Target Tracking Techniques for Wireless Sensor Networks

Mostafa Borouomand zadeh[1*] Sayed Mohsen Hashemi [2]and Mitra mohmedi karbalaii[3]

[1]Faculty Member, Department of ICT, Payam Noor University, Khuzestan of IRAN
[2]Young Researchers and Elite Club, Mayboad Branch, Islamic Azad University, Mayboad, Iran
[3]Expert of Khuzestan Water and Power Authority Company, Ahvaz, Iran

*Corresponding Author E-mail: mostafaboroumandzadeh@gmail.com

Abstract

A wireless sensor network consists of many tiny sensor nodes that can be used for collecting and processing of environmental information. One of the most important applications of wireless sensor networks is detect and target tracking. Also energy consumption is a critical problem in the design of wireless sensor networks. According to this note that energy efficient target tracking algorithms are used for precise tracking; in this paper we review the benefits and applications of WSN and analyze the some efficient target tracking techniques that proposed for WSN.

Keywords: Wireless Sensor Network (WSN), Energy Consumption, Target Tracking, Network Lifetime.

1. Introduction

In recent years, wireless sensor networks have been of interest to researchers. A wireless sensor network consists of many tiny sensor nodes that can be used for collecting and processing of environmental information. Nowadays, many applications have been proposed for sensor networks and their numbers are increase. These applications can be used in battle fields, identification of contaminated environments, environmental monitoring, analysis of structural conditions of buildings, roads and highways in intelligent applications in medicine and etc. Nodes in sensor networks, usually no addresses are unique, and what is most important in these networks is information collected by the sensor network. Also, due to the lack of available nodes in the process of dispersing them, the network nodes after energy consumption, would be practically useless (Zheng and Jamalipour, 2009; Akyildiz and Vuran, 2010; Akyildiz *et al.*, 2002). So the

optimization of energy consumption it is one of the challenges in this networks which many research has been done in recent years in this case. Other important application of wireless sensor networks is detect and target tracking. Target tracking is a one of the important applications in the WSN. Energy efficient target tracking algorithms are used for precise tracking (Ramya *et al.*, 2012). In this paper we review benefits and applications of WSN and some efficient target tracking techniques that proposed for WSN. In recent years, wireless sensor network has been of interest to researchers. A wireless sensor network consists of many tiny sensor nodes that can be used for collecting and processing of environmental information. Nowadays, many applications have been proposed for sensor networks and their numbers are increase. These applications can be used in battle fields, identification of contaminated environments, environmental monitoring, analysis of structural conditions of buildings, roads and highways in intelligent applications in medicine and etc. Nodes in sensor networks, usually no addresses are unique, and what is most important in these networks is information collected by the sensor network. Also, due to the lack of available nodes in the process of dispersing them, the network nodes after energy consumption, would be practically useless (Zheng and Jamalipour, 2009; Akyildiz and Vuran, 2010; Akyildiz *et al.*, 2002). So the optimization of energy consumption it is one of the challenges in this networks which many research has been done in recent years in this case. Other important application of wireless sensor networks is detect and target tracking. Target tracking is a one of the important applications in the WSN. Energy efficient target tracking algorithms are used for precise tracking (Ramya *et al.*, 2012). In this paper we review benefits and applications of WSN and some efficient target tracking techniques that proposed for WSN.

2. Applications and Benefits of WSN

WSNs have many applications. Some applications of these networks include:

Military applications: wireless sensor networks can be uses as an important part of communication systems, surveillance, navigation, and intelligent processing system. In these networks, nodes sometimes have GPS which uses for accurate positioning in war zones.

Fields of war: In the war field, sensor networks can be used for identification, statistical review of equipment and enemy forces as well as classification and tracking the arrangement and movement of enemy or friendly forces, and finally status of friendly forces towards enemy forces.

Identification of contaminated environments: In different environments possibility of infection is likely. Therefore, with use of these networks there could be significant pollution in the environment and even the concentration of pollutants in different areas may be seen. Finally using the data obtained can be achieving the state of environment.

Roads and smart highways: A social problem in the city is traffic control. By establishing a network of sensor nodes in the city and to locating nodes in the highways and city streets, can you make "smart" highways and streets and was aware of the status of vehicle traffic density.

Medical applications: In the fields of biology and the human studies, for knowledge of their physical condition sensor nodes can be used.

Target tracking: Tracking targets is one of the most important things that can be used in wireless sensor networks. For example, we can mention the following: Descendants of embedded systems, military surveillance, environmental monitoring, and industrial monitoring systems, personnel and wildlife tracing programs are needed. Energy source of sensor nodes in wireless sensor networks is usually a battery which recharge or replacement is harmful or even impossible. Therefore, the main research challenges of routing techniques in wireless sensor network are optimizing energy consumption and maximize network lifetime through energy saving and balancing the energy consumption of all nodes. Select the type of sensor nodes is a principle in the target tracking applications in sensor networks; because choosing the correct type of sensor nodes has a significant impact on increasing the tracking performance. Usually sensor nodes select according to targets type.

3. Target Tracking Challenges in WSN

Some of the advantages of target tracking system in WSN include: qualitative observations and correct, accurate signal processing, tracking accuracy and strength of the system. Challenges of wireless sensor networks include: source of energy and communication bandwidth constrained, control and distributed control algorithms and performance constraints of sensor nodes, especially when the network size is large and etc. Wireless sensor network has its limits in the design and resource. Energy limited, low bandwidth, short-range communication and limited processing and low storage capabilities in the each node is limited to the source. Design constraints dependent to the network application and is based on a controlled environment. Environment plays an important role in determining the size of the network, and how the pattern of network deployment. Energy consumption of wireless sensor networks is very important design factor. Therefore, in the target tracking methods should be considered that (Ramya *et al.*, 2012).

4. Target Tracking Techniques for WSN

Target tracking methods can classified as follow: tree-based target tracking, cluster-based target tracking, prediction-based target tracking, mobicast message-based target tracking and hybrid methods. By clustering, the network nodes are classified into two cluster heads and cluster members. In the cluster-based tracking algorithm, the cluster member nodes identify target and send the information to cluster heads. Cluster heads collect all information from members and calculate and

determine target location and send this information for sink node (central node). One of the most important advantages of clustering methods is to keep energy consumption to increase network lifetime. In the prediction-based tracking algorithms, the next position of target predicted by velocity and current path of target. This algorithms uses from node sleeping, so reduce energy consumption and increase lifetime of network. Mobicast-based algorithms for sink are actor for reliability and delivery of messages (Ramya *et al.*, 2012).

Some of the tree-based tracking methods are STUN (Scalable Tracking Using Networked Sensors), DCTC (Dynamic Convoy Tree-based Collaboration) (Zhang and Cao, 2004), OCO (Optimized Communication & Organization) (Tran and Yang, 2006), DAT (Deviation Avoidance Tree) and Z-DAT (Zone based-Deviation Avoidance Tree) (Ramya *et al.*, 2012). LEACH (Low Energy Adaptive Clustering Hierarchy) is a cluster-based method. PES (Prediction based Energy Saving) (Xu *et al.*, 2004a), DPT (Distributed Predicted Tracking) (Yang and Sikdar, 2003) and DPR (Dual Prediction-based Reporting) (Xu *et al.*, 2004b) are prediction-based methods. FAR (Face-aware routing) is a Mobicast-based method. In the following will examine some of the proposed and efficient methods.

OCO method (Tran and Yang, 2006) is a tree-based target tracking method which has capability to self-organization and routing with low computation overhead. OCO have four main step includes: position-collecting step, processing step, tracking step and maintenance step. In the position-collecting step, base sensor node collect positions of all nodes. In the processing step cleaning up the redundant nodes, detecting the border nodes and routing (finding shortest path between each node to the base) will be done with applies image processing techniques. In the tracking step all objects coming from outside the perimeter of the network will be detect and track. When a node was dead, maintenance phase is started. In the OCO there are three types of nodes: border nodes, forward nodes and redundant nodes. After the processing step, the base broadcasts messages to activate the set of border nodes. The border nodes have the sensor modules and the radio receiver modules ON state (i.e., ACTIVE state). The redundant nodes initially will be OFF state (i.e., SLEEP state). Periodically they wake up after a predefined long period to receive commands from the base node. If there is no command or the commands are not related to them, they again switch to OFF state. The rest of the nodes in the network are forwarding nodes, which have their sensor modules OFF state but the radio receiver modules ON state (i.e., FORWARD state) (Tran and Yang, 2006). Performance of this method evaluated in various simulation scenarios and show appropriate performance. Various states in OCO shows in the table. 1.

Table.1 various states in OCO

	Boarder nodes	Forwarding nodes	Redundant nodes
Sensor	Active	Sleep	Sleep
Radio	Receive	Receive	Sleep
MCU Board	Sleep; Weak up To Create Messages Only	Sleep; Weak up To Create Messages Only	Sleep

According to this note that sometimes movements of tracked objects are predictable, energy saving based on prediction which named PES (Xu *et al.*, 2004a), proposed for reduce energy consumption for target tracking. While other nodes will turn off and set in sleep modes in this method, also reduce the number of participating nodes in tracking activities. PES have three step: Prediction Model which predict next movement of participating nodes in tracking activities, Weak up mechanism which is based on some Initiatives in energy consumption and performance calculating, and Recovery mechanism which only uses while in tracking network, object is lost.

In (Bhuiyan, 2010) a prediction-based target tracking protocol proposed for saving energy consumption which named PET. This protocol proposed for extracting target movement path and using patterns of moving targets for energy savings, based on anticipated target tracking in wireless sensor networks. Simulation and evaluation results show that this method efficient tracks a target. The authors claim that the proposed protocol outperformed existing protocols in energy consumption. So increases the lifetime of wireless sensor networks.

Using heuristic-based methods can improve energy consumption of network. In the heuristic-based methods only nodes that are in the path of target are active and other nodes are inactive and hold off your energy. In (Deldar and Yaghmaee, 2011) authors proposed a heuristic-based energy aware method. This method considers two main parameters: space of Explored environment and residual energy of nodes for tree tracking. This method uses from a heuristic-based method in the network clustering. Authors classified this algorithm in two main sections: clustering and tracking. Clustering step is the starting of network and uses from static method for clustering. At the end of this stage, the network is divided into clusters that can begin tracking operations. At the beginning of the track step, only cluster heads are awake and other nodes in the cluster are in the sleep mode. When one target enters in the network, first cluster head which detect target becomes active. This cluster head register in its memory the three nodes for tracking with use of tracker node selection algorithm. These three nodes calculate the target. Three criteria are used to evaluate performance: number of nodes that died in a time period,

network lifetime and average energy consumption of nodes. Simulation results show that the proposed algorithm is energy efficient and achieve a high network lifetime.

5. Conclusion

In recent years, wireless sensor networks have been of interest to researchers. Energy consumption is a critical problem in the design of wireless sensor networks. Each research in this network should be considered energy consumption and network lifetime. According to this note that energy efficient target tracking algorithms are used for precise tracking; in this paper we review and analyze the some efficient target tracking techniques that proposed for WSN that consider energy consumption and network lifetime and improves its.

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