

# *Novel GPS activation strategy for Minimization of Localization Error with improved Energy Efficiency in Wireless Sensor Networks*

Mohd, Alam  
Electronics and Communication,  
BBD University, Lucknow, India  
mohdalam45@gmail.com

Ashwini Kumar  
Electronics and Communication,  
BBD University, Lucknow, India  
Ashwinikumar7@gmail.com

**Abstract--** The positioning of wireless nodes has been a dynamic research area in the course of the most recent decade. Numerous system situating calculations have been proposed to tackle this issue. Most by far accept that an altered arrangement of nodes (called seeds) have a mechanism to position themselves at all times (utilizing GPS or different means). Alternate nodes evaluate their positions in light of positional data traded between nodes utilizing Wireless Communication. The money related expense of a GPS unit is diminishing so frameworks where most nodes are furnished with a GPS unit is predictable. An issue with this presumption is that the assignment of self-situating through a GPS unit is costly regarding energy utilization which results in speedier battery rot. In this paper, we expect that each node is fit for self-situating yet enacts that module specifically. This considers adjusting the energy expenses of self-situating among all nodes and results in decreased positional error. We explore a few unique techniques for administering the self-situating module and report on their execution.

**Keywords--**Ad-hoc, GPS, Localization, WSN.

## **1. Introduction:**

Wireless Sensor Network (WSN) is a collection of large number of sensor nodes deployed in a particular region. The positioning of wireless nodes has been an active research area over the last decade. Many network positioning algorithms have been proposed to solve this problem. The problem of positioning, or the estimation of the geographical positions of wireless nodes in ad hoc and sensor networks. The position information is used in many parts of the network infrastructure, including topology maintenance, medium access control (MAC) protocols and routing protocols like geographic routing, event localization, target tracking and sensed data mapping. Node positions in a global co-ordinate system. For this, they have to assume that a fixed set of nodes (called seed nodes) have some mechanism to position themselves at all times. One such mechanism is GPS. The other nodes estimate their positions based on positional information of other nodes obtained using wireless communication. This is sometimes called network positioning. Recent advances in MEMS-based sensor technology, low-power analog and digital electronics, and low-power RF design have enabled the development of relatively inexpensive and low-power wireless micro sensors. These sensors are not as reliable or as accurate as their

expensive macro sensor counterparts, but their size and cost enable applications to network hundreds or thousands of these micro sensors in order to achieve high quality, fault tolerant sensing networks. Reliable environment monitoring is important in a variety of commercial and military applications. For example, for a security system, acoustic, seismic, and video sensors can be used to form an ad hoc network to detect intrusions. Micro sensors can also be used to monitor machines for fault detection and diagnosis. Micro sensor networks can contain hundreds or thousands of sensing nodes. It is desirable to make these nodes as cheap and energy-efficient as possible and rely on their large numbers to obtain high quality results. Network protocols must be designed to achieve fault tolerance in the presence of individual node failure while minimizing energy consumption. In addition the data being sensed by the nodes in the network must be transmitted to a control center or base station, where the end-user can access the data. There are many possible models for these micro sensor networks. In this work, we consider micro sensor networks where: The base station is fixed and located far from the sensors. All nodes in the network are homogeneous and energy constrained. Thus, communication between the sensor nodes and the base station is expensive, and there are no "high-energy" nodes through which communication can proceed. This is the framework for MIT's -AMPS project, which focuses on innovative energy-optimized solutions at all levels of the system hierarchy, from the physical layer and communication protocols up to the application layer and efficient DSP design for micro sensor nodes. Sensor networks contain too much data for an end-user to process. Therefore, automated methods of combining or aggregating the data into a small set of meaningful information is required. In addition to helping avoid information overload, data aggregation, also known as data fusion, can combine several unreliable data measurements to produce a more accurate signal by enhancing the common signal and reducing the uncorrelated noise. The classification Proceedings of the 33rd Hawaii International Conference on System Sciences - 2000 0-7695-0493-0/00 \$10.00 (c) 2000 IEEE 1 performed on the aggregated data might be performed by a human operator or automatically. Both the method of performing data aggregation and the classification algorithm are application-specific. For example, acoustic signals are often combined using a beam forming algorithm to reduce several signals into a single signal that contains the relevant information of all the individual signals. Large energy gains can be achieved by

performing the data fusion or classification algorithm locally, thereby requiring much less data to be transmitted to the base station.

The work considers a system of battery operated computing devices that are capable of wireless communication. Each device is located in an environment and communicates with nearby nodes via the exchange of messages. The devices are mobile so the position of a sensor can change over time. The model describes the environment, wireless communication and mobility of the devices. The dynamics of the system of devices are captured in discrete time steps. In each time step a node can communicate, perform some computation, and change its location. We will assume that every node is capable of self-positioning but activates that module selectively. This allows for balancing the energy costs of self-positioning among all nodes and results in reduced positional error.

## 2. Related Work:

Today, Cluster based routing protocols are well known schemes for extending Wireless Sensor Networks lifetime. However, there are several energy efficient cluster-based protocols in the literature; most of them use the topological neighborhood or adjacency as main parameter to form the clusters. This work presented by a new **Neda Enami et. al., (2010)** [2], centralized adaptive Energy Based Clustering protocol through the application of Self organizing map neural networks (called EBC-S) which can cluster sensor nodes, based on multi parameters; energy level and coordinates of sensor nodes. We applied some maximum energy nodes as weights of SOM map units; so that the nodes with higher energy attract the nearest nodes with lower energy levels. Therefore, formed clusters may not necessarily contain adjacent nodes. The new algorithm enables us to form energy balanced clusters and equally distribute energy consumption. Simulation results and comparison with previous protocols (LEACH and LEA2C) prove that our new algorithm is able to extend the lifetime of the network, while it can insure more network coverage in its lifetime through distributed death of nodes in network space.

The main concern in Wireless Sensor Networks is how to handle with their limited energy resources. The performance of Wireless Sensor Networks strongly depends on their lifetime. According to **Neda Enami, Reza Askari Moghadam, Kourosh Dadashtabar & Mojtaba Hoseini (2010)** [3], as a result, Dynamic Power Management approaches with the purpose of reduction of energy consumption in sensor nodes, after deployment and designing of the network, have drawn attentions of many research studies. Recently, there have been a strong interest to use intelligent tools especially Neural Networks in energy efficient approaches of Wireless Sensor Networks, due to their simple parallel distributed computation, distributed storage, data robustness, auto-classification of sensor nodes and sensor reading. Dimensionality reduction and prediction of sensor data obtained simply from the outputs of the neural-networks algorithms can lead to lower communication costs and energy conservation. All these characteristics show great analogy and compatibility

between wireless sensor networks and neural networks. This work aims to present the most important possible application of neural networks in reduction of energy consumption according to research studies have been done in the literature so far through a general classification of them.

In Wireless Sensor Networks (WSNs), localization is one of the most important technologies since it plays a critical role in many applications, e.g., target tracking. If the users cannot obtain the accurate location information, the related applications cannot be accomplished. The main idea in most localization methods is that some deployed nodes (landmarks) with known coordinates (e.g., GPS-equipped nodes) transmit beacons with their coordinates in order to help other nodes localize themselves. In general, the main localization algorithms are classified into two categories: range-based and range-free. In this work, we reclassify the localization algorithms with a new perspective based on the mobility state of landmarks and unknown nodes, and present a detailed analysis of the representative localization algorithms by **Guangjie Han, Huihui Xu, Trung Q. Duong, Jinfang Jiang, and Takahiro Hara (2011)** [4]. Moreover, we compare the existing localization algorithms and analyze the future research directions for the localization algorithms in WSNs.

For many applications of small wireless devices, secure communication is an important requirement. In this work, they quantify the energy costs of authentication and key exchange based on public-key cryptography on an 8-bit microcontroller platform. **Arvinderpal S. Wander, Nils Gura, Hans Eberle, Vipul Gupta, Sheueling Chang Shantz, (2015)** [5], presented a comparison of two public-key algorithms, RSA and Elliptic Curve Cryptography (ECC), under two authentication scenarios. In the first scenario, an untrusted client authenticates itself to a trusted authority. This scenario applies, for example, to a contactless smart card authenticating itself to a trusted reader. In the second scenario, we consider mutual authentication and key exchange between two untrusted parties such as two nodes in a wireless sensor network. For authentication and key exchange, we use a simplified version of the Secure Sockets Layer (SSL) handshake tailored to the constraints of small devices. Our measurements on an Atmel ATmega128L low-power microcontroller indicate that public-key cryptography is viable on 8-bit energy-constrained devices even if implemented in software. For single-party authentication, we found that challenge-response authentication based on ECC-160 used only 1/12 of the energy of its RSA-1024 counterpart. With a given amount of energy, we were able to perform 4.2 times the number of key exchange operations (including mutual authentication) with ECC-160 compared to RSA-1024. The benefits of ECC over RSA manifested not only in less computation, but also in the amount of data transmitted and stored. While the relative cost of public-key cryptography depends on the application, we show that for applications that require infrequent authentication and key exchanges, the energy cost of public-key cryptography is minimal, if not negligible.

Localization in Wireless Sensor Networks has become a significant research challenge, attracting many researchers in the past decade. This work provides a review of basic techniques and the state-of-the-art approaches for wireless sensors localization by **Mert Bal, Min Liu, Weiming Shen, Hamada Ghenniwa (2015)** [6]. The challenges and future research opportunities are discussed in relation to the design of the collaborative workspaces based on cooperative wireless sensor networks.

### 3. Methodology:

We will discuss a conventional clustering approach to routing and the drawbacks of using such an approach when the nodes are all energy-constrained. Using a direct communication protocol, each sensor sends its data directly to the base station.

If the base station is far away from the nodes, direct communication will require a large amount of transmit power from each node. This will quickly drain the battery of the nodes and reduce the system lifetime. However, the only receptions in this protocol occur at the base station, so if either the base station is close to the nodes, or the energy required to receive data is large, this may be an acceptable (and possibly optimal) method of communication.

The second conventional approach we consider is a "minimum-energy" routing protocol. There are several power-aware routing protocols discussed in the literature.

In these protocols, nodes route data destined ultimately for the base station through intermediate nodes. Thus nodes act as routers for other nodes' data in addition to sensing the environment. These protocols differ in the way the routes are chosen.

Some of these protocols [1, 7, 8], only consider the energy of the transmitter and neglect the energy dissipation of the receivers in determining the routes.

In this case, the intermediate nodes are chosen such that the transmit amplifier energy (e.g.,  $ET_{xamp}(k; d) = \text{amp} k d^2$ ) is minimized; thus node A would transmit to node C through node B if and only if:  $ET_{xamp}(k; d = d_{AB}) + ET_{xamp}(k; d = d_{BC}) < ET_{xamp}(k; d = d_{AC})$  (3) or  $d^2_{AB} + d^2_{BC} < d^2_{AC}$  (4) However, for this minimum-transmission-energy (MTE) routing protocol, rather than just one (high-energy) transmit of the data, each data message must go through n (low energy) transmits and n receives.

Depending on the relative costs of the transmit amplifier and the radio electronics, the total energy expended in the system might actually be greater using MTE routing than direct transmission to the base station.

To illustrate this point, consider the linear network shown in Figure 2, where the distance between the nodes is r. If we consider the energy expended transmitting a single k-bit message from a node located a distance nr from Base Station r n nodes.

The devices are represented by a set of n nodes  $V = \{u_1, \dots, u_n\}$  and a two-dimensional Euclidean space R where a transmitted message can be received by another node. This work uses the unit disk model of communication where the communication The positions of the nodes change over time.

The random waypoint mobility model is used to describe node movement. Under this model each node selects a destination point from the space R a line towards it.

In each time step the node moves a random distance chosen uniformly from the interval. The nodes in the system under consideration are mobile so their position is always changing which necessitates periodic position estimation.

It is assumed that each node in the system is equipped with a GPS unit that can be activated and deactivated at the discretion of the node. When a GPS unit at a node i is activated it provides the node with its position  $pt(i)$  but consumes a large amount of energy.

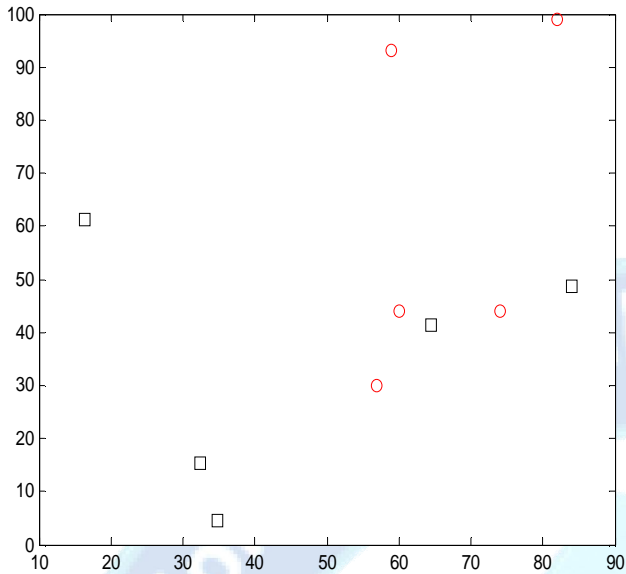
When a GPS unit is deactivated a nodes relies on a network positioning algorithm to estimate its position. The objective of this work is to investigate strategies that balance the use of the GPS unit with the need to conserve energy .A GPS activation strategy is a component of a positioning algorithm and determines when a node's.

GPS unit is active. If a GPS unit is active a node knows its position. Three activation strategies have been formulated for this work: fixed, random and error. The activation strategy is integrated formulated for this work: fixed, random and error.

### 4. Result and Discussion:

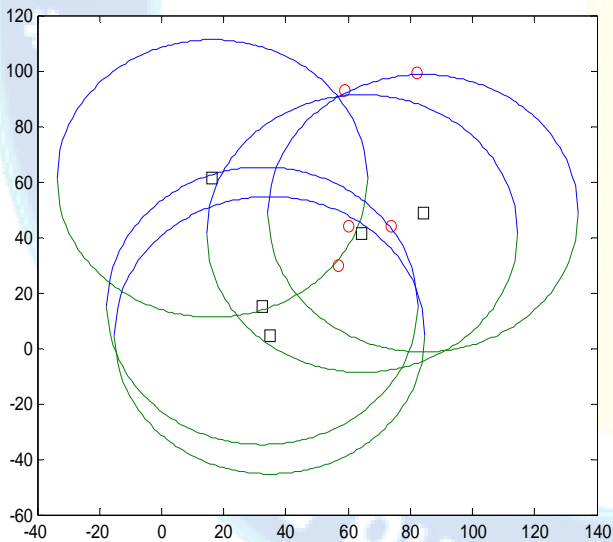
In this paper we have described the step wise result generation and it analytical discussion in terms of various plot, tables and network layout figure to demonstrate the working of our proposed algorithm .We have use the Matlab 2010 platform for developing the Matalb code script programming. We have considered an area of dimension 100x100 with 5 sensor nodes distributed in the field and each node is placed randomly with different location. Each sensor device is located in an environment and communicates with nearby nodes via the exchange of messages. The devices are mobile so the position of a sensor can change over time. The model describes the environment, wireless communication and mobility of the devices. The dynamics of thesystem of devices are captured in discrete time steps. In each time step a node can communicate, perform some computation, and change its location.

As shown in figure 1 the square markers are the nodes and since these node are dynamic they have a given destination as given by red circles. The positions of the nodes change over time. The random waypoint mobility model is used to describe node movement. Under this model each node selects a destination point from the space and moves along a line towards it. In each time step the node moves a random distance chosen uniformly from the interval  $[0, \delta]$  on this line. When the node reaches the destination it selects a new destination point for the next time step. This model has been used extensively in previous work s.

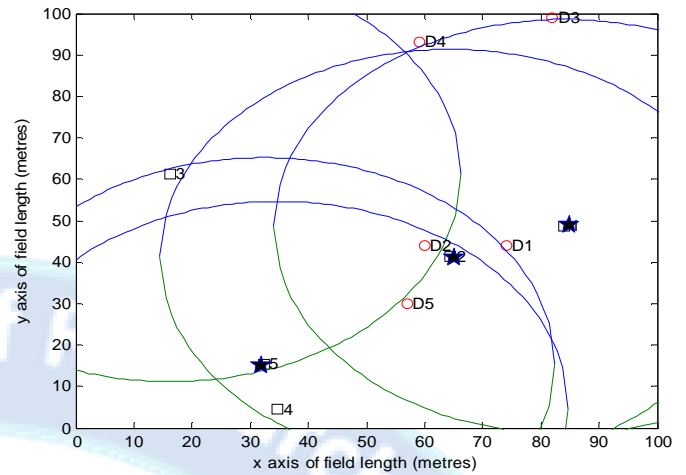


**Fig. 1. The WSN network with sensor devices are in square marker heading towards destination as red circle.**

The communication range and the maximum movement distance per times step  $\delta$  are known to each node. The circles shows the range area upto which a node can transfer its data. Hence the surrounding nodes which lie under the range circle of particular node are considered as neighboring node. The communication range of each nodes are shown in the fig 2.



**Fig. 2: The sensor nodes with their encircled range.**



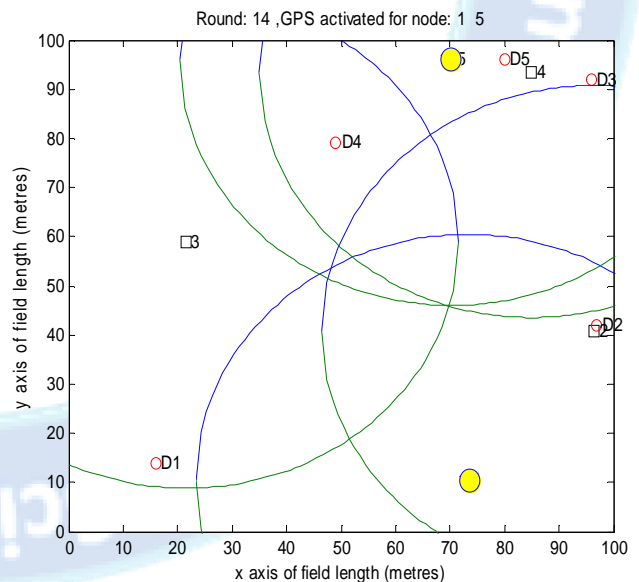
**Fig. 3. Complete Network status with Node and destination Id.**

In this algorithm 5 nodes are considered with node id (1,2,3,4 and 5)at different initial position are randomly allotted in an area of 100 x 100 m<sup>2</sup> as given below:

Node Initial position :

Id	x pos	y pos
1	81	10
2	91	28
3	13	55
4	91	96
5	63	96

We have considered that each node as a range of 50 m radius encircled in this radius the node can communicate with the nearby nodes and these nodes are considered as the first neighbor.



**Fig. 4. Network diagram with randomly distributed nodes.**

Figure 1 shows the network diagram and node placement. Here x and y axis are field branches of 100 m and nodes are with square markers with node id numbering 1,2 ,3 ,4 and 5.Each node is heading towards its destination shown by

circles and identified by names D1,D2,D3,D4 and D5. Initially the nodes which are under range circle of the given node are considered as first neighbor nodes. The nodes which are the neighbor of first neighbor node are considered as second neighbor node. For example at initial step i.e. step 1 for above mentioned node positions the first neighbors are:

Step :1

node 1 has neighbour node 2

node 2 has neighbour node 1

node 3 has neighbour node

node 4 has neighbour node 5

node 5 has neighbour node 4

Above table shows that node has node 2 as first neighbors ('fngnbr') and similarly node 2 3 4 and 5 has 1, none, 5, 4 as the first neighbor.

fngnbr = [2] [1] [1x0 double] [5] [4]

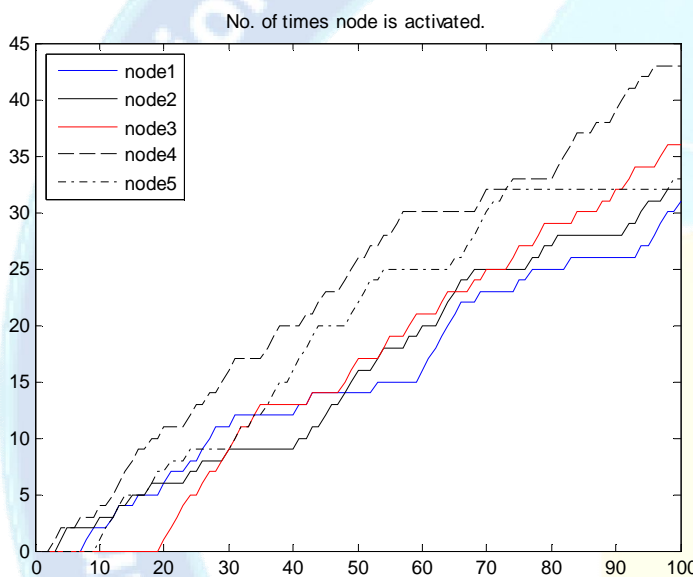


Fig. 5. Number of times the node GPS is activated in 100 rounds.

Fig 5 shows that each node is activating its GPS in particular round when the positional error increases above a threshold. We can see that in total 100 rounds nodes has activated its GPS in 25 to 45 rounds only Hence it shows that nodes are not required to keep their GPS ON always they only consumes energy in position localization out of 25% to 45 % times thus it reduces the energy consumes and helps in enhancing the network lifetime.

### 5. Conclusion:

The improvement in mean positional error of by GPS activation energy as per error calculation in node to its first and second neighbour is performed and compared with the other strategy. It is noteworthy that the proposed strategy is superior to the random strategy in all instances. The proposed strategy performs best compared others when the node speed is low and an appropriate threshold is used. As the node speed expands the positional error becomes drastically with node speed. The simulation can respond to the increasing positional error by activating more GPS units. When the node speed is lower the positions of the nodes are

changing slowly which causes the change in error with respect to time to be lower. Therefore when the node speed is low and the error threshold is high it can take many time steps before a GPS unit is activated. The error threshold parameter for our strategy should be chosen carefully to balance the trade-off between energy consumption and the mean positional error. The plots of the mean positional error accomplished for the positional algorithm working under the methodology for a scope of node speeds. There is little advantage to picking a error for little edge subsequent to there is no adjustment in the mean positional error and the reduction in GPS activation is very small. When thresh hold is large the positional error starts to increase and the number of GPS activations starts to decrease quickly. It is the region above a threshold where a tradeoff between energy usage and positional error occurs. It is notable that the rate of change in energy usage is greater than the rate of change in the positional error in the intermediate. The fractional improvement in positional error that the random strategy achieves over the fixed strategy. The improvement diminishes as the maximum node speed  $\delta$  increases. The advantage of random activation of GPS units decreases as the mean number of GPS units per time step increases.

### Reference:

- [1] Choi, y.-g., kang, j., and nyang, D., "Proactive code verification protocol in wireless sensor network. Lecture Nodes in Computer Science", 2007 vol. 4706, 6, Springer, 1085–1096.
- [2] Neda Enami et. al., " Energy Based Clustering Self Organizing Map Protocol For extending Wireless Sensor Networks lifetime and coverage", Canadian Journal on Multimedia and Wireless Networks Vol. 1, No. 4, August 2010.
- [3] Neda Enami, Reza Askari Moghadam, Kourosh Dadashtabar & Mojtaba Hoseini, "Neural Network Based Energy Efficiency In Wireless Sensor Networks: A Survey", International Journal of Computer Science & Engineering Survey (IJCSSES) Vol.1, No.1, August 2010.
- [4] Guangjie Han, Huihui Xu, Trung Q. Duong, Jinfang Jiang, and Takahiro Hara, "Localization algorithms of Wireless Sensor Networks: a survey" Springer Science, Business Media, LLC 2011.
- [5] Arvinderpal S. Wander, Nils Gura, Hans Eberle, Vipul Gupta, Sheueling Chang Shantz, "Energy Analysis of Public-Key Cryptography on Small Wireless Devices", Hans Eberle, 24 November 2015.
- [6] Mert Bal, Min Liu, Weiming Shen, Hamada Ghenniwa, " Localization in Cooperative Wireless Sensor Networks: A Review", IEEE International Conference on Computer Supported Cooperative Work in Design, Santiago, Chile, April 22-24, 2015.
- [7] Li, S., Xu, C., & Yang, Y., "Getting mobile beacon path for sensor localization. Journal of Software", 2008, 19(2), 455–467.
- [8] S. Srivathsan and S.S. Iyengar, "Minimizing Latency in Wireless Sensor Networks - A Survey," Proc. of Advances in Computer Science and Technology, ACST 2007, Phuket, Thailand, pp. 559, 2007.