# ENERGY EFFICIENT TARGET TRACKING IN WIRELESS SENSOR NETWORK

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***ABSTRACT***

*Energy Efficiency has been a main challenge in Wireless sensor networks (WSNs) and their applications such as battlefield surveillance, target monitoring etc. Target tracking is one of the most important of these applications. We understand the problem of conserving energy of sensor node in WSNs. In this paper, target tracking is done using new algorithm Hope Counting Tracking Algorithm (HCTA) based single hop routing technique and LEACH (Low Energy Adaptive Clustering Hierarchy) based tracking and routing. We simulate cases, HCTA based single hop routing technique and LEACH (Low Energy Adaptive Cluster Hierarchy) based cluster routing on Castalia simulator with same parameter and analyse result.*

***KEYWORDS:*** *Data Aggregation, Energy Efficiency, Target Tracking, Wireless Sensor Network*

## I. INTRODUCTION

Wireless sensor network is consisting of numerous light weight and tiny sensor nodes with limited power, storage, communication and computation capabilities. Each such sensor network node has typically several parts, a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source usually a battery. The task of the sensor nodes is to collectively monitor physical or environmental situation, such as temperature, motion, sound, vibration, pressure etc. as described in [1][2] and [3]. The sensor network deployed for the deliberate applications such as environmental monitoring and battle field surveillance to condition based maintenance applications. Target tracking and localization appear as an essential part of most of these applications and thus, here we focus on developing a novel target tracking approach.

The sensor nodes are commonly battery powered and difficult to recharge or replace battery. These facts accentuate the importance of devising energy conservation techniques for WSN. Energy efficient algorithms in WSN certainly help to prolong the network lifetime. Challenge concerning energy limitation of WSN, in this paper we can use minimum number of sensor node to trace of mobile target (e.g. enemy vehicle or tank) for an energy efficient approach. Tracking area can be defined where target possibility to reach its current position in [4]. We can reduce the number of working sensor nodes and gathering data of target's trajectory. Data aggregation and clustering process are required for transmitting data to base station. Data aggregation technique eliminates redundancy in source data [5].

Low Energy Adaptive Clustering Hierarchy ("LEACH") is a TDMA-based MAC protocol which is integrated with clustering and a simple routing protocol in wireless sensor networks. LEACH (Low Energy Adaptive Clustering Hierarchy) is designed for sensor networks where an end-user wants to remotely monitor the environment. In such a situation, the data from the individual nodes must be sent to a central base station, often located far from the sensor network, through which the end-user can access the data.[6][7]

The rest of this paper is organized as follows: in Section II, we briefly discuss the related work and Section III, we describe our proposed tracking algorithm. In Section IV, discuss energy model. Finally in Section V, covers the simulation results and analysis.

## II. RELATED WORK

One of the primary research issues of wireless sensor network is energy, because all the wireless sensor network devices are more energy constrained and we can't change battery frequently. To improve network life time it is require that each node should spend minimum energy during routing the target tracking data packet. Clustering is one of the technique that can be used to minimized traffic by performing aggregation of data lots of processing overhead of other nodes can be reduce. We have increased system robustness and tracking accuracy.

Target tracking in WSN is a main area of research in various fields such as battlefield surveillance, disaster management, wildlife monitoring [8]. There are several tracking algorithms where sensor node transmits its sensing information towards a processing node which acts as a central processor and fuses the report collected from all sensing nodes [9], it is centralized approach. Minimal Contour Tracking Algorithm target tracking based on the vehicular kinematics in [4], optimization of tracking area and minimization of communication energy consumption. Target tracking in Single hop routing, sensing node communicate with the closest neighbour in multiple path mode, nodes route data destined ultimately to the base station through intermediate nodes [10].

Tree-based, cluster-based and hybrid method are tracking algorithm in hierarchical network. Tree-based methods organize the network into a hierarchy tree. Examples of tree-based methods include OCO (Optimized Communication & Organization) [11], DCTC (Dynamic Convoy Tree-based Collaboration) [12], STUN (Scalable Tracking Using Networked Sensors) [13]. OCO is a tree-based method for target tracking that provides self organizing and routing capabilities with low computation overload on sensor nodes. DTDC algorithm, dynamically constructs a tree for mobile target tracking and depending on the target location, a subset of nodes participate in tree construction. STUN a cost is assigned to each link of network graph, tree construct based on cost. Cost is computed from the Euclidean distance between two nodes. Leaf nodes collect information of moving target and transmit data to sink node through intermediate node.

Routing model schemes are "Address-centric Protocol" and "Data-centric Protocol". In the AC protocol each source independently sends data along the shortest path to sink and DC protocol can look at the content of the data and perform aggregation on multiple input packets. In which multiple input packets can be aggregated into a single output packet using simple aggregation function.[5]

We can reduce the number of working sensor nodes and gathering data of target's trajectory. Data aggregation and clustering process for transmit data to base station. Data aggregation technique eliminating redundancy in source data[4].

Cluster- based target tracking algorithm, clustering algorithms are more energy efficient compared to the direct routing algorithms. Network is divided into clusters and each cluster elects cluster head (CH) based on energy level[5][6][7]. CH transmits target information to base station or sink node. Overall minimizing the number of transmissions and thus extending the life of WSN.

## III. PROPOSED TRACKING ALGORITHM

Step 1: (t, p, v) ←Retrieve Target Information
Step 2: H ←Hop Counting (RSSI)
Step 3: SN position ←Get SN Position ()
Step 4: flag ←Am I Sensing Target (Hs, SN position)
Step 5: if flag = TRUE then
Step 6: Start Sensing Broadcast (Target info. t, v, p)
Step 7: end if

Perform tracking based on proposed algorithm Hop Counting Tracking Algorithm, sensing node broadcast target information using target movement such as time t, position p, velocity v. Those sensor nodes receive broadcast message they receive signal strength indicator (RSSI) value of

broadcast message and according to receive signal strength indicator value compare with fix RSSI value and check their position.
If RSSI value is greater than fix RSSI value then this sensor node is nearer neighbour of sensing node. This sensor node warms up its sensing device for tracking target accurately. Sensor node starts sensing target information then broadcasts new information to neighbour node and same process follows for neighbour node. It is tracking target accurately and minimize active node conserve energy.
If RSSI value is lesser or equal to fix RSSI value then this sensor node will be remain sleep mode. so, overall sensor network lifetime increase.
In this paper, we design goal target tracking using minimum number of nodes and reduces transactions of transmission and reception signals for conserving energy.

## 2.1. Single hop routing

The single hop routing technique was initially used in wired network. In recent years, such technique is extended to wireless ad hoc and sensor networks. Each node communicate with the closest neighbour in multiple path mode, nodes route data destined ultimately to the base station through intermediate nodes[10].

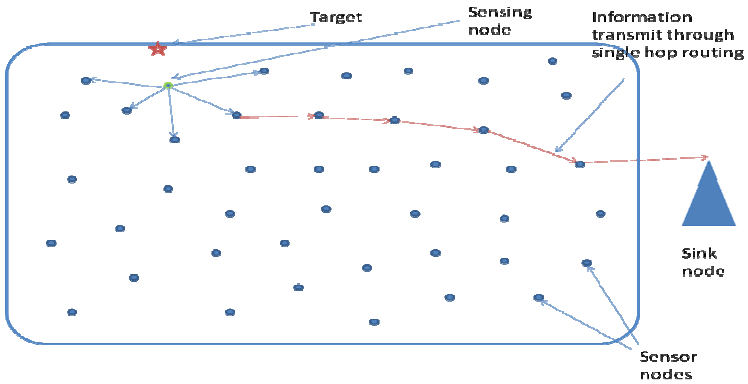


**Figure 1.** Target tracking using HCTA and single hop routing scenario.

In proposed algorithm sensing node broadcast target information using target movement such as time t, position p, velocity v. Neighbour node best route with the lowest cost and target's movement information route towards sink node.

## 2.2. LEACH based tracking and routing

LEACH forms clusters by using a distributed algorithm, where nodes make autonomous decisions without any centralized control. Our goal is to design a cluster formation algorithm such that there are a certain number of clusters, during each round. LEACH provides a balancing of energy usage by random rotation of cluster heads. The algorithm is also organized in such a manner that data-fusion can be used to reduce the amount of data transmission. The decision of whether a node elevates to cluster head is made dynamically at each interval.

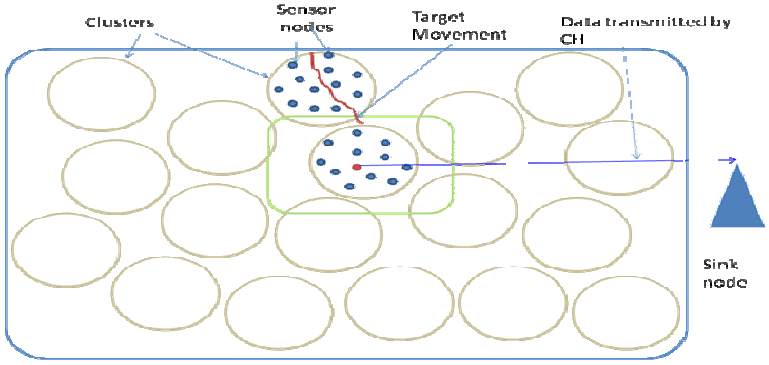


**Figure 2.** LEACH based tracking and routing scenario

The cluster head must be awake to receive all the data from the nodes in the cluster. Once the cluster head receives all the data, it performs data aggregation to enhance the common signal and reduce the uncorrelated noise among the signals [6].

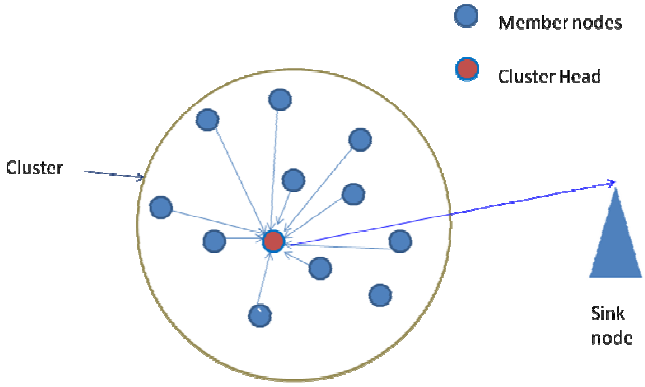


**Figure 3.** Each cluster have a CH and information receive from member nodes

The resultant data are sent from the cluster head to the BS. Since the BS may be far away and the data messages are large, this is a high-energy transmission so, ensure low energy dissipation in the nodes and no collisions of data messages within a cluster. It is useful to minimize transmission and reception process and conserve sensor node's energy [6].

## IV. ENERGY MODEL

The resource manager module of Castalia is responsible to calculate amount of energy used in different operations like transmission, reception etc. The default value is 18720 joules it is a typical energy of AA battery. Energy is linearly subtracted based on overall power drawn and time passed. Modules that model hardware devices (i.e., the radio and the sensor manager) send messages to the resource manager in order to signal how much power they currently draw. Energy consumption by radio module is separately defined by Castalia [14]. To define the main operating parameters of a radio Castalia follows a specific format. Castalia defines 2 radios: CC1000 and CC2420. CC2420 and CC1000 define the real radios of the same name by Texas Instruments. For evaluating simulation performance we have used CC2420 radio.

## V. SIMULATION RESULTS AND ANALYSIS

In this section, using computer simulation performance of proposed algorithm. Our simulation is done in OMNET++ platform based Castalia simulator.
We compare our proposed HCTA based tracking and single hop routing with LEACH based tracking and clustering routing. We have pass random target through wireless sensor network and use below parameters to evaluate simulation performance.

**Table 1.** Simulation parameter

| Parameter name | Value |
|---|---|
| Simulation second | 100 sec. |
| Area | 30X30m, 60X60m, 90X90m, 120X120m, 180X180m |
| Number of nodes | 30,60,90,120,180 |
| Sink node | Node 0 |
| Radio parameter | CC2420 |
| TX Power | -5dbm |
| MAC protocol | TMAC |

We have created different scenario and implement on Castalia simulator, like as we had deployed 30 nodes in 30m X 30m region then passing target in sensor region and monitoring variation in energy level on each sensor node. Same as 60 sensor nodes was deployed in 60m X 60m region, 90 sensor nodes was deployed in 90m X 90m region, 120 sensor nodes was deployed in 120m X 120m region and 180 sensor nodes was deployed in 180m X 180m region. Table 2 shows average consumed energy in millivolt of all sensor nodes in particular scenario.
In 30X30 region 30 sensor nodes are deployed than performed base on HCTA there average of 30 nodes consume 6.797 millivolt and 4.225 millivolt by LEACH so, HCTA algorithm 37.84% more consume energy than LEACH. Similar ways energy comparisons given in the Table 2.

**Table 2.** Energy consumed by sensor node

| Region | Sensor nodes | HCTA (mV) | LEACH (mV) | Variation in (%) |
|---|---|---|---|---|
| 30X30 | 30 | 6.797 | 4.225 | 37.84 |
| 60X60 | 60 | 6.902 | 4.413 | 36.06 |
| 90X90 | 90 | 7.241 | 4.576 | 36.80 |
| 120X120 | 120 | 7.937 | 4.700 | 40.78 |
| 150X150 | 150 | 9.241 | 4.908 | 46.88 |
| 180X180 | 180 | 11.081 | 5.310 | 52.08 |

Table 3 shows average transmitted packets of all sensor nodes in particular scenario and calculate how many numbers of packets are transmitted by each sensor node and calculate how many numbers of packets transmitted of each sensor node. Like as 30 sensor nodes deployed in 30X30 region than performed base on HCTA there average of 30 nodes transmitted 49.968 data packets and LEACH transmitted 11.700 data packets for tracking target. Similar ways other scenario transmitted number of packets as per Table 3, LEACH require minimum transmission process for tracking target.

**Table 3.** Nos of packets transmitted data

| Region | Sensor nodes | HCTA | LEACH |
|---|---|---|---|
| 30X30 | 30 | 49.968 | 11.700 |
| 60X60 | 60 | 72.350 | 18.083 |
| 90X90 | 90 | 92.627 | 24.733 |
| 120X120 | 120 | 135.011 | 40.219 |
| 150X150 | 150 | 241.630 | 63.407 |
| 180X180 | 180 | 408.193 | 88.112 |

Table 4 shows average received breakdown packets at receiver of all sensor nodes in particular scenario and calculate how many numbers of packets breakdown of each sensor node. Like as 30 sensor nodes deployed in 30X30 region than performed base on HCTA there average of 30 nodes breakdown data packets 21.194 and 5.452 data packets breakdown by LEACH at receiver for tracking target. Similar ways other scenario breakdown number of data packets as per Table 4, LEACH minimize data loss.

**Table 4.** Nos of packets breakdown data

| Region | Sensor nodes | HCTA | LEACH |
|---|---|---|---|
| 30X30 | 30 | 21.194 | 5.452 |
| 60X60 | 60 | 38.754 | 10.869 |
| 90X90 | 90 | 45.560 | 19.725 |
| 120X120 | 120 | 56.785 | 26103 |
| 150X150 | 150 | 80.312 | 35.714 |
| 180X180 | 180 | 102.191 | 47.357 |

As per simulation, we generate graph based on number of sensor nodes vs energy consumed by sensor node.

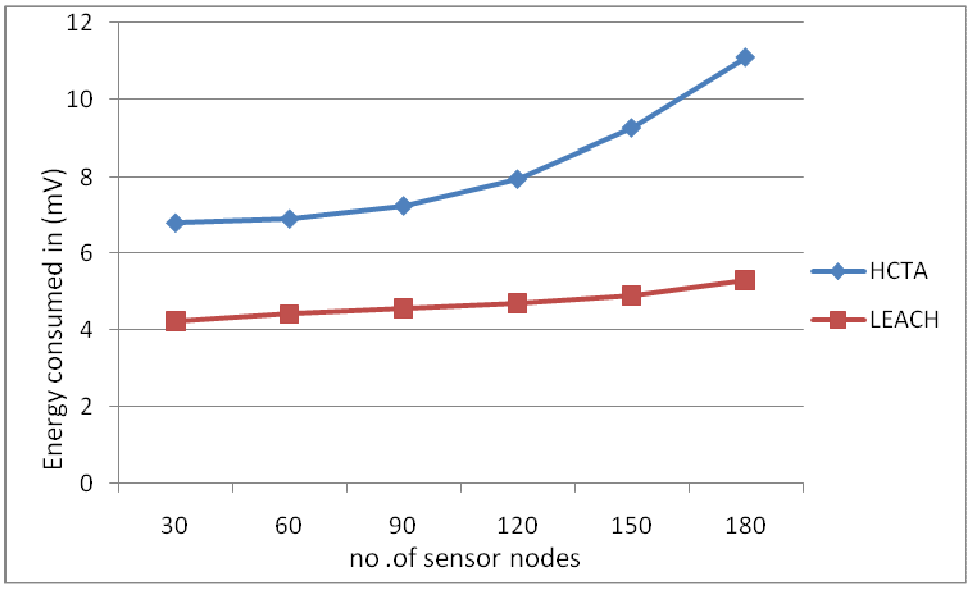


**Figure 4.** Energy consumed by sensor node

As per simulation, we generated graph based on number of sensor nodes vs. number of packets transmitted by sensor node.

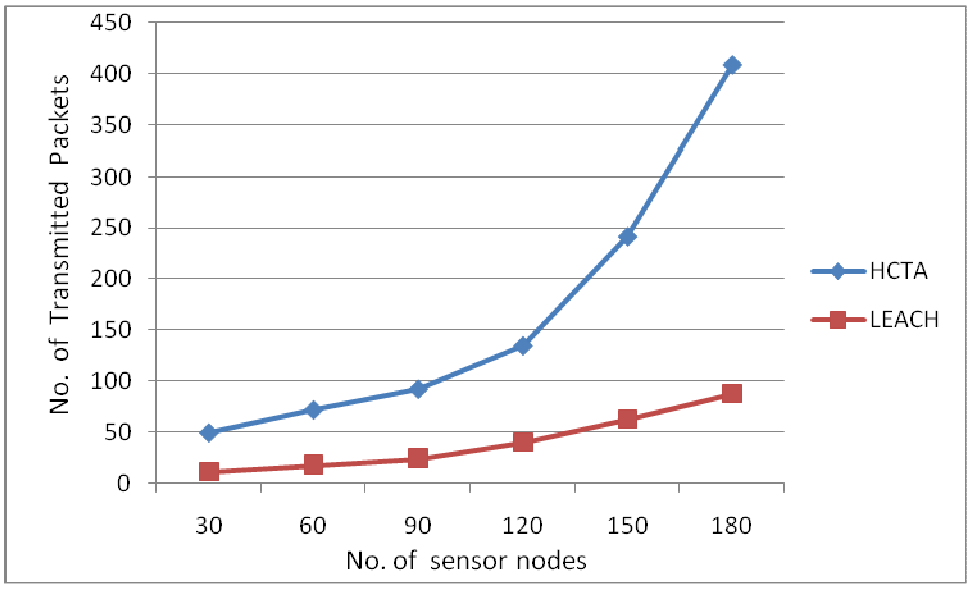


**Figure 5.** Number of packets transmitted by sensor node

As per simulation result, we generated graph based on number of sensor nodes vs number of packets breakdown of sensor node.

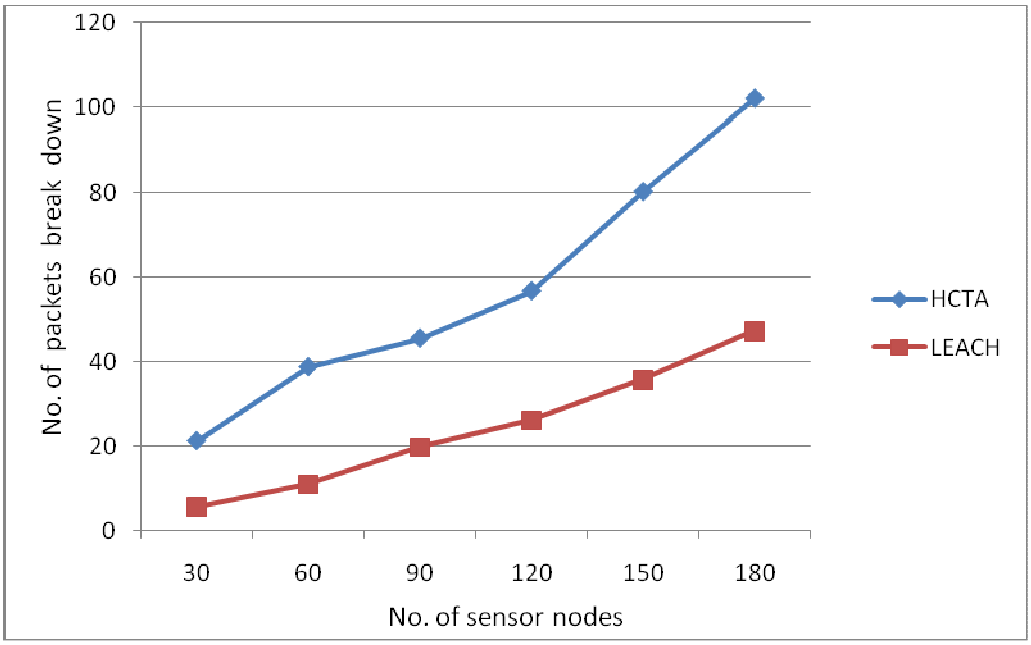


**Figure 6.** Number of packets breakdown at receiver

## VI. CONCLUSION

In this paper, we have discussed HCTA based tracking and single hop routing and LEACH based tracking and clustering routing. LEACH based tracking is divides sensor nodes in cluster. In each cluster CH (cluster head) applies aggregation process on packets then directly transmits to sink node. Thus, minimum packets transmit and packets does not route entire sensor nodes in WSN. CHs in clusters transmit packets based on carrier sense multiple access collision avoidance (CSMA/CA), to prevent collision and minimize transmission and reception process. Overall energy conserve by LEACH during simulation is same.

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