



HIERARCHICAL LOCALIZATION TRACKING SCHEME FOR WIRELESS SENSOR NETWORKS

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Abstract: Using wireless sensor networks (WSN) to track a moving object provided a practical solution to a wide variety of applications including, for example, wild life, military operations, intruder tracking and monitoring in indoor office buildings. While much work has been done in this area, failures are not considered in most of the existing solutions. However, failures have to be handled carefully in target tracking applications because of their unpredictable and dynamic nature of communication, such as sensor energy depletion, severe environment conditions, unstable communication links and malicious attacks. Traditional approaches of fault tolerance are not well suited to address these new challenges. Therefore we have proposed a Hierarchical Localization Tracking Scheme (HLTS) for the tracking of moving object. Extensive simulations are carried out using NS-2 show that our algorithm achieves good performance.

KEYWORDS: Wireless Sensor Network, Hierarchical Localization Tracking Scheme (HLTS), Tracking, Binary Tree, NS-2

I. Introduction

The technology has improved significantly due to the usage of small, inexpensive, low-power, distributed devices. This has the potential of local processing and wireless communication which helps in the technological improvement. These are called as sensor nodes. By limiting the amount of processing, we restrict the ability of each sensor node. The physical environment can be measured in detail using the sensor nodes, where large number of other nodes co-ordinate to give the information.

Thus the sensor network is a collection of sensor nodes which coordinate to perform some specific action. Dense deployment and coordination which are mainly used in the sensor networks differentiate them from the traditional networks [1]. Industrial, military, biomedical, and environment application areas widely use sensor networks. The sensor network applications include [2]:

- Intrusion Detection and Tracking: The battlefields are equipped with sensors along their borders so that they can detect, classify and track intruding personnel and vehicles.
- Environmental Monitoring: Specialized sensor nodes can detect temperature changes and smoke. These sensor nodes are arranged in high risk areas of a forest in order to provide early warning about forest fires.
- Indoor Surveillance: These surveillance sensor networks can be used for security purposes in an art gallery, or in a shopping mall
- Traffic Analysis: Traffic sensor networks are used to monitor vehicle traffic on a highway or a crowded part of the city.[2]

A. Tracking in Sensor Networks

Tracking in sensor networks mainly focus on identification of an object by its particular sensor signature and detection of a path over a period of time. By developing the characteristics of the wireless networks, we can obtain effective tracking in the sensor networks. Tracking of multiple objects can be done at the same time by using intrinsic parallelism of the distributed sensors. It is necessary to deploy the sensor networks within a period of time during tracking in remote or unreachable locations, in spite of its low cost and simplicity of deployment. Assistance of large nodes and the distributed target tracking algorithm helps in the study of target tracking. The communication, processing and energy constraints of the ad hoc networks make it complex for tracking with micro sensors. The profits of sensor data fusion can be utilized when the sensor networks work together. The network gets overloaded and the energy supply is used for the fusion, but this is done without sending the data requests and receiving the data from all sensors. [3]

B. *Approaches for Target Tracking in WSN*

For the purpose of target tracking in WSN, centralized and distributed techniques are considered.

Centralized target tracking system: The sensors handled by the sensing network senses the target and forward the target signatures to the base station (BS). In some cases the base station also acts a sensor which is linked to a laptop or processing unit. BS helps in detecting and tracking the target with the help of those target signatures. Since there is a possibility that many sensor nodes can transmit the target information to BS, this centralized technique result in expiry of data receiving sensor at BS due to surplus information.

Distributed target tracking approach: The entire sensor network is subdivided into regions. Each region constitutes a supervisor node including the base station; the processing task is also done at the supervisor nodes. [4]

From the existing works done in the target tracking of WSN we can say that many techniques were proposed for tracking the target effectively. But these existing techniques have few drawbacks in localization such as increased latency and complexity. Here we prepare a hierarchical scheme for localization and tracking of targets in a Wireless Sensor Network environment.

This paper is organized as follows. In Section II we give a brief description of the Hierarchical Localization Tracking Scheme (HLTS). Section III presents the details of performance evaluation. Section IV presents the Simulation results followed by discussion. Finally, conclusions are presented in Section V.

II. Hierarchical Localization Tracking Scheme

We prepare to improve a logical hierarchical binary tree like structure for WSN to store the localization information at different selected nodes in the hierarchy and track the targets quickly. The hierarchical tree structure is proposed to store the location information redundantly in multiple nodes in a controlled manner in order to reduce the tracking time. Reduction in localization time is important, as we need to store the information before another object appear in the sensing zone of a sensor node. The location information is stored in multiple nodes (parent and grand parent node) of the sensor, which locate the target together with the sensor, which located the information about the target object. This can enable the WSN to track the target in the event of failure of same sensor node, as there will be multiple copies of the location information in the network. The number of multiple copies is restricted to only parent and grandparent node to reduce the time to store the location information.

A. *Algorithm*

Every sensor node stores the location information in a two dimensional matrix. The rows represent the target object and the columns represent the sensor node, which detected the target. Each target information is supposed to be noted in the sensor, which is closed to the target in the path. An algorithm for localization and tracking is given below.

Algorithm: (Localization):

Step 1 : Define a two dimensional grid.

Step 2 : Generate position of the sensor nodes at the different grid position randomly.

Step 3: Define a/ multiple path in terms of serial location.

Step 4: Initiate the object at a random position on the path.

Step 5: with every iteration, find the location of the object in the path.

Step 6: Find the nearest sensor node 'A', which can detect the object 'X'.

Step 7: Sensor-target [i] [j] [k] = 1 denotes that sensor node 'i' stores the information that target object "j" is located by sensor node "k". Let sensor node 's', locate the target 't'

Sensor-target [s] [t] [s] = 1

Sensor-target [s/2] [t] [s] = 1

Sensor-target [s/4] [t] [s] = 1

Step 8: Repeat step 3 through 7 for the entire moving target object in the system.

Step 9: Stop.

Algorithm: (Tracking):

Step 1: Let the target object to be tracked is "t".

Step 2: Start from the root node (any node)

Repeat step 3 & 4 until node = Null

Step 3: Varying node-1 from 1 to no of sensor

If sensor-target [node] [t] [node-1] = 1

Then store node-1 in tracking.

Step 4: Node = Lchild [node] i.e. left child

Start from the next node (say node)
Repeat step 5 & 6 until node = Null
Step 5: Same as step 3
Step 6: Node = Rchild [node] i.e. right child
Step 7: Display tracking
Step 8: Stop.

III. Performance Evaluation

HLTS is evaluated through Network Simulator (NS2). We use a bounded region of 500 x 500 sqm, in which 100 sensor nodes are randomly placed and a sink node is located in the center of the network. We have used two target objects which randomly move across the network, whose location information has to be tracked by the sensor nodes. The power levels of the nodes are assigned such that the transmission range and the sensing range of the nodes are all 250 meters. We vary the speed of the target objects as 5,10,15,20 and 25m/s and the transmission range as 250, 300, 350, 400 and 450 m. Some important simulation parameters are summarized in Table I.

Table 1 Simulation Parameter

Parameter	Value
Simulator	NS-2
WSN protocols	HLTS
MAC type	IEEE 802.11
Application	Location estimation
Antenna type	Omni directional
Simulation time	100 seconds
Grid size (mxm)	500X500
Transmission range	250 m, 300m, 350m, 400m
Target speed	0 – 25 m/s in steps of 5 m/s
Number of sensors	10, 20, 30, ... 100
Transmit Power	360 mw
Receiving Power	395 mw
Idle Power	335 mw
Initial Energy	12. J
Propagation model	Two-ray ground reflection, free-space, fixed model
Number of Targets	2
Number of discrete points with path	3, 5, 10, 15, 20
Sensor Radius (m)	50, 100, 200, 300

IV. Results and Discussion

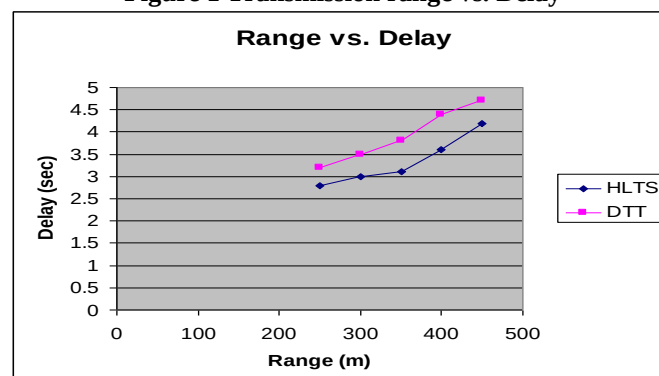
The performance of our proposed HLTS is compared with the DTT –Distributed Target Tracking method. We evaluated the following performance metrics:

Average energy consumption: The average energy consumed by the nodes in receiving and sending the packets.

Packet delivery ratio: It is defined as the number of data packets received successfully with the total number of packets sent.

Average end-to-end delay: It includes the localization delay, tracking delay and transmission delay.

Figure 1 Transmission range vs. Delay



A. Based On Transmission Range

The performances of different techniques under different ratios of communication range/sensing range; we varied the communication range by 250, 300, 350, 400 and 450m, in the network.

When the transmission range is increased, the delay increases. Figure 1 shows the delay is less for HLTS compared to DTT.

From figure 2, it is observed that when the transmission range increased, the energy consumption slightly increases. It shows that the energy consumption is less for HLTS,

Figure 2 Transmission range vs. Energy

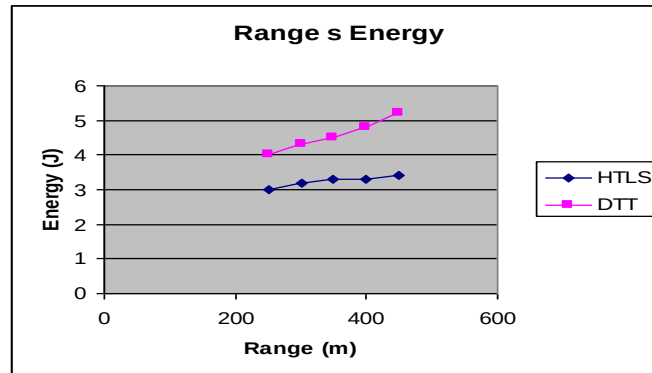
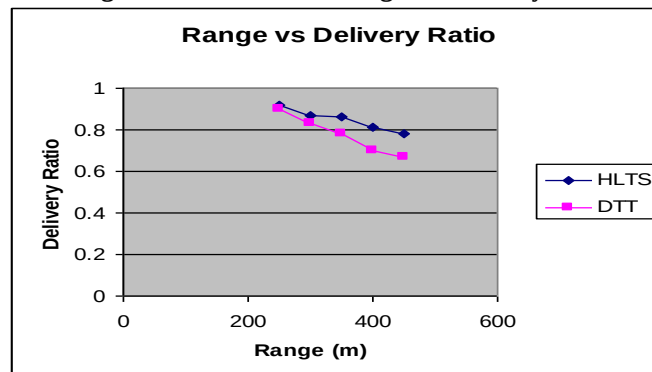


Figure 3 Transmission range vs. Delivery Ratio



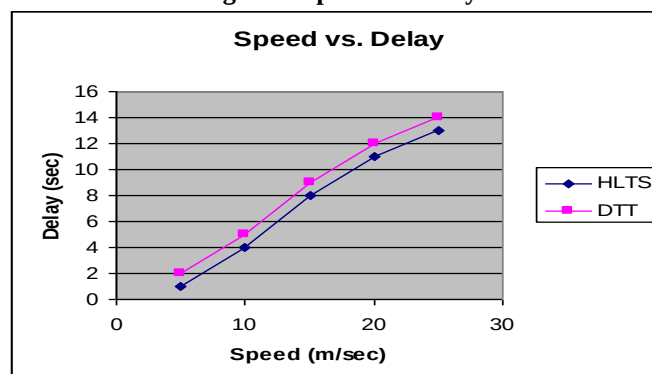
The delivery ratio decreases as the transmission range is increased. It is seen from the figure 3, the delivery ratio for HLTS is higher

B. Based On Object Speed

The performance of different techniques under different object speed, we varied the speed of the moving target as 5, 10, 15, 20 and 25 in the network.

When the speed is increased, the delay linearly increases. It shows the end-to-end delay occurred for both HLTS and DTT. HLTS perform well as shown in figure 4.

Figure 4 Speed vs. Delay



From figure 5, it is observed that when the speed increased, the energy consumption slightly increases. It shows that the energy consumption is less for HLTS.

Figure 5 Speed vs. Energy

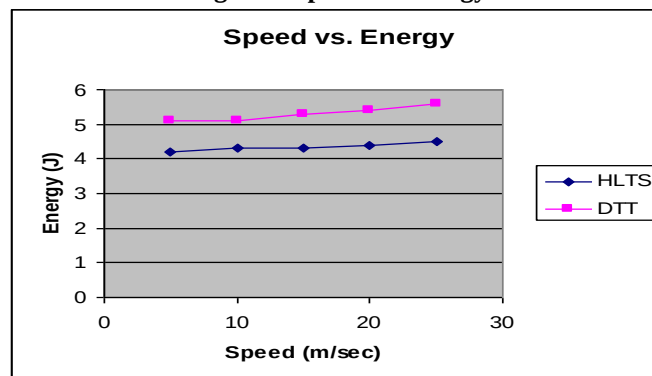


Figure 6 Speed vs. Delivery Ratio

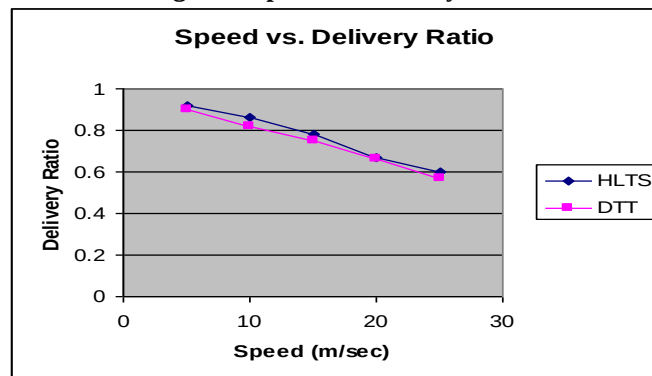


Figure 6 gives the packet delivery ratio for both HLTS and DTT. The delivery ratio decreases as the speed is increased.

V. Conclusion

The hierarchical tree is rooted at the node that is closest to the target. Thus as the target moves some nodes get added to the tree and some get deleted. This scheme reduces the overhead in terms of energy and information flow, as the information flows from the root to the end or periphery of the network through a particular route, as the information flows is controlled so energy consumption automatically gets controlled. The result show that the proposed HLTS technique acquires reduced delay and energy consumption with increased packet delivery ratio.

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