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# A low energy based event driven and secure node deployment protocol for Wireless Medical Sensor Network

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## ABSTRACT

A wireless sensor network consists of a huge number of sensor nodes associated via wireless medium. Nodes in a WMSN(Wireless Medical Sensor Network) are organized with limited battery energy and thus improvement on network lifetime by reducing energy-usage is of extreme important. One of the solutions to minimize such energy-usage is associate clustering of network nodes. In this paper an associate clustering scheme in WMSN is proposed where cluster heads are formed by creating a probable associate list is in descending order in which cluster heads are organized according to their residual energy. We have conducted simulation-based evaluations to compare the performance of EEACPSC against Energy Aware Coverage Preservation and Lifetime Enhancement Protocol (EACPLEP) and Enhanced-Energy Efficient Protocol with Static Clustering (E3PSC). Our experiment results show that the performance of present scheme is much better than the previous one. And it provides better result. 40.3% gain of EEACPSC over E3PSC and 25.3% gain over EACPLEP in terms of number of nodes alive in the network.

**KEY WORDS:** CLUSTER HEAD, NETWORK LIFETIME, ENERGY EFFICIENCY, WIRELESS MEDICAL SENSOR NETWORK

## INTRODUCTION

Innovations in industrial, home and automation in transportation represent smart environments. Data for smart environments are obtained through Wireless Medical Sensor Networks (WMSN), where thousands of sensors are deployed at different locations operating in different modes, (Cook et al, 2004). A sensor network is capable of sensing, processing and communicating which helps the base station or command node to observe and react according to the condition in a particular environment (physical, battle field, biological) (Sohraby et al, 2007). Sensor network protocols have a unique self-organizing capability. Another interesting feature of WMSNs is

that the sensor nodes cooperate with each other. Sensor nodes have an in-built processor, using which raw data are processed before transmission. These features facilitate wide range of applications of WMSNs ranging from biomedical, environmental, military, event detection and vehicular telematics, (Akyildiz et al, 2002). In this paper we assume a sensor network model, similar to those used in (Mandal et al, 2018), with the following properties:

- All sensor nodes are immobile and homogeneous with a limited stored energy.
- The nodes are equipped with power control capabilities to vary their transmitted power.
- None of the nodes know their location in the network.
- Each node senses the environment at a fixed rate and always has data to send to the base station.
- Base station is fixed and not located between sensor nodes.

In this paper, we propose EEACPSC (An Enhanced Energy Aware Coverage Preservation with Static Clustering), a hierarchical static clustering based protocol, which eliminates the overhead of dynamic clustering and as a result prolongs the network lifetime. In this scheme, cluster heads are selected by creating a probable associate list where cluster heads are organized according to their residual energy and all the rounds are divided into iteration. The rest of paper is organized as follows. Section 2 describes the proposed scheme followed by the supporting algorithm. Performance-evaluation (Mandal et al, 2019) and simulation results are presented in section 3. The entire work is concluded in section 4 and 5.

## PROPOSED SCHEME

This section contains the proposed scheme, An Enhanced Energy Aware Coverage Preservation with Static Clustering (EEACPSC) followed by the algorithm of the proposed scheme. The present scheme is a modification of an existing scheme, An Enhanced Energy-Efficient protocol with Static Clustering (E3PSC) [Loscri V et al, 2005] and Energy Aware Coverage Preservation and Lifetime Enhancement Protocol (EACPLEP) [Junepei et al, 2004]

In the present work, cluster heads are choose by creating a probable associate list for next n number of rounds and the entire cluster heads are organized according to their residual energy.

### Algorithm (EEACPSC)

1. BEGIN
/* Setup Phase (tasks are performed by the base station) */
2. Form $k$ clusters taking n randomly distributed nodes based on distance
/* Same as EACPLEP */
3. For i ← 1 to k

4. Compute mean position of node distribution, mean in $cluster_i$
5. for j ← 1 to $m_i$
/* $m_i$ → No. of nodes in $cluster_i$ */
6. Compute distance of $node_j$ from $P_{mean\ i}$, $d_{mean\ i}$
7. End For
8. Select Temporary Cluster Head ($TCH_i$) randomly for $cluster_i$
9. Create TDMA schedule for the nodes of $cluster_i$
10. for j ← 1 to $m_i$
11. Send 3-tuple ($TCH_i$, TDMA, $d_{mean\ i}^{\ j}$) data to $node_j$
12. End For
13. End For
/* End of Setup Phase */
14. For v ← 1 to round
/* round → Total no. of rounds */
/* Responsible Node Selection Phase */
15. For i ← 1 to k
16. For Alive_node ← 1 to $m_i$
/* Alive_node → Nodes whose residual energy is greater than or equal to threshold energy (Eth) */
17. Send 2-tuple ($d_{mean\ i}^{\ j}$, $E_{residual\ i}^{\ j}$) information to $TCH_i$
18. End For
/* $TCH_i$ performs the following tasks */
19. Call Responsible_Node_Selection()
/* Select $CH_i$ for the current round Select $TCH_i$ for the next round */
20. End For
**/* Steady-State Phase */**
21. For i ← 1 to k
22. For Alive_node ← 1 to $m_i$
23. Send data to $CH_i$
/*Data transmission by Alive_node(s) */
24. End For
25. Send aggregated data to the base station /* Data transmission by $CH_i$ */
26. End For
27. End For /* End of rounds */
28. END /* End of Algorithm */
**Responsible_Node_Selection( )**
1. BEGIN
2. For i ← k /* Creating a list of probable $CH_i$. */ /*k=length (Cluster.nodes)*/
3. RGroup=[ ]; /*R denotes Right*/
4. LGroup=[ ]; /*L denotes Left*/
5. if ~isempty([Cluster.TCH])
6. for i=1:k
7. if $R_{energy} > L_{energy}$
8. [C,T]=ISelection(Anode,RGroup,Eth); /* Select the node from right group*/
9. else
10. [C,T]=ISelection(Anode,LGroup,Eth); /* Select the node from left group*/
11. End
12. $CH_i$=C;
13. $TCH_i$=T;
14. Else
15. $CH_i$=[ ];
16. $TCH_i$=[ ];
17. end
/*End of Algorithm */

# PERFORMANCE COMPARISON

## Qualitative Analysis

The network lifetime is defined in terms of energy-usage. The associate list is determined in such a manner that presence of cluster head within a list is sufficient and further, to keep the network alive, probable list needs to be associated. To declare the network alive, we can say that for every round the cluster head with maximum energy among all the pre-decided cluster heads within that list should be greater than a threshold energy level $E_{threshold}$ beyond which the node is considered as a dead. Since this must hold for every round, we can easily considered that only the minimum of these energies should be above $E_{threshold}$ thereby guarantees that each round has sufficient energy to keep the network alive.

## Quantitative Analysis

### Simulation Environment

To evaluate the performance of EEACPSC, MATLAB 7.1 is used as a simulation tool. We consider that the sensor nodes are deployed randomly across in plain area of ($x_m$ = 100m X $y_m$ = 100m) and the base station is located (x=50, y=175). Each node is equipped with equal amount of initial energy (2J) at the beginning of the simulation. Further we assume that WMSN is working in continuous data flow application domain. Table 1 represents various parameters and their values used in simulation.

### Simulation Metric

The performance of the scheme is evaluated considering network lifetime as a parameter which is defined as the time until the last node dies in the network. Network lifetime is measured using following yard-stick.

- Number of nodes alive in the network : more number of nodes alive involves network lifetime last longer.
- 3D result: results are in 3D format which outperforms better performance as compare to E3PSC and EACPLEP.

# RESULTS AND DISCUSSION

A set of experiments is conducted to compare the performance of present scheme EEACPSC with E3PSC (Zahmati et al, 2007) and EACPLEP (Lindsay et al, 2002).

Fig.1 shows that, after 26 seconds, only 67 nodes are alive over the network.

Fig. 2 shows that, after 26 seconds, only 75 nodes are alive over the network.

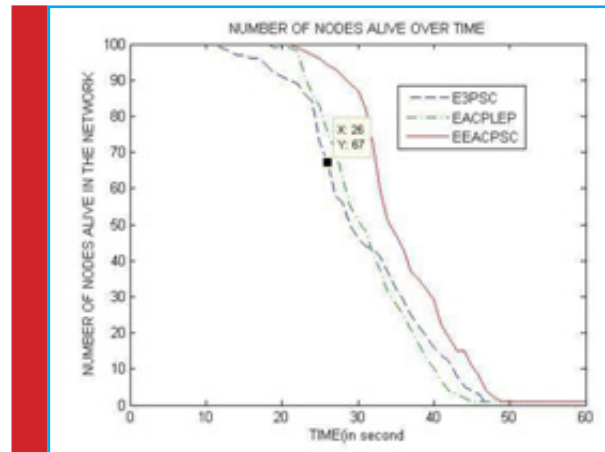| Table 1. Parameters and Corresponding Values used in Network Simulation for Medical Sensor Network | |
|---|---|
| Parameter | Parameter's Name |
| Network Area | 100m X 100m |
| Base Station's Position | (50m, 175m) |
| Initial Energy for Nodes | 2 Joule |
| Number of Deployed Nodes | 100 |
| Size of Data Message | 4000 bits |
| Energy Consumed in Data Aggregation(EDA) | 5nJ/bit/signal |
| Energy Consumed by Transceiver's Circuitry (Eelec) | 50nJ/bit |
| Energy Expenditure in Transmit-Amplification in free-space model(efs) | 10pJ/bit/m2 |
| Energy Expenditure Transmit-Amplification in multipath fading model (Emp) | 0.0013pJ/bit/m4 |



FIGURE 1. Comparison of EEACPSC with E3PSC in terms of number of nodes alive in the network over time
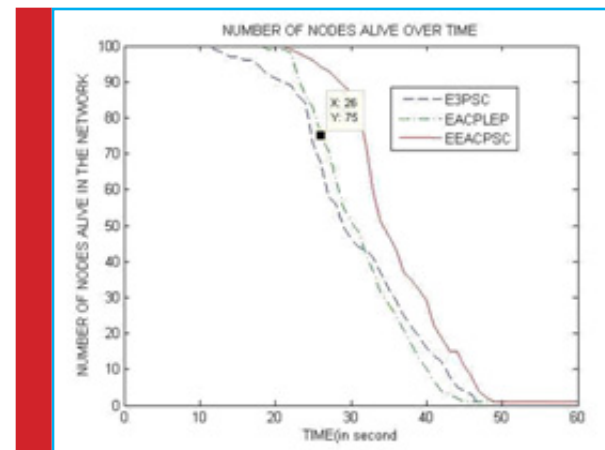


FIGURE 2. Comparison of EEACPSC with EACPLEP in terms of number of nodes alive in the network over time
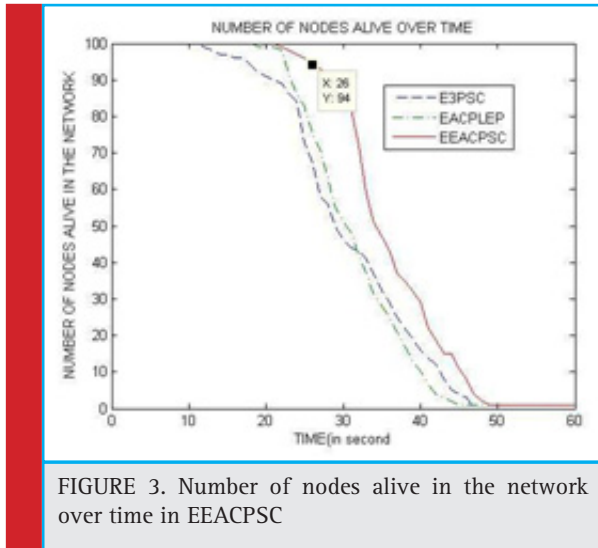
FIGURE 3. Number of nodes alive in the network over time in EEACPSC



FIGURE 5. Number of nodes alive over time in EACPLEP (3D)

Fig. 3 shows that, after 26 seconds, 94 nodes are alive over the network.

After comparing these 3 graphs we conclude that the performance of present scheme is much better than the previous one. And it provides better result. 40.3% gain of EEACPSC over E3PSC and 25.3% gain over EACPLEP in terms of number of nodes alive in the network. Following are the representation of 3D graphs.

In fig 4, there is a deployment of 150 nodes instantly and after 460 seconds there are 145 nodes alive in the network.

Fig.5 indicates that, after 460 seconds, there are 150 nodes alive over the network.

Fig.6 shows that, after 460 seconds, 155 nodes are alive over the network.

After comparing these 3D graphs, we conclude that the performance of present scheme is better as compare to previous scheme. 6.89% gain of EEACPSC over E3PSC
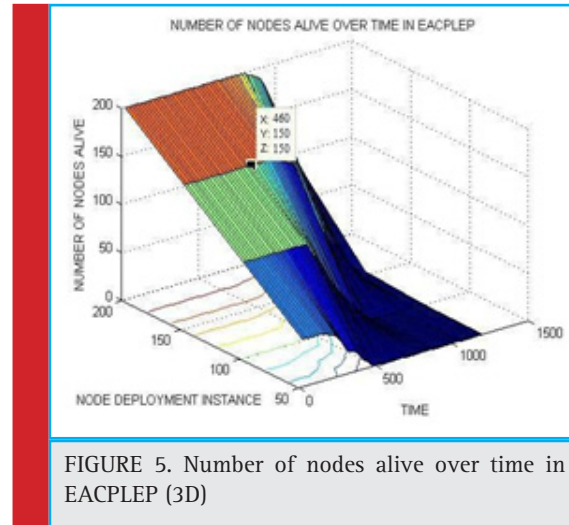
and 3.33% gain over EACPLEP in terms of number of nodes alive in the network.

In this paper an energy-efficient routing scheme EEACPSC for WMSN is proposed. The EEACPSC is developed by modifying an existing routing scheme E3PSC and EACPLEP with an objective to prolong network lifetime further (more number of nodes alive in the network). With the results of simulation, we can conclude that in the case of EACPLEP, the intra-cluster communication is increased, which is removed in the EEACPSC, because the cluster head will be choose on the basis of creating a probable list of nodes.

So the energy dissipated in the node to cluster head is less than the EACPLEP. And it organizes by the 3D graph also. So we can say that EEACPSC is more energy efficient and coverage preserving as compare to E3PSC and EACPLEP and spatial allocation of nodes plays a vital role in the election of cluster-heads for network opera-
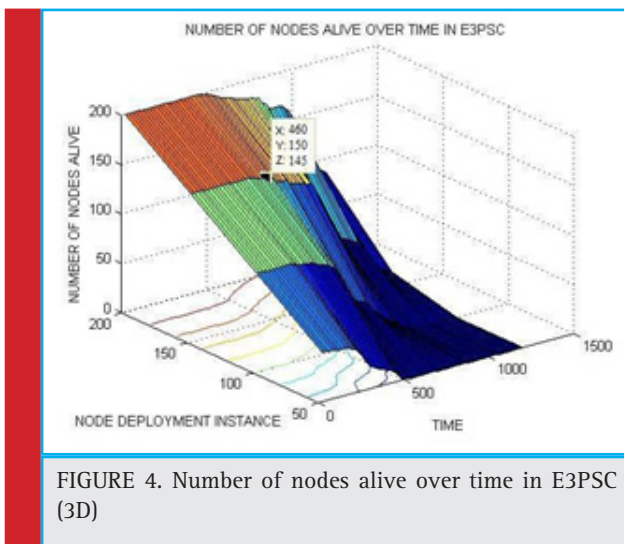


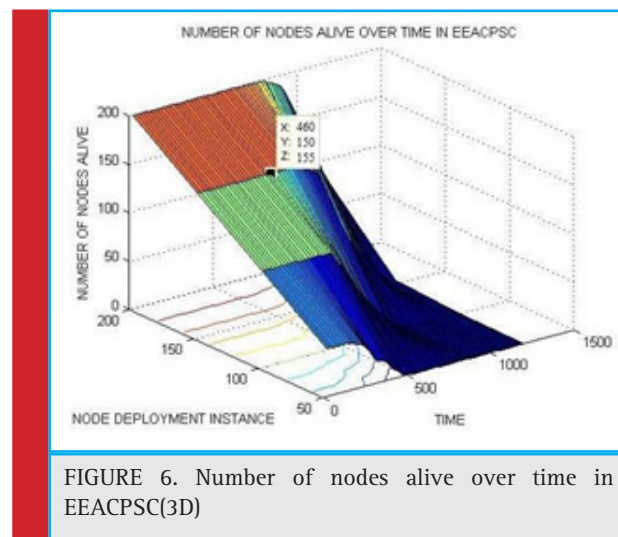FIGURE 4. Number of nodes alive over time in E3PSC (3D)



FIGURE 6. Number of nodes alive over time in EEACPSC(3D)

tion. As per the quantitative results, EEACPSC proves to be better performer than EACPLEP and E3PSC.

As future work, we intend to study more complicated situations, like coverage problems in case of mobile nodes, heterogeneous sensor networks consisting nodes of different capabilities, and other non-disk coverage models.

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