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Tree Based Tracking Targets in Wireless Sensor Network

Poonam P Kakatkar, N. S. Sirdeshpande

M.Tech Student, Department of E&C, GIT, Udyambag, Belagavi, Karnatak, India

Professor, Department of E&C, GIT, Udyambag, Belagavi, Karnataka, India

ABSTRACT*:* A wireless sensor network is a collection of nodes organized into a cooperative network. Wireless sensor networks (WSNs) have gained worldwide attention in recent years. Tracking mobile targets using wireless sensor networks is a potential surveillance framework of practical importance suitable for military as well as civilian fields. Target tracking in WSN is more challenging because WSNs have issues such as limited battery power, unpredictable environments, high mobility of nodes as well as targets and failure of sensor nodes at runtime etc. This paper include the issues which are to be resolved in WSN like high energy consumption and low packet delivery rate.

KEYWORDS*:* WSN, Tree based Target tracking, Red Black Tree etc.

I. INTRODUCTION

Target tracking in WSN is more challenging because WSNs have issues such as limited battery power, unpredictable environments, high mobility of nodes as well as the mobility of the targets. There are also other challenges like scalability, node deployment and communication costs and data aggregation present in object tracking. Challenging task in target tracking is to maintain the balance between resources like energy and overhead [1]. There are many approaches present in object tracking each deal with either of the issues mentioned above. Our project deals with the Tree based approach of tracking the target by considering mobility of nodes, energy as basic object.

The general working Tree-based object tracking technique is to typically organize or form a network into tree like structure, make sensor nodes to keep sensing the target object and report to the sink whenever the target object is detected. Object tracking involves two activities i.e. query and update [2]. Different tree-based object tracking techniques focus on different parameters to improve tracking mechanism like query cost reduction, update cost reduction, coverage area, lifetime etc. A main advantage of tree-based object tracking techniques is better network lifetime over other techniques [3].

II. METHODOLOGY

The Figure 1, depicts the methods used in tree based target tracking in wireless sensor networks. The details regarding the block diagram are described below.

A. Node Initialization

The very first step is to create a network by deploying some set of nodes.

B. Ranking the Nodes

The next step is to calculate the remaining energy of each node to rank them in network for the purpose of creating tree structure. By doing process communication the tables are generated which are having the parameters like node ID’s, Channel used, Energy, distance etc.

C. Tree Construction

Considering the energy of nodes as a parameter the tree is constructed. For the construction of tree the Red Black Tree Algorithm is used. The exact flow of RBT is shown in Figure 2.

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D. Red Black Tree Algorithm

A red-black tree is a binary search tree with extra one bit of storage per node and its color, which can either have the colour combination as RED or BLACK. By obligating the way nodes can be colored on any path from the root to a leaf, red-black trees ensure that no such path is more than twice as long as any other, so that the tree is approximately balanced.

A binary search tree is called as red-black tree, if it satisfies the following red-black properties:

- Every node is either red or black
- The root is always black
- Every leaf (NULL) is black
- If a node is red, then both its children should be black
- For each node, all paths from the node to descendant leave contain the same number of black nodes.

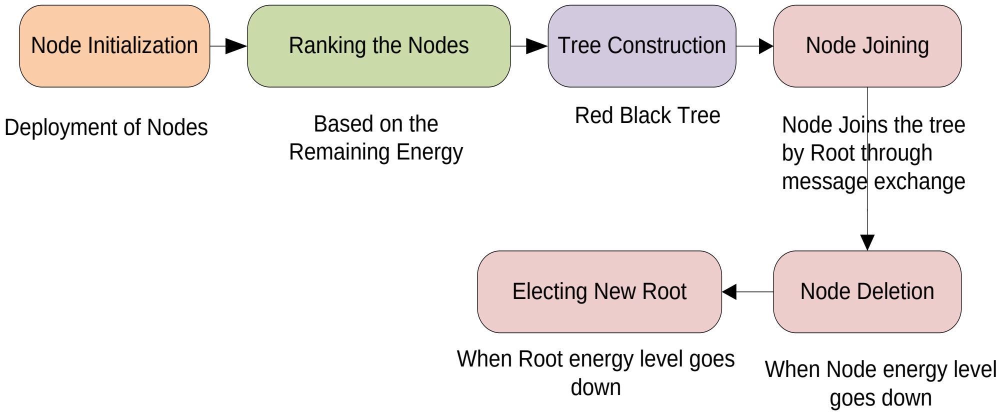

Figure 1: Block Diagram

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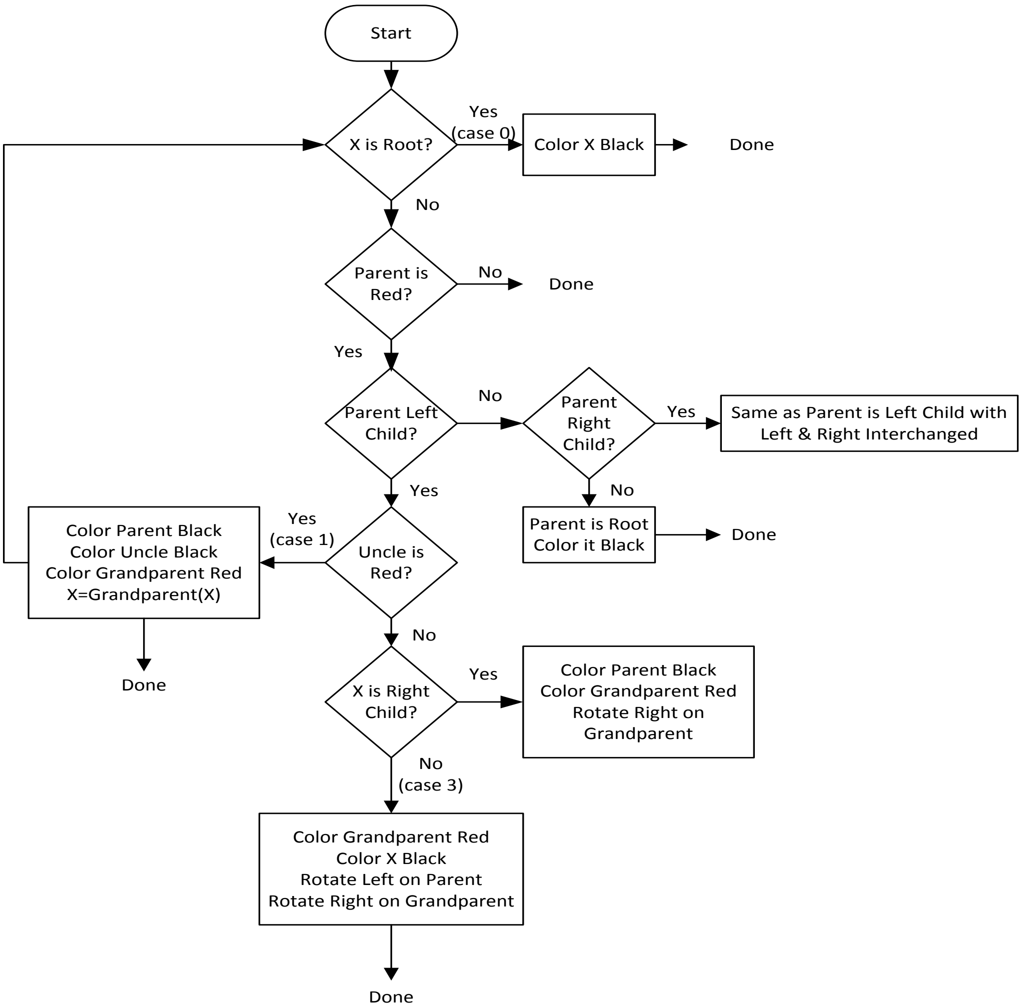

Figure 2: Process Flow of RBT

III. Literature Survey

Many of the Target tracking techniques has been implemented in the field of mobile sensor network [4][5]. However, the design of more efficient target tracking techniques with efficient tracking performance still remains a challenge.

Chinmayee Pande et.al. [6] includes five approaches of target tracking in WSN. In WSNs Moving object tracking has received considerable attention in recent years and classified into five schemes and three approaches, five schemes are the part of three approaches.

Suvidha D Dhore et.al. [7] includes energy efficient target tracking techniques for energy consumption and extending lifetime of the sensor network are two main constrains. Various field factors such as environment noise, sensing capability has to be considered to make the network robust against these factors. Thus tracking target in such dynamic environment is of great interest.

Shereen Ismail et.al. [8] includes the applications of WSN's such as border patrolling, military intrusion detection, wild life animal monitoring, surveillance of natural disasters and health care systems.

Ashvini Pawar et.al. [9] proposed a new polygon based target-tracking scheme, which is a predictive, and cluster based scheme. In this scheme, the clusters are polygon shaped, so the whole network is arranged in the form of polygons. The sensor nodes are interconnected with their neighbouring nodes to form the edges of the polygons. This scheme is more energy efficient than the existing schemes because only selected nodes of the polygon are kept active during the tracking process rather than keeping the entire nodes active.

Sanjay Pahuja et.al. [10] include Hierarchical localization tracking scheme based on hierarchical binary tree structure is used to evaluate localization and tracking target. The target detected information is stored at multiple sensor nodes which deployed using complete binary tree structure to improve fault tolerance. This drastically reduces number of messaging in the network. The scheme increased the network lifetime by 25%, target detection probability by 25%, and reduces error rate by 20%, increased energy efficiency by 20%, fault tolerance, and routing efficiency.

Shirin Shoaee et.al. [11] include a NBSOTT protocol which is an another technique of target tracking in wireless sensor networks. It tries to reduce the number of transmitted packets energy consumption in order to meet the current needs of clustering. Also virtual grid usage reduces time of decision which causes to the object retaining and faster recovering.

Reshma. T. J et.al. [12] include the centralized target tracking approaches which are both time and energy consuming; to avoid this limitation tree-based tracking methods are proposed. While tracking a target the nodes that detect the target communicates with each other and selects a root node. The root node collects information from all the nodes via a distributed spanning tree. If the root node is far away from the target, then the tree will be reconfigured. Although the spanning tree based approaches track the moving objects more accurately, tree organizations result in high-energy consumptions.

Shengnan Lia et.al. [13] include a mathematical model for tracking of a moving target by multiple mobile sensors in the framework of a partially observable Markov decision process is also proposed along with survey on other techniques. Applications of this process include the use of a fleet of unmanned aerial vehicles for purposes such as search, surveillance, and target tracking.

K. Ramya et.al. [14] include classification of tracking moving objects in WSN's. In WSNs Moving object tracking has received Considerable attention in recent years and the solutions can be mainly classified into three schemes, such as Tree - based tracking, Cluster-based tracking and Prediction-based tracking.

Kabita Hazra et.al. [15] include some of the solutions to the issues in tracking targets in WSN. In wireless sensor network by providing solutions to key components like node localization, time synchronization, target detection and tracking the methodology computes the state parameters of the adversary target, tracks it and associate the same with the location in the periphery of wireless sensor networks.

IV. IMPEMENTATION

The implementation steps of the tree based tracking targets in WSN are depicted below. Some Fixed set of nodes are to be deployed to form a network with specific range. The tree is constructed by using Red Black Tree Algorithm.

A. Network Creation

The very first step in network creation is to initialize nodes. The next steps are fixing the distance for nodes, setting the coverage area for node localization, fixing some mobility range for node movement in network and setting the required parameters to nodes like Id, channel, BW, energy etc.

B. Process Communication

In the process communication function the nodes exchange messages with each other by considering the Id's. If one node is communicating with itself, the condition is altered to no communication state. Otherwise distance between the nodes Id's for further table creation and communication is calculated. Transmission range for node communication is set previously. The calculated distance is compared with the transmission range to ensure further communication steps like table generation and message exchange.

C. Tree Construction

The RBT construction is done with the cases as explained in methodology part. The more generalized flow chart of RBT is given below by mentioning the appropriate cases at distinct conditions. The basic rules are also obeyed which are depicted in methodology section.

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D. Node Joining

Node Joining is the function wherein, the new node is also termed as target node when it wants to join the network it sends node_join message to all the nodes in the network. With that node RBT is newly constructed as shown in Figure 3.

V. EXPERIMENTAL RESULT

The following Figures illustrates how exactly the nodes are deployed, communicated with the above mentioned messages and constructed Red Black tree.

E. Node Deletion

When any node's energy level goes down then the node with lowest energy circulates node_leave message. The corresponding root node will delete that node from the network. The network with the deleted node is updated and red black tree is reconstructed.

F. Elect New Root

When the energy of root goes down then it circulates root_leave message to all the other nodes. The other nodes will elect the new root based on the energy level. Updates network as well as reconstruct the red black tree also.

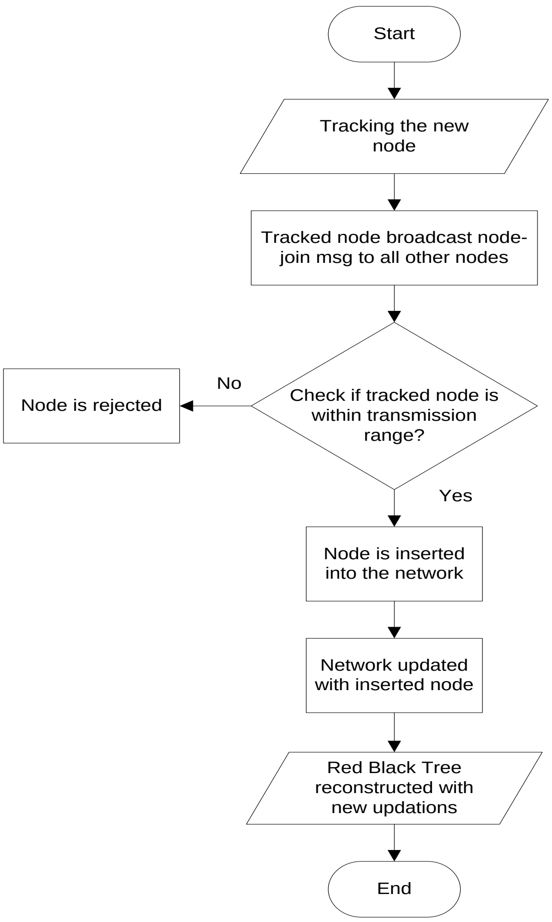

Figure 3: Flow chart of Node Insertion

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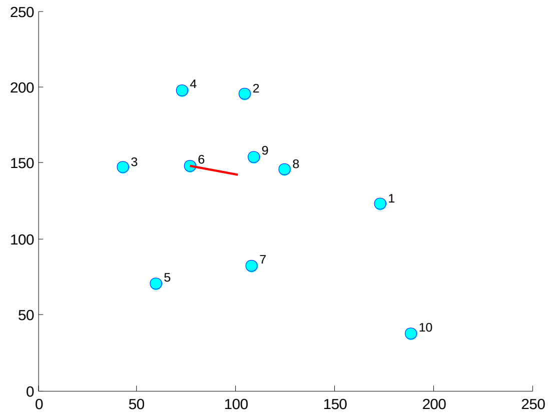

Figure 4: Node deployment with network creation with communication

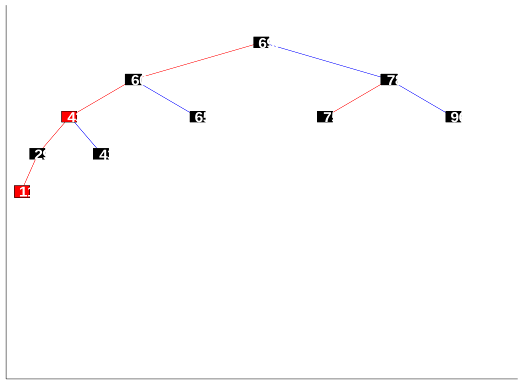

Figure 5: Red Black Tree construction initially with entered number of nodes

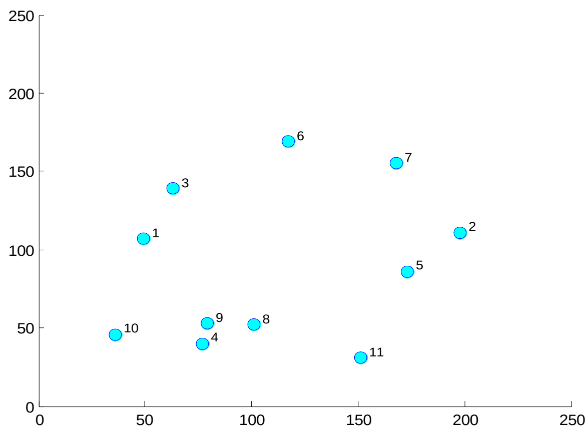

Figure 6: New Node Insertion (Node 11 is inserted with node_join msg)

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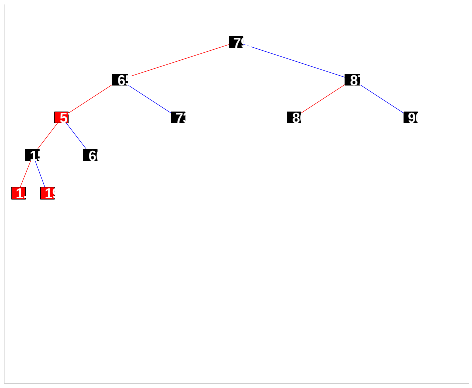

Figure 7: RBT Reconstruction after Node Joining

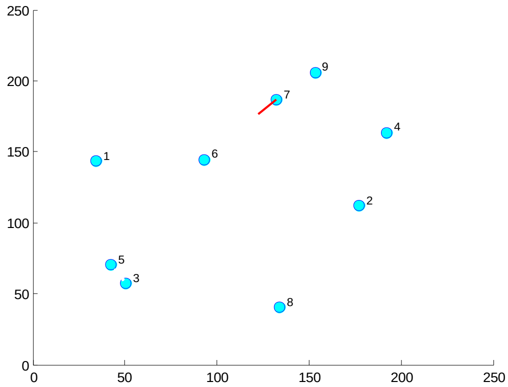

Figure 8: Node and Old Root deletion is performed based on energy check (root_leave msgs)

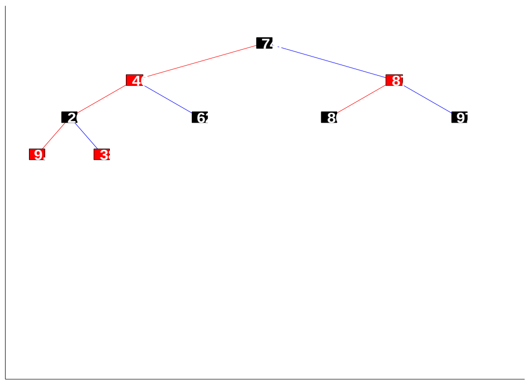

Figure 9: RBT reconstruction after the lowest energy node/Root deletion

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The Figure 4 depicts the network creation with entered number of nodes with communication. Figure 5 will be the initial red black tree constructed with entered number of nodes. Figure 6 and 7 are the plots of newly inserted node and updated RBT with new node. Similarly Figures 8 and 9 are the New root election process and RBT reconstruction with new root when the energy of old root goes down.The following Table 1 depicts the communication cost of network initially when the nodes are deployed. Also the communication cost in each case like Node Joining, Node Deletion, Elect New Root. Finally it is concluded that as the number of nodes increases the communication between the nodes increases which intern increases the communication cost of the network.

Table 1: Communication Cost of entered nodes in each case

Nodes (N)	Communication Costs in Each Case				Overall Communication Cost
	Node Initialization	Node Joining	Node Deletion	Elect New Root	
N = 5	10	6	15	10	41
N = 10	45	11	55	45	156
N = 15	105	16	120	105	346
N = 20	190	21	210	190	611

From the implementation part it is clear that if the communication network is following mesh topology then the communication cost will be very high which intern increases the propagation delay. In our implementation part instead of mesh topology star topology is preferred to minimize propagation delay and communication cost.

VI.CONCLUSION

The proposed scheme efficiently tracks the target in all the three cases considered in our work. The resultant implementation part indicates the steps followed in each case. The result part depicts how exactly the targets are tracked by generating tree and communicating with each other by forming star topology to minimize the number of links, communication cost, propagation delay, network traffic etc.

From the implementation it is cleared that as the number of nodes increases then the number of communication between the nodes increases, the energy consumption of the node also increases which intern increases the communication cost and propagation delay.

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