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Survey on Target Tracking Techniques in Wireless Sensor Network

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ABSTRACT: Due to widespread applications from wireless technology has given them eminent role worldwide. But the efficiency of the sensor network application highly depends on reliable communication among nodes. With the advance in the field of wireless most of the task like surveillance, tracking etc rely on it. Target tracking is done by finding spatial coordinate of nodes or target. Goal of effective sensor network is to provide appropriate information of sensing field for prolonged period of time. One of the key application of wireless sensor network is target tracking. Task of tracking target is challenging because of the various constrained on sensor nodes. Energy efficient target tracking techniques for energy consumption and extending lifetime of the sensor network will be discussed. 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. Cooperative and non-co-operative target tracking is challenging task, thus to solve this type of challenges solved with suitable target tracking sensor network defining suitable parameter for existing sensor network.

KEYWORDS: Target Tracking, Wireless Sensor Network, Hierarchical, Peer to Peer, Polygonal.

I. INTRODUCTION

Wireless Sensor Network is collection sensor nodes. Hundreds of thousands of sensor nodes connected to each form sensor network. Sensor nodes typically consist of radio transceiver, microcontroller and it is powered with battery. WSN application has proven great area of interest for many researcher. Wireless technologies is contributing to various field of application are environmental monitoring, traffic control monitoring, patient health care monitoring etc. Sensor nodes are of important part in these fields of application. WSN have many applications in which sensor nodes collect data from particular location and process it for that location of collected data has to be known. Localization techniques are used to calculate the location of sensor nodes. When wireless sensor network detects the target and estimates the location of target when they move in network and forward data to base station or sink called as target tracking. In the process of tracking target sensor nodes which sense data kept active nodes and others nodes are kept in inactive mode so that energy conserved till the process of target tracking get accomplished. It is important to turn sensor nodes in to active nodes to continuously track target. As WSN comes with many challenges. These challenges affect the performance of the sensor network. While tracking the target in wireless sensor networks these challenges has to consider getting performance accuracy. These challenges are limited energy supply, power, communication channel and size of the sensor network. As the size of the sensor networks becomes large to deal with performance limit of sensor node is very challenging. These challenges build constraints on the task of tracking in sensor network. A resource constraint decides the lifetime of sensor network for example the battery failure may interrupt the target tracking in network. Size of the sensor network for specific application, deployment of the particular sensor network and the topology for that sensor network are the design constraints of the wireless sensor network. Design constraints for the specific application largely depend on environmental condition. In sensor network sensor nodes battery get depleted so the energy saving can be done using various architecture of sensor network that will help to minimize energy consumption as minimum number of nodes will participate in tracking the target. Designing sensor network depends upon the considering constraints. Power consumption also plays an important role in sensor networking.

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During the process of target tracking in wireless sensor network, whenever the target enters in the network the sensor senses the target but the dissipation of energy required for each sensor for this sensing operation is different for all sensors. Target tracking can be done by centralized approach but in this type system overload can be mode and the process becomes slow. As size of sensor network is large more sensor will be there in the network and hence frequency of message will be more towards sink which consume additional bandwidth. This approach cannot be recovered if failure of the node occurs. This centralized approach even time consuming sensing can be perform at time only one node it lead to the less accuracy in the network. For successful target tracking there should betradeoff between the tracking accuracy and network resources. One more tracking method is minimalist binary sensor network. Types of target tracking are numerous but there are common procedures applicable for the target tracking these are as follows:

- 1] Errors involved in the localization of the nodes should be few.
- 2] Measurement of distance from the target to the node.
- 3] Creating groups of nodes commonly called as cluster.
- 4] Information exchange between leader node and the sink as movement of target detected. The various types of target tacking are being summarized and discussed in this paper.

II. RELATED WORK

There is no standard fix for target tracking; it is done with various perspectives to achieve the accuracy in tracking. For classification various criteria to be considered are frequency of target, energy usage, formation of network, security in the network, recovery from the node failure can be a part of classification of tracking and so on.

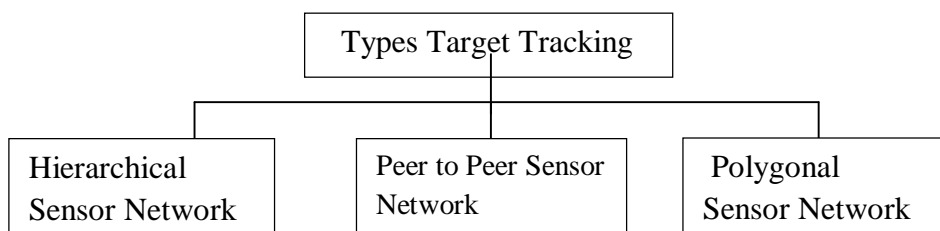


Fig.1. Types Target Tracking

Depending upon the formation of network target tracking classified into hierarchical and peer-to-peer. In which further classification is done. Hierarchical tracking is nothing but the multi hop routing sensor network. In the hierarchical network of sensors they form mesh like structure when the target moving detected by one of the sensor from the network they report it to sink. The chain of the nodes acts as repeater in network to pass the information. as the failure of one node can be covered by this action of repeatability as one node can admit itself in place of other sensor node. Peer to peer tracking is single hop routing sensor network. Information exchange is between neighboring nodes. Scenario of the network looks like line if nodes are deployed in one line.

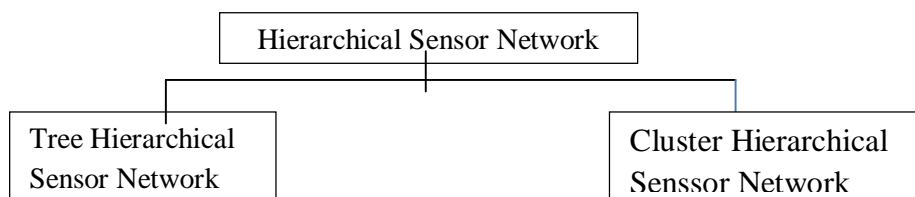


Fig.2 Hierarchical Sensor Network



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Hierarchical Sensor Network

Hierarchical network looks like presenting a levels; similar to the twinges of the tree, some looks like group of nodes forming a rings. Tracking methods for hierarchical sensor network is classified into tree-hierarchical sensor network tracking, cluster-hierarchical sensor network tracking, and other techniques.

Tree Hierarchical Sensor Network

In this tree hierarchical sensor network the sensor nodes forms network similar to tree network. In which tracking is done forming the tree from start to end. While maintaining the tree structure some nodes get in the network and some get out from the network.

When the tree hierarchical sensor represented as graph vertices connected to edge are the nodes that are taking part in tracking. There are some approach that uses tree hierarchy that are , Scalable Tracking Using Networked Sensors(STUN), Drain and Balance(DAB),Dynamic Convoy Tree-Based Collaboration (DCTC),Dynamic Object Tracking (DOT). This are explained below.

Scalable Tracking Using Networked Sensors:

The work on Scalable Tracking Using Networked Sensors is done by H. T. Kung and D. Vlah. In this approach considering the predicted movement of the object bounds limit on speed and hence travel maximum distance within considered time. Leaf sensor nodes keep root node aware of the current status of the object, only after the change in the recognize set of detected event. If the node at lower level are not modified then message exchange can be terminated. This will stop passing redundant message and lowers the communication cost. DAB is method to construct STUN structure. It is constructed in inverted tree fashion considering the frequency of the moving objects. DAB gives the scenario of draining water where it highlights high peaks. Andthen grouping these highlighted high peaks.

Dynamic Convoy Tree-Based Collaboration (DCTC):

In Dynamic Convoy Tree-Based Collaboration for target tracking in sensor network when the target is shown for the first time initial tree in formed by considering its path. It moves further to select the root by collaborating with other sensor nodes. As target moves ahead to dynamically structure reconfigured to add and to extract nodes to reduce energy consumption of the network. The optimal DCTC is for selecting appropriate nodes. For constructing DCTC framework practical sequential configuration and expansion of tree are considered.

Dynamic Object Tracking (DOT):

In this protocol one source object is subjected to track moving object in wireless sensor network. Active sensors from the network can detect the moving object also keep the tracking information for source. Identified polygonal area from the wireless sensor network is considered to prevent loss of tracking. In this type of tracking priority given to the sensor closest to moving object. Adjusting the face track will help to chase target faster and timely fashion.

Cluster-Hierarchical Sensor Network

Wireless Sensor Network is divided into cluster. Every cluster has one high energy node typically called as cluster head and others are the member of the cluster. A number of clusters are presents in the network are collaboratively used for data processing. The process of target detection and target tacking takes place in cluster itself as cluster collects information from the other nodes from the cluster .Cluster-Hierarchical Sensor Networks classified into static cluster hierarchical network, Dynamic-hierarchical network. Cluster-hierarchical sensor network can also be divided depending upon formation of the cluster and the parameter considered for selecting cluster head of the clusters; thatare probabilistic and non-probabilistic algorithms for clustering.

Static Hierarchical Sensor Network

In this hierarchical sensor network cluster are formed at once, after its formation it remain same for lifetime. Clusters from the sensor network are in fixed numbers, members from the clusters are of same numbers. Due to fixed type of structure network is not robust enough. Depletion in energy of cluster head effect overall performance of the network because that cluster gets inactive with the power loss from the cluster head.

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Dynamic hierarchical Sensor Network

The hierarchical Sensor Network is said to be dynamic when the election of cluster head takes place regularly or clusters from the sensor network are organized timely with respect to network topology change. Rotation of cluster head among the other nodes just improves the energy efficiency of the sensor network. Dynamic nature of sensor network makes better use of the sensors and manage lifetime of sensor network.

Probabilistic Algorithm for Clustering

In probabilistic algorithm for clustering probability is given to each sensor node from the cluster to select the cluster head. Probability in selection of cluster head is divided among whole cluster network. Probabilistic algorithm for clustering works to achieve better energy consumption by procedure of re selection of cluster head by considering communication cost. Low Energy Adaptive Clustering Hierarchy (LEACH) Energy-Efficient Hierarchical Clustering (EEHC) Hybrid Energy-Efficient Distributed Clustering (HEED) are some probabilistic protocols.

Non-Probabilistic Algorithm for Clustering

Non-probabilistic algorithm for clustering is more clarified criteria for selection of cluster head and cluster formation as it consider the degree of connectivity among nodes. Strong communication nodes means the closely located nodes are consider during formation of the nodes. Intensity of message received is more at the neighboring nodes is more but this factor build sometimes worse time complexity compare to that of the probabilistic algorithms for clustering. Weight-Based Clustering Protocols(WCA) Node Proximity and Graph-Based Clustering Protocols are mainly considered in this type of algorithm.

Peer-To-Peer Sensor Network (P2P)

Peer to peer networks are of two kinds centralized and decentralized. In decentralized peer to peer network each node can directly communicate with other nodes without any common connection points in the network. Whereas in centralized peer to peer network there is centralized server connected to nodes. There can be one or more central server connected in the network. Nodes send message to central server. The centralized approach suffers from traffic overload when number of nodes in the network increases. Centralized approach is prone to malicious attacks and single point failure can occurs in the network. Decentralized approach is strong against the single point failure. Decentralized network is reliable than centralized approach. There is one more approach called as hybrid peer to peer wireless sensor network. In hybrid there are no server nodes in the network as capability to act as server. These nodes are super nodes or the super peers from the network.

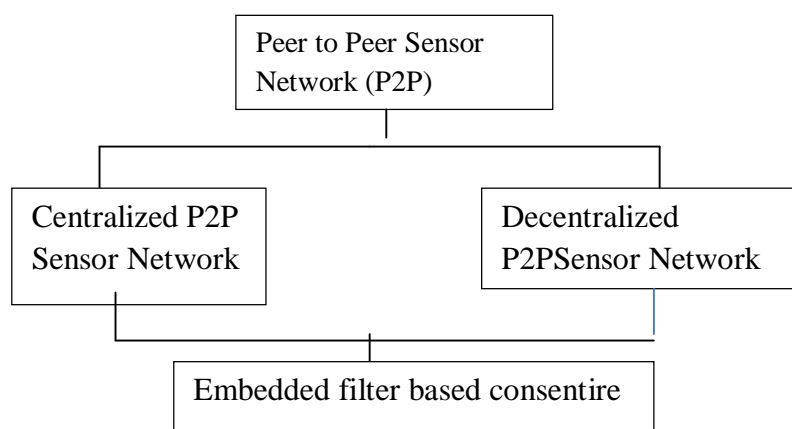


Fig.3 Peer To Peer Sensor Network

Xu wang proposed distributed peer to peer approach for target tracking in wireless sensor network the nodes acts as peers they detect the target and localization of the target is performed by collaboration among nodes that make network robust. Signal processing is carried out on the selected nodes so it builds tradeoff between energy and information

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processing. Embedded filter based consentire includes later. Various filters used like Kalman filter(KF), extended Kalman filter, particle filter,unscented Kalman filtering (UKF).The linear Kalman filter is used to predict future value according to past movement of the target. Set of equations of Kalman filter determines state of process recursively such that mean of the squared error minimizes. In prediction step the time update equations calculates current state from the previously estimated state which known as priori estimate, in correction step the measurement equation work as feedback combines current state with priori estimate to calculate posterior estimate that improves the state estimate.However the system presents in the real world are not linear one's to deal with this nonlinearities extended kalman filter is developed. A extended Kalman filter calculates position and velocity of the target. In practice the original velocity and position differ from the true ones therefore to obtain correct and fast initial coverage constrained form of the extended kalman filter is introduces by anders eriknordis.Unscented extended kalman filter for taget tracking by liu it consist of unscented transformation and extended kalman filter. The fundamental thought is to join the unscented change UT with the EKF specially UNEKF, the sigma focuses and weights are ascertained from the earlier mean and covariance of the state through UT ,then sigma points are passed through the nonlinear system.Particle filters for positioning navigation and tracking by Fredrik it is framework for positioning, navigation and tracking problem using particle filter. It has motion models and nonlinear equations for measurement. Some algorithms are not compatible with particle dimension for that kalamam filter is used to calculate derivatives of the position and hence particle filter is low dimensional. Advantages of automotive and airborne applications are superior over kalman which is promising solution to task of navigation and tracking.Target Tracking Using Kalman Filter Embedded Trust Region by Zhu Hua-ping for target tracking developed a new algorithm with kalman filter and trust region. Initial position and the area of the target is required it helps to solve the problem of minimum local coverage of trust region

Polygon Sensor Network

As target tracking methods are clearly divided into tree and cluster type hierarchical sensor network. In such case of target tracking mostly combines group of sensor nodes with accurate distance measurement of target from node. This type of tracking can be failed in some harsh environmental condition. Polygonal framework of target tacking achieved using various algorithms.Md. Zakirul Alam Bhuiyan, Guojun Wang and Jie Wu Proposed Polygon-Based Tracking Framework in Surveillance Wireless Sensor Networks. This polygonal framework called as face track in which nodes of geographical region are the faces. In this target techniques in place calculating the target location figure out the target moving towards another face i.e polygon. In order to track target timely fashion edge detection algorithm being used in order to overcome the sensor defects and failure of the target tracking. They developed optimal node selection algorithm for selecting sensors from available sensors from the polygonal area. Thus it helps to minimize the number of active sensors participating in tracking and minimizes energy consumption. This tracking technique builds tracking accuracy and energy efficiency. Fig.4 below shows polygon sensor network. Blue line shows how target being tracked through polygons. This polygons are also called as faces.

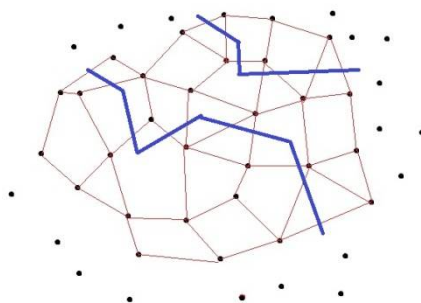


Fig.4 Polygon Sensor Network

III. CONCLUSION

Widespread research on target tracking of wireless sensor network brings lot solutions for target tracking applications to make it accurate, reliable and robust. Target tracking method depending upon wireless sensor network is explored to classify them to adjust in that category. Tree and the cluster are type of hierarchical sensor networks. Peer to peer



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hierarchical sensor network categories into centralized and decentralized and then into embedded filter consentire. Newly developed algorithms for target tracking and there accuracy makes system reliable being proved by number of researcher that are discussed successfully. Comparative study of target tracking of wireless sensor network is essential to do more work on quality of tracking. Effectiveness of target tracking depends upon the energy consumption, recovery from the sensor failure & missing of target etc. Designing algorithm and modification in algorithms of kalman filter (KF) , Extended Kalman Filter(EKF), unscented kalaman filter (UNKF) and particle filter for linear and nonlinear systems respectively improves tracking in wireless sensor network. New tracking framework by Wang is effective against misguide of target, sensor failure. Newly developed algorithms like optimal selection algorithm minimizes energy consumption and it also do best work in selecting appropriate number of sensor from the available sensors to forward data for tracking. Some open research issues such as channel based tracking, multiple target tracking, unreliable node approach; mobile nodes make wireless sensor network applications of concern. Researches on such issues make wireless technology more reliable and useful.

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