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Study of Target Tracking Techniques in Wireless Sensor Network

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Abstract: Target tracking is one of the eye catching applications in wireless sensor network. The network employees the object tracking techniques which track the moving target when it moves through sensor network. This paper contains study of some target tracking techniques used in today's life. It gives the understanding of the target tracking approaches which is essential for further researches.

Keywords: WSN, target tracking, tracking techniques, Tracking methods, face tracking.

INTRODUCTION

Wireless Sensor network (WSN) is an embryonic technology with great potential to be employed in acute situations. The Main objective of a Wireless Sensor Network is to provide reliable and precise information of the environment in which the sensors are installed. The origination of development of wireless sensor networks is military applications like battlefield investigation. However, Wireless Sensor Networks are also used in many areas such as Manufacturing, Resident, Health, Territory Monitoring, Environmental and Military, Home and Office application areas, tracking targets of interest. Moving target detection and tracking, when it moves through a sensor network become a gradually more significant application for sensor networks. Wireless sensor network technology make it possible to implement the wireless sensor network (WSNs) in a variability of circumstances because of its continuous evaluation [1]. WSNs contains number of tiny sensor nodes deployed in a physical environment to track the occurrence of interest. The sensors present in the surrounding area of the target must be able to monitor it and report back to the sink. A sink sensor node is used to connect with outside world such as workstation, base station. Sensor nodes have been deployed to plays an important roles in traffic control, field, territory monitoring and intruder tracking in recent years [2]. Challenging task in target tracking is to maintain the balance between resources like energy, bandwidth and overhead. In this target tracking application, sensor nodes becomes an active when they sense the target otherwise they will be in inactive mode. Sensor nodes have conserve energy when they are in inactive mode and as sensor nodes operate on limited battery power, energy usage is a very important concern in a WSN. The purpose of this paper is to study, introduce, summarize and compare some of the target tracking methods currently used in sensor networks [1]. To continuously monitor mobile target, a group of sensors must be turned in active mode just before target reaches to them. Active sensors vary depending on the velocity of moving target and schedule from cluster head [1].

1. CLASSIFICATION OF TARGET TRACKING

The Kay focusing area in target tracking application is the phase of interaction between sensor node and target [1]. After detection of target, smart sensor node collects, process, store and communicate the information from one node to another to calculate current location of the object using different types of algorithms. Sensors can monitor a wide variety of information like temperature, pressure, humidity, soil makeup, vehicular movement, noise levels, lightning, the presence or absence of certain kinds of things, mechanical stress levels on [3].

In WSNs Moving object tracking has received considerable attention in recent years and it classified into five schemes and three approaches, five schemes are the part of three approaches.

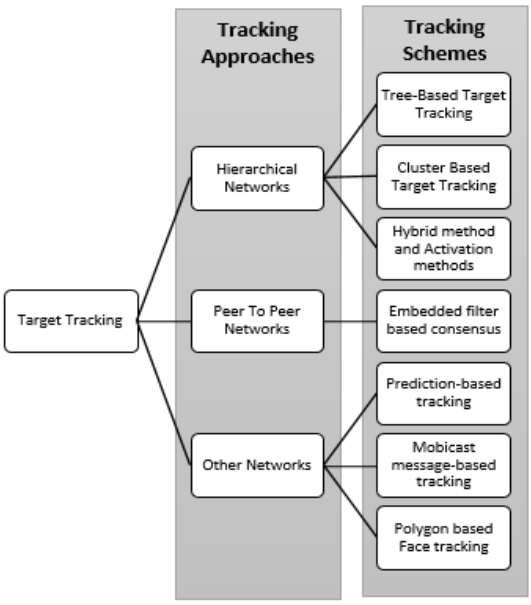

Fig: Target tracking classification

1.1 Tracking Schemes for Hierarchical Network

In Hierarchical networks mesh-based systems are used. The system present with multihop radio connectivity between wireless nodes is employed. The sensors in the area of an object must be able to monitor the object of interest and report back to the sink. A sink sensor node has capability to communicate with outside world such as laptop, base station. Tree-Based Target Tracking, Cluster

Based Target Tracking, Hybrid and Activation methods are belongs to Hierarchical Networks [2].

1.1.1 Tree based target tracking scheme

In Tree-Based Target Tracking, nodes in a network are arranged in a hierarchical tree structure. This structure is represented as a graph. The apexes present in the structure represent sensor nodes and edges are used to link the nodes that can use to establish the direct communication between each other. The root node is selected by the node that identified the target and interconnects with each other. Distributed spanning tree helps the root node for collecting information from all the nodes. If the root node is outlying away from the target, then the tree will be reconfigured [2].
Advantage: - The spanning tree based approaches track the moving objects more accurately.

Disadvantages: - Tree based target tracking organizations result in high-energy consumptions.

Dynamic Convoy Tree-Based Collaboration (DCTC):
Dynamic Convoy Tree-Based Collaboration is a Tree-based tracking method. It detects the target first and then monitors it by tracking the surrounding area of the target. It depend on a tree structure called convoy tree, convoy tree contains sensor nodes around the moving object [1].

Optimized Communication and Organization (OCO):
Optimized Communication & Organization is a tree-based method for target detection. It provides self-organizing and transmitting capabilities with low computation overhead on sensor nodes. It consists of four steps.

The position-collecting phase: - The base sensor node collects positions of all the nodes in the network.
The processing phase: - The base cleaning up the redundant nodes, detecting the border nodes, and routing.
The tracking phase: - Detects the objects which is coming from outside the perimeter of the sensor network.
The maintenance phase: - The base deletes the dead node from the list, and then reorganizes the network by starting the four-step procedure again [2].

1.1.2 Cluster based target tracking scheme

Cluster-based method supports the collaborative data processing by dividing the network into clusters. A cluster consists of cluster head and member sensor nodes. When a sensor detects an object its volunteers act as a CH (Cluster Head). Multiple volunteer nodes may exist in cluster based tracking when more than one powerful sensor may detect the signal. So a decentralized approach has to be applied to ensure that only one Cluster Head (CH) is active in the vicinity of a target to be tracked with high probability. Cluster based method is divided into three types. Low-Energy Adaptive Clustering Hierarchy, Static Clustering and Dynamic Clustering [1].

Low-Energy Adaptive Clustering Hierarchy (LEACH):
Low-Energy Adaptive Clustering Hierarchy is used to reduce energy consumption. In LEACH method clusters are formed using sensor nodes select one of them as cluster-head. Sensor node first detects the target and sends the data to its cluster-head. Then the cluster head aggregates and compresses the data collected from all the nodes. Collected data sends to the base station. The Cluster head requires more energy than other nodes in the network. To save energy consumption LEACH uses random rotation of the nodes [2].

Static Clustering:
Clusters are formed statically at the time of network deployment. The attributes of each cluster are static.

Attributes:-

- Size of a cluster
- Area it covers
- Members it possesses

The static cluster architecture suffers from several drawbacks. i. fixed membership is not robust from the perspective of fault tolerance. ii. Fixed membership allows same cluster sensor nodes from sharing information and collaborating on data processing. iii. Fixed membership cannot adapt to highly dynamic scenarios in which sensors in the region of high event concentration may be instrumented to stay awake [1].

Dynamic Clustering:
As compared with the static cluster, sensors are not statically belonging to a single cluster; it may support different clusters at different times. In dynamic clustering only one cluster is active in the area of a target with higher chances due to which data redundancy is reduced and potential interference & contention at the MAC level is mitigated [1].

1.1.3 Hybrid and Activation methods

Hybrid methods are the tracking algorithms contains more than one type of target tracking. Hybrid Clustering consists below methods [2]

Distributed Predictive Tracking (DPT):-

DPT is used for scalability and prediction based Tracking mechanism to provide distributed and energy efficient solution.[2]

Dynamic Clustering for Acoustic Tracking (DCAT):-

Dynamic Clustering for Acoustic Tracking is mainly used for single target tracking. Clusters are formed using Voronoi Diagrams. Only one Cluster Head turn out to be active when the signal strength sensed by Cluster Head exceeds a pre-determined threshold.[2]

Hierarchical prediction strategy (HPS):-

Hierarchical prediction strategy is formed using Voronoi division and the target next location is predicted via Least Square Method.[2]

1.2 Tracking Schemes for Peer to peer Networks

In tree or cluster-based methods, tracking task is performed by several nodes at a time and result in heavy computation burden on the root node or the CH. This will lose the healthiness of the system by failing root node or CH. To overcome this limitation architecture for target tracking is invented that is peer-to-peer. This tracking approached is based on single hop communications between neighboring nodes. [2]

1.2.1 Embedded filter based consensus

Distributed estimation using peer-to-peer Wireless Sensor Networks is based on successive improvements of local evaluations maintained at individual sensors. Each iteration of the algorithm contains a communication step where the sensors interchange information with their neighbors, and an update step where to improve its local estimate.[2]

1.3 Tracking Schemes for Other Networks

1.3.1 Prediction-based tracking

Prediction-based tracking methods are used to predict the future movement locations of the moving objects using current position and historical movement data. Some methods are used in prediction based tracking are mentioned below [1]

Distributed Predictive tracking algorithm (DPT):-

This is one of the distributed and scalable reduction based algorithm used for precisely tracking mobile targets using sensor networks. Cluster based architecture is used for more scalability and toughness. Algorithms are required after sensors are deployed and clusters are formed. Central control point is not needed in. So it eliminates the single point failures.[2]

Dual prediction reporting (DPR):-

DPR is that a sensor node which firstly predicts the movement of the object for the next reporting period. In the meantime, the base station does the same prediction based on the same objects movement history. If the observed object's movement matches the sensor node's prediction, no transmission is needed, since the base station has the same predictions as the sensor node. [2]

Prediction-based Energy Saving scheme (PES):-

Prediction-based Energy Saving scheme based on three mechanism prediction model, wake up mechanism, recovery mechanism. Prediction model anticipates the future movement of an object. Wake up mechanism decides which nodes has to be activated and when they should be activated. A recovery mechanism comes in picture only when the network misses the path of an object. [2]

Prediction-based tracking using sequential pattern (PTSP):-

Prediction-based tracking technique using sequential pattern predicts the future movements of the objects using least sensor nodes. PTSP is based on two stages: pattern generation and object tracking/ monitoring. In the first stage, huge data is collected from sensor nodes to build the the prediction model and aggregated at the sink in a database. Actual tracking of moving objects uses Activation Mechanism and Missing Object Recovery Mechanism. [1]

1.3.2 Mobicast message-based tracking

A new multicast communication paradigm called a "spatiotemporal multicast" or "Mobicast" was investigated to support spatiotemporal coordination in applications over wireless sensor networks. In a geographic zone at a particular point in time multicast is the delivered the information to all nodes. [1][2]

1.3.3 Polygon based Face tracking

It is method different from other tracking method. Polygon based face tracking is a tracking framework that identifies the movements of a target using polygon created by active sensors. Here face represent a polygon that construct to track the target. Here brink detection algorithm is used, which detects, 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.[1][2]

2. CONCLUSION

A wide range of methodology, network architectures are available for tracking in wireless sensor networks. Each algorithm/ methodology has its problems, benefits and possible improvement area. If we used prediction and detection together for object tracking error will be minimized in greater percentage.

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