROTL^5(A) + f + E + W_t + L_t
        E ← D ; D ← C ; C ← ROTL^30(B) ; B ← A ; A ← temp
    V_0 ← V_0 + A ; V_1 ← V_1 + B ; V_2 ← V_2 + C ; V_3 ← V_3 + D ; V_4 ← V_4 + E
    V ← V_0 || V_1 || V_2 || V_3 || V_4
return V
```

Figure 4. SHA-1 Algorithm.

Figure 4 The SHA-1 Algorithm construction is shown in the diagram how the data is processed is shown in the figure.

3. Experimental Analysis

The observance of the above mentioned method was analyzed using a simulation process in NS-2. The different parameters that were set are as stated below. The established network is an ad-hoc network. In which the node deployment is very much static in nature i.e. once placed in a network there is no movement. The nodes present in the network have the same sensing rate. The traffic which is attached at each node is same i.e. CBR (Constant Bit Rate). As the traffic generated at one ring passes on in to the denser network towards the sink the traffic rate increases. There are many considerations made in the experimental setup some of the ones playing the crucial role were stated below. The mean arrival rate at the first ring is considered as 0.1λ and we consider it increasing in a Gaussian matter as the rings get denser ie $\{\lambda_1\ \lambda_2\ \lambda_3\ \lambda_4\} = \{1\lambda,2\lambda,3\lambda,4\lambda,\}$.Where λ for experimental purpose is considered as 0.25. The transmission bandwidth is considered to be 275 kbps. The nodes deployed in the network use UDP protocol. Figure 5 depicts the parameter values considered for simulation. The average power consumption ration was improved by a factor of 4% in ring1 and ring 2 when compared with existing system which is depicted in the below graphs. The Figures 5 and 6 show how the power consumption in the rings would be when the mean arrival rate λ is considered to be 0.3 at the threshold value for λ and the number of packets that are being buffered is changed starting from to 20. The result is shown in Figure 6.

In Figure 7 the existing method and the proposed method were plotted and the lifetime elongation index was shown with respect to the number of packets that are being queued.

The communication of nodes needs some power which is set up with the below parameters:

Sleep mode power setup	0.85 watts
Active mode power setup	1.5 watts
Idle mode power set up	0.032 watts
SHA-1 algorithm implementation	0.12seconds

Figure 5. Setup parameter values.

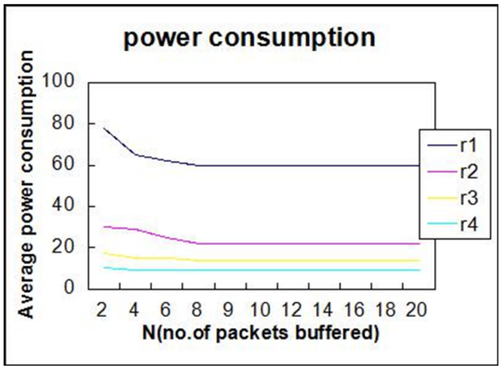

Figure 6. Power consumption pattern for rings with λ = 0.3.

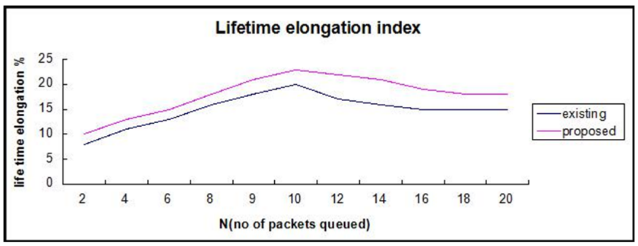

Figure 7. Lifetime elongation index with λ = 0.3.

4. Conclusion

This paper proposes a hashing technique algorithm for the wireless sensor nodes. By using this technique the advantages are three fold while majorly concentrating on power consumption. Firstly the hashing scheme SHA-1 used reduces the arbitrary size data to 160 bits of size. Second it provides security against duplication which reduces the stress on the nodes located in rings near a sink node and ultimately reduces the power consumption by 4% when compared with the other existing algorithms.

5. Acknowledgements

We gratefully acknowledge the constant assistance and guidance of K L University in completion of this work. We also mention our special gratitude to Embedded Systems and Sensor Networks (ESSN) group of K L University for their valuable inputs and suggestions.

6. References

1. Ur Rahman A, Alharby A, Hasbullah H, Almuzaini K, et al. Corona based deployment strategies in Wireless Sensor Network: A survey. Journal of Network and Computer applications. 2016 Apr; 64:176–93.
2. Jiang FC, You I, Leu FY. Approaching green sensor field using queue based optimization technique. Journal of Network and Computer Applications. 2016 May; 66:128–36.
3. Wang TY, Wang KH, Peam WL. Optimization of the T policy M/G/1 queue with server breakdowns and general start up times. Journal of Computational and Applied Mathematics. 2009 Jun; 228(1):270–8.
4. Hash functions. 2015. Available from: https://en.wikipedia.org/wiki/Hash_function
5. Nunoo-Mensah H, Boateng KO, Gadze JD. Comparative analysis of energy usage of hash functions in secured Wireless Sensor Networks. International Journal of Computer Applications (0975 – 8887). 2015 Jan; 109(11):20–3.
6. Pandey GK, Singh AP. Energy conservation and efficient data collection in WSN-ME: A Survey. Indian Journal of Science and Technology. 2015 Aug; 8(17):1–11. Doi No.: 10.17485 August 2015,
7. W. hash. 2015. Available from: https://cseweb.ucsd.edu/~mihir/cse207/w-hash.pdf
8. Ashok J, Thirumoorthy P. Design considerations for implementing an optimal battery management system of a wireless sensor node. Indian Journal of Science and Technology. 2014 Sep; 7(9):1255–9.
9. Janani ESV, Ganeshkumar P. Compliant data-centric network processing for energy economic data collection in Wireless Sensor Networks. Indian Journal of Science and Technology. 2015 May; 8(S9):506–12.
10. Choi MY, Moon CJ, Baik DK. The shortest path data aggregation using hash function on mesh wireless sensor. Network Embedded Multimedia Computing. 2012; 181:409–16.
11. Pellisier S, Prabhakar TV, Jamadagni HS, Vekatesh Prasad R. Providing security in energy harvesting sensor networks. The 8th Annual IEEE Consumer Communications and Networking Conference - Security and Content Protection; Las Vegas, NV. 2011 Jan 9-11. p. 452–6.
12. Macii D, Ageev A, Somov A. Power consumption reduction in Wireless Sensor Networks through optimal synchronization. I2MTC 2009 - International Instrumentation and Measurement Technology Conference; Singapore. 2009 May 5-7. p. 1346–51.