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A Review of Target Tracking Approaches in Wireless Sensor Network

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Abstract – *Wireless sensor network are independent sensors that sense and monitor physical or environmenal condition such as temperature, humidity, pressure, sound, etc. and generate digital signals and by them pass the data to main location. The recent developed networks are bi-directional, we can control the activity of sensors. The application areas of WSN comprises of environmental monitoring, military surveillance, health care, industrial process control, home intelligence, security, remote metering and many more. Target tracking is one of the most practical application of wireless sensor networks. This paper review the various techniques used for the target tracking for static as well as moving target.*

Keywords: *Wireless sensor network, target tracking methods, object tracking, mobicast, tree based tracking.*

I. INTRODUCTION

The continuous improvements in wireless sensor technology make it feasible to implement the wireless sensor network (WSN) in a variety of scenarios. WSN consists of thousands of tiny sensor nodes deployed in a physical environment for observation of an event of interest. The sensors in the vicinity of an event must be able to monitor it and report back to the sink. A sink sensor node has capability to communicate with outside world such as laptop, base station. Sensor nodes have been deployed to play significant roles in traffic control, battlefield, habitat monitoring and intruder tracking in recent years [1].

Tracking of a mobile target by a network is the important use of sensor networks. The wireless sensor networks track the objects by predict the location of the target position and also to follow or capture the moving object. The active nodes are used for sensing the object easily, and the dead nodes are no longer sense the objects. To improve the tracking quality the surrounded nodes are waked up in time otherwise, it should be in sleeping mode. Sensors are grouped based on the clusters either statically or dynamically. The sensors nodes are accurately predict trajectories, but the moving nodes are noted. A node closed that to the sensor are noted and will save for the location tracking [2].

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 [3].

The various types of target tacking approaches are being summarized and discussed in this paper.

II. TARGET TRACKING APPROACHES

Target tracking is an application of WSN where the aim is to trace the travelling path of an object which is the target and to detect the positions of target. As WSN continuously monitor the environment, it provides us the space to enhance the energy efficiency. Some of the energy efficient algorithms for wireless sensor network have been presented in the literature [5-6].

Target tracking protocols may be classified into following major categories [7] –

2.1 HIERARCHICAL NETWORKS

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 [3].

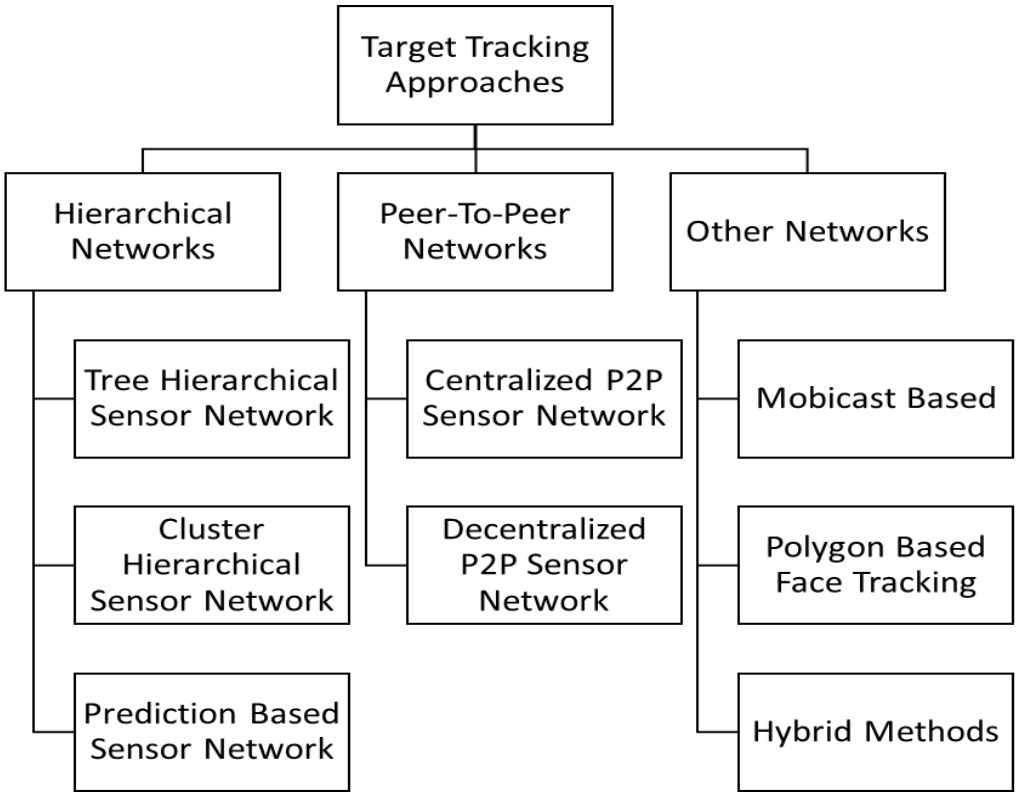

Figure 1. Different tracking Approaches

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 [3].

2.1.1 TREE HIERARCHICAL SENSOR NETWORK

In Tree-Based Target Tracking, nodes in a network may be organized in a hierarchical tree structure or represented as a graph. The vertices in the structure represent sensor nodes and edges are links between nodes that can directly communicate with each other. 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. The centralized target tracking approaches are both time and energy consuming; to avoid this limitation tree-based tracking methods are proposed [8].

2.1.2 CLUSTER HIERARCHICAL SENSOR NETWORK

Cluster-based method divides the network into clusters to support collaborative data processing. A cluster consists of cluster head and member sensor nodes. When a sensor detects an object it volunteers to act as a CH(Cluster Head). There is No need of explicit election of leader. So message exchanges are not incurred. If more than one powerful sensor may detect the signal, multiple volunteer nodes may exist. So a decentralized approach has to be applied to ensure that only one Cluster Head is active in the vicinity of a target to be tracked with high probability. Cluster based method is divided into three types. Static Clustering and Dynamic Clustering [8].

a) STATIC CLUSTERING

In Static Clustering, clusters are formed statically at the time of network deployment. The attributes of each cluster, such as the size of a cluster, the area it covers, and the members it possesses, are static. In spite of its simplicity, the static cluster architecture suffers from several drawbacks. First, fixed membership is not robust from the perspective of fault tolerance. If a Cluster Head dies of power depletion, all the sensors in the cluster render useless. Second, fixed membership prevents sensor nodes in different clusters from sharing information and collaborating on data processing.

Finally, fixed membership cannot adapt to highly dynamic scenarios in which sensors in the region of high event concentration may be instrumented to stay awake [9].

b) DYNAMIC CLUSTERING

Dynamic cluster architecture has several desirable features. When a sensor with sufficient battery and computational power detects signals of interest, it volunteers to act as a CH. Compared with the static clustering approaches, dynamic clustering networked sensors do not statically belong to a cluster and may support different clusters at different times. Moreover, as only one cluster is active in the vicinity of a target with high probability, redundant data is suppressed and potential interference and contention at the MAC level is mitigated [8].

The biggest problem with this algorithm is that it will not work with mobile nodes. The network calculates the sensor node's locations at start-up. Since these locations need to be known by the cluster head and are calculated only once, this prevents any nodes from moving or even being added to the network. This problem could be easily fixed by periodically refreshing the locations of the sensor nodes, although this will decrease the network's life- time. So it is better to use a detection algorithm and constantly refreshing the nodes' location isn't an optimal solution is better in this case [8].

2.1.3 PREDICTION BASED METHODS

Prediction-based methods are used to predict the Future movement locations of the moving objects. In which predict movements of target in future [8]. These models assume that moving object will continue the current speed and direction for the next few moments and process historical data to deduce subsequent movement of a mobile object. These methods allow limited number of sensors to track the moving object [10].

2.2 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 [3].

2.2.1 CENTRALIZED APPROACH

In centralized approach, a single node acts as a base station. It has the responsibility of processing the target tracking. All other nodes send a request to the base station. At the same time, many nodes send a request to the base station, so there may be chance to get overload. In centralized approach, there are four stages. The first stage is location detection stage and second stage is the processing stage which is responsible for routing, terminating the duplicate nodes and to sense the border nodes. The third stage corresponds to detect the target and sends the information to the base station. The last stage corresponds to maintenance of the sensor nodes [2].

In centralized approach each node send the data to the central node which is base station. Monitoring and algorithm is always executed at the base station and result is distributed to the sensor nodes. There may be many sensor node sending data to the base station at the same time so station may get overloaded. As there is a single station processing complete data therefore single point of failure can affect whole network as well as degrade tracking performance [4]. 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 [3].

2.2.2 DECENTRALIZED APPROACH

In distributed approach, there is no central controller. Kalman filter is one of the best filtering techniques used, and it is the powerful one. Another approach is a particle filter. The node is used to detect the target and assigned with a particle with its weight. Each iteration of this algorithm comprises of two steps. The first one is the communication step in which sensors communicate with each other by passing the information to the base station. The second one is the update state in which each sensor uses this information to refine its local estimate [2]. Decentralized approach is strong against the single point failure. This network is reliable than centralized approach [3].

2.3 OTHER TRACKING METHODS

2.3.1 MOBICAST BASED METHOD

A new multicast communication paradigm called a "spatiotemporal multicast" or "Mobicast" [11] was investigated to support spatiotemporal coordination in applications over wireless sensor networks.The distinctive feature of multicast is the delivery of information to all nodes that happen to be in a geographic zone at a particular point in time. The set of multicast message recipients is specified by a forwarding zone which continuously moves and evolves over time. When continuously monitoring an entity, forwarding zones at different time intervals greatly differ. This provides a mechanism for application developers to express their needs for spatial and temporal information dissemination directly to the multicast communication layer [8].

It also offers a new just-in-time multicast delivery paradigm. While conceptually simple, this mobicast protocol is useful for coordination scenarios where the mobile coordination event does not change its velocity and spatial confinement very often, and is very challenging to implement [8].

2.3.2 POLYGON BASED FACE TRACKING

It is method different from other tracking method. FaceTrack [12], a tracking framework that detects the movements of a target using polygon face tracking. Here the term face represent a polygon that construct to track the target. Here uses a brink detection algorithm that enables the Wireless sensor network to be aware of a target entering the polygon a bit earlier, and to work in a timely fashion. In Brink Detection Algorithm[13], the common edge across which the target is about to cross is called a brink. The end nodes of brink are the couple nodes. If a Target reaches the location near to the brink, the edge node broadcast the message which will wake up the sensors in next polygon [8].

An Optimal Selection Algorithm is also used to select couple nodes on the target's moving path to keep the number of active sensors to a minimum. In case of failure in any node, the possible node to detect the target in the same face will sense the Target. This concept will reduce the Data Redundancy and Energy Consumption of the network [8].

2.3.4 HYBRID TRACKING METHODS

Some protocols fulfill the requirements of more than one types of target tracking which are termed as hybrid tracking methods [7].

Tracking Protocol	Tree Based	Cluster Based	Prediction Based	Mobicast based
Heuristic object tracking algorithm	√			
DOT	√			
STUN	√			
DAT	√			
OCO	√			
M. Abdelkader et al.	√			
HPS	√	√	√	
W.-P. Chen et al.	√	√		
F. Zhao et al.		√		
DELTA algorithm		√		
RARE		√		
CODA		√		
Y. Zou et al.		√		
DPT		√	√	
Y. Xu et al.		√	√	
PES		√	√	
G.-y. Jin et al.		√	√	
S. Pino-Povedano et al.		√	√	
C.-Y. Chong et al.		√	√	
Sung Min et al.			√	
DPR			√	
Q. Huang et al.			√	√
VE mobicast			√	√
HVE mobicast		√	√	√

Table 1. Classification of target tracking approaches [7]

III. CONCLUSION

This paper surveys the related research works on wireless sensor networks as far as the target tracking is concerned. Here different approaches has been surveyed and as per that some widly known techniques are classified as per different approches. This paper will help to get the knowledge about traget tracking or object tracking techniques used in wireless sensor network.

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