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Energy Efficient Target Tracking Based on HCTA in Wireless Sensor Network

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Abstract— **Energy Efficiency has been a main challenge in Wireless sensor networks (WSNs). Battlefield surveillance, target monitoring, disaster management etc. are very important application of target tracking. This is consuming more energy. We understand the problem of conserving energy of sensor node in WSNs. In this thesis, target tracking is done using novel algorithm, named "Hope Counting Tracking Algorithm (HCTA)". HCTA reduces energy consumption for tracking targets in WSNs during sensing and communication. HCTA based single hop routing technique and LEACH (Low Energy Adaptive Clustering Hierarchy) based clustering routing technique is simulated on Castalia simulator with same parameters and the results analyzed. We find the clustering routing technique reduces the energy consumption by at least 50% as compared to the single hop routing technique.**

Keywords— **Data Aggregation, Energy Efficiency, Target Tracking, Wireless Sensor Network**

I. INTRODUCTION

We Wireless sensor network is consisting of numerous light weight and tiny sensor nodes. Tiny node is self organized and autonomous device. It has 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 appearance 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 for transmit 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 routing 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 2, we briefly discuss the related work and Section 3, we describe our propose tracking algorithm. Section 4 is energy model. In Section 5, covers the simulation and result analysis.

II. RELATED WORK

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 algorithm 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 toward 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 are collect information of moving target and transmit data to sink node through intermediate node.

Routing model scheme "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 eliminates redundancy in source data [4].

Cluster-based routing algorithm is more energy efficient compared to the direct routing algorithms. Sensor nodes are densely deployed in sensor field. Sensor field divide into clusters and each cluster elect cluster head (CH) based on energy level [5][6][7]. CH reduced gathered data than transmits information to base station or sink node. Overall minimizing the number of transmissions and thus extend the life of WSN.

III. Proposed Algorithm

Proposed algorithm of target tracking is as below:

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, and p)

Step 7: end if

Target tracking perform based on proposed algorithm, HCTA based sensing node broadcast target information such as time t, position p, velocity v. Those sensor nodes who have received broadcast messages they compare receive signal strength indicator (RSSI) with fixed RSSI value. According to receive signal strength indicator value define their position.

If RSSI value is greater than fixed RSSI value then these sensor nodes are nearer neighbour of sensing node. These sensor nodes warm up its sensing device for tracking target accurately. Sensor node start sensing target information then broadcast new information to neighbour node and same process is followed by neighbouring node. It is tracking target accurately and minimizes active node conserve energy and increase network life.

If RSSI value is less or equal to fixed RSSI value then this sensor node will remain in sleep mode.

3.1 Single Hop Routing

Figures 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 communicates with the closest neighbour in multiple path mode, nodes route data destined ultimately to the base station through intermediate nodes [10].

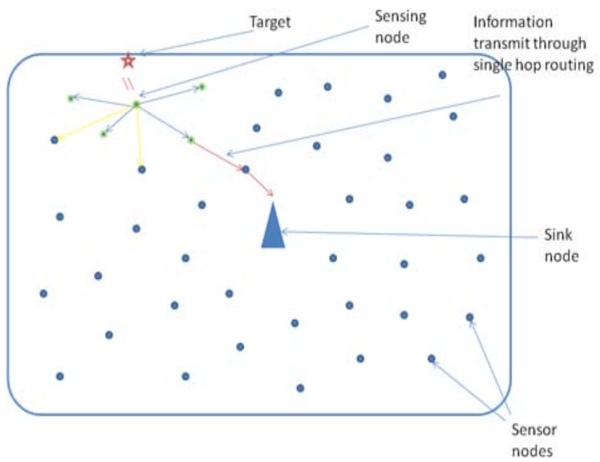

Fig. 1 Single hop routing scenario

Sensing node (Green color node) broadcast target information such as time t, position p, velocity v. Those sensor nodes who have received broadcast messages they compare receive signal strength indicator (RSSI) with fixed RSSI value. Here, we showed neighbour nodes with arrow. There are six neighbour nodes. Four nodes among six nodes were RSSI is greater than flexed RSSI. Here, four arrow links was highlighted with blue arrow link. All four nodes start sensing and retrieve information from target.

Aim of single hop routing protocol to find the best route with the lowest cost and target's movement information route towards sink node. It is tracking target accurately and minimize active node conserve energy. Sensor nodes highlighted with yellow arrow link have RSSI value less then fixed RSSI value then those sensor nodes goes to sleep mode.

3.2 LEACH based Clustering Routing

LEACH operation has been divided in rounds and each round performs two phases. First phase is setup phase. Setup phase performs Cluster Head (CH) selection and cluster formation. Second state is steady state. Steady state performs schedule creation and data transmission.

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. Sensing node is sense target information than broadcast their information as per HCTA.

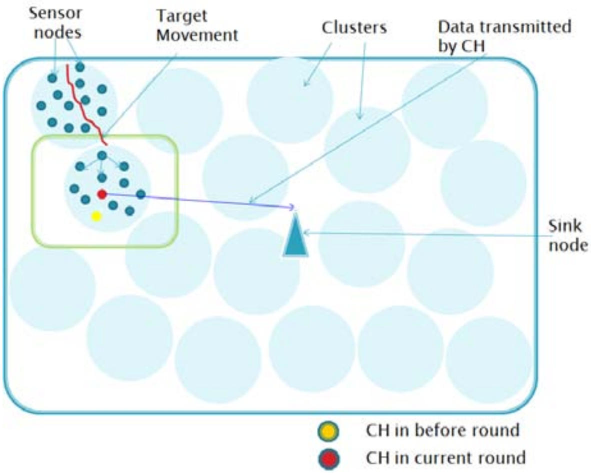

Fig. 2 LEACH based tracking and routing scenario

The cluster head must be awake to receive all the data from sensing 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. In our analysis, we assume perfect correlation such that all individual signals can be combined into a single representative signal. 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. 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.

Above figure 2 previous round cluster head showing yellow colour node. Next round yellow node work as member node and participate in election of cluster head. All nodes follow election procedure and choose new cluster head node. Red node is CH of current round. CH selection process follows throughout tracking activity. The preceding discussion describes communication within a cluster, where the TMAC and routing protocols are designed to ensure low energy dissipation in the nodes and no collisions of data messages within a cluster.

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. Result And Performance

We have used single hop and LEACH routing protocol of Castalia Simulator to simulate our proposed approach so first of all we have studied single hop and LEACH routing protocol and verified its simulation. We have also compared the performance of LEACH routing with single hop routing. Table 1 shows simulation parameters.

Table 1. Simulation Parameter Value

Simulation second	3600 sec
Area	500X1000, 1000X500, 1500X500, 2000X500, 2500X500
Number of nodes	121, 242, 363,484, 605
Deployment type	Uniform
Sink node	Node 0
Sink Position	Center of sensing field
Radio parameter	CC2420
Initial Energy of each node	18720 Joule
MAC protocol	TMAC

We summarize performance of Castalia simulation result based on single hop routing technique and LEACH based routing technique. Average consumed energy in particular scenario and calculate how much energy consumed by each node in mili-watt (mW).

Table 2. Energy consumed by sensor node

Sensor nodes	Single hop (mW)	LEACH (mW)	Varition in (%)
121	20.789	10.143	51.20
242	24.937	12.102	51.46
363	30.241	13.982	53.76
484	38.890	17.551	54.89
605	52.121	20.609	60.45

Table 2 showed average transmitted packets in particular scenario and data are numbers of packets transmitted by each sensor node.

Table 3. No. of packets transmitted data

Sensor nodes	Single hop	LEACH
121	92.350	22.626
242	126.181	29.581
363	165.319	39.703
484	209.522	54.813
605	270.663	70.813

Table 4 showed average received breakdown packets at receiver in particular scenario and data are numbers of packets breakdown of each sensor node.

Table 4. No. of packets breakdown data

Sensor nodes	Single hop	LEACH
121	44.611	9.916
242	61.382	12.624
363	82.747	17.139
484	109.925	25.383
605	139.986	38.569

As per simulation result generate graph basis on number of sensor nodes verses energy consumed by sensor node.

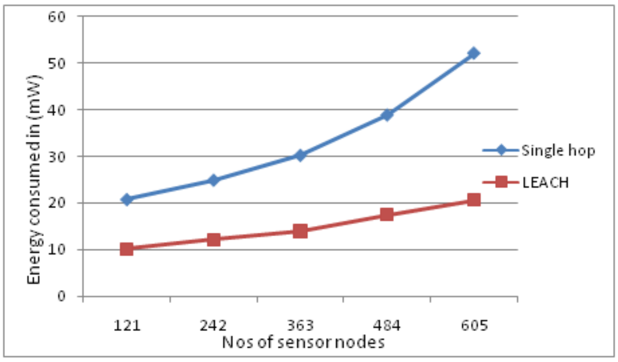

Fig.3: Energy consumed by sensor node

As per the simulation result generate graph basis on number of sensor nodes verses number of packets transmitted by sensor node.

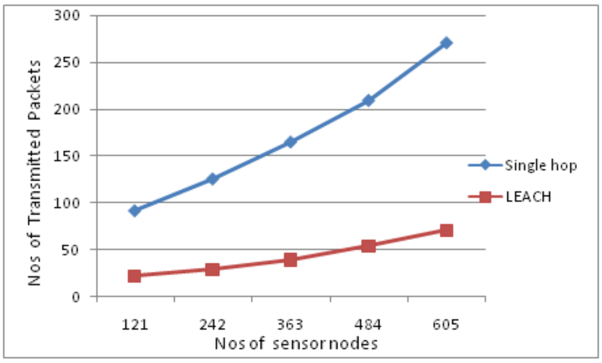

Fig. 4: Number of packets transmitted by sensor node

As per the simulation result generate graph basis on number of sensor nodes verses number of packets breakdown of sensor node.

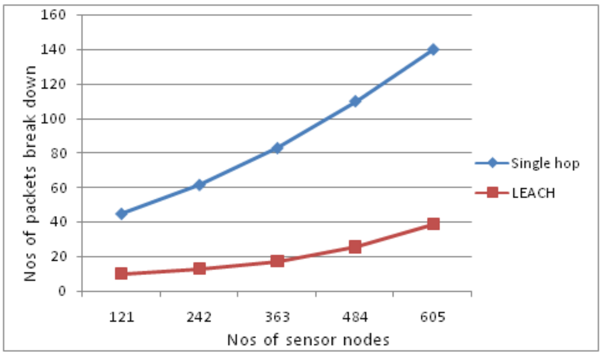

Fig. 5: Number of packets breakdown of sensor node

VI. CONCLUSION

We have proposed novel energy efficient routing technique using target tracking.

A primary task of our proposed algorithm is to measure movement of target accurately using minimum sensor nodes to conserve energy. In clustering routing technique, sensor nodes are divided in clusters. Each cluster is having a Cluster Head (CH) therefore member node reporting to their CH instead of sink node. Here, transceiver process is locally therefore high energetic signal is not required.

Clustering routing technique consumes energy uniformly and it consumes less energy compare to single hop routing technique. Energy efficient tracking and routing technique maximize life time of the network.

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