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# Target Tracking in Wireless Sensor Network

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## ABSTRACT

Wireless Sensor Network (WSN) comprises of huge number of spatially distributed homogeneous or heterogeneous 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. As WSN continuously monitor the environment, target tracking proved out to be one of the most practical application of WSN. This paper reviews different techniques of target tracking for static as well as moving target. Energy efficiency and optimized allocation of sensor nodes are critical requirements to maximize the life time of sensor network. So the basic evaluations of target tracking along with the energy conservation and task allocation optimization techniques for multi sensor and multi target tracking have also been discussed.

**Keywords-** WSN; task allocation; multi sensor; target tracking; energy conservation.

## 1. INTRODUCTION

WSN comprises of spatially distributed nodes that are capable of sending and receiving information from one node to another. The sensor nodes are capable of performing different functions such as sensing, processing, storing and communicating. Sensor nodes are typically small in size and are equipped with small size battery which are mostly non rechargeable and irreplaceable. Therefore energy conservation is the most critical issue in many application specially target tracking. Tracking can be done using single node or through collaboration between different nodes. Single node tracking results are not energy efficient and consume more power whereas choosing appropriate technique of collaborative tracking gives us better result of tracking as well as low energy dissipation. Collaborative tracking is also used for multi target tracking that perform operations for estimating the trajectories and finding out the velocity of mobile target.

## 2. TARGET TRACKING: AN OVERVIEW

Target tracking is the application of WSN whose goal is to trace the roaming path of an object which is considered as a target and to detect the position of target. As WSN continuously monitor the environment, it provides us space to enhance the energy efficiency. Target tracking scheme comprises of three interrelated subsystems which are shown in the figure 1.

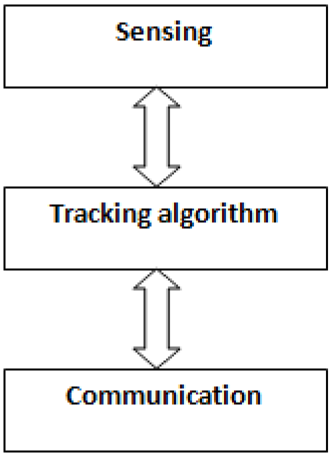


**Figure 1.** *Target tracking scheme classification*

The sensing subsystem is used to sense the target i.e. it comprises of the node that first detects the target and other nodes which gradually take part in detecting the target. Second subsystem is the prediction based algorithm which is used to trace the path of the desired target. The last one is communication subsystem which is used to send the information from one node to another. All these three subsystem works collaboratively and maintains the relationship among them.

## 3. TARGET TRACKING APPROACHES

In this section we have concentrated on presenting different approaches that can be used to track desired target. Most existing research into WSN target tracking adopts a uniform sampling interval which is time between two successive tracking events. In [19] nearest three nodes are used to track the target. Entropy based sensor selection is another approach [20] that is used to select next sensor such that its measurement leads to greatest reduction of target local distribution and it select one tasking sensor at each time step. This section outlines the existing algorithms that were designed by the researchers in context of target tracking problem in WSN.

### *3.1 Centralized approach*

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.

Optimized Communication and Organization (OCO) is based on centralized approach and comprises of four stages. The first stage is position collecting stage which collect the position of all the nodes in the network and store it in the base station. The second is processing stage which is used for sensing, detecting the border nodes, eliminating redundant nodes and routing. Next stage is tracking stage, which detect the target and send the relative information of the target to the base station. Initially the border nodes are on which sense the target and when it lost the target, a signal is sent to the neighboring nodes to track the lost target. Final stage is maintenance stage which is called when any of the nodes becomes dead. The base simply eliminates dead node. This method is better than the above two methods mentioned above as it not only show the maximum accuracy but also efficient energy dissipation and low communication overhead.

### *3.2 Distributed Approach*

In distributed approach there is no central entity in the network and all nodes are provided with same level of responsibility and work. Kalman Filter uses a set of mathematical equations that provides an efficient computational and recursive methods to estimate the state of a process while focusing on minimizing mean of squared error. Kalman filter is considered to be the best filtering technique and very powerful one.

Another distributed approach is particle filter. The problem of target tracking in particle filter algorithm is considered as dynamic state estimation problem and is based on monte carlo technique. PF creates a state transition model that is used to calculate target position at every time step and an observation model relating to current target observation. PF uses a sample of continuous posterior density function and assign appropriate weights to it that is updated as time progresses. The node that first detects the target is assigned with a particle along with appropriate weight. Sampling of density function is converted into discrete set and then prior is calculated using Gaussian method. Weights are updated and resampling of posterior function is done as the target moves. Each iteration of the algorithm comprises of two steps, one is communication step where the sensors interchange information with their neighbors, and another is an update step where each sensor uses this information to refine its local estimate.

## 4. ENERGY EFFICIENCY AND POWER MANAGEMENT IN TRACKING

Target tracking involves many sensor nodes to track the target. The nodes should be properly organized and the variations of nodes from sleep state to running state should be efficient so that unnecessary wakening of nodes can be eliminated. Network self organization provide us the solution which can be utilized to extend the network lifetime.

### *3.1 Network Self Organization: Energy Efficiency*

This approach decides when and which nodes should be on and also the network topology to be adapted for zentire process. Following are the subclasses of network self organization method:

#### *3.1.1 Sleep Scheduling*

The most commonly used approaches for sleep scheduling are Duty Cycle and Proactive wakeup. The idea of duty cycle is to put the nodes in sleep state most of the time and only wake them up periodically that is nodes are forced to sleep and awakened on demand whereas in proactive wakeup only those nodes are on where the target is expected to arrive. When the target moves farther neighboring nodes are on. Therefore activating only subset of nodes helps us to extend network lifetime. The various other approaches that have been proposed are Face based object tracking [11], Controlled greedy sleep algorithm [10] which determine optimal period length of activation in sleep schedule, P-GEP [9].

#### *3.1.2 Node Selection*

Node selection is the second subclass of network self organization which relates to maximizing the network lifetime. Network Lifetime Maximization Problem [12], Routing Path Length Problem [12], Naïve shortest Path selection are some of the approaches that have been proposed. The node selection problem can be viewed as Knapsack problem [13] whose goal is to maximize network lifetime by minimizing the number of nodes.

#### *3.1.3 Dynamic Clustering*

There exists pure dynamic clustering as well as hybrid clustering schemes. The simplest one is Adaptive Dynamic Cluster Based Tracking [14]. It consists of formation of cluster head which is chosen based on smallest ID and distance. This message is broadcasted within sensing range and the nodes which reply becomes member of that cluster. Reconfiguration is done in timely manner. Another scheme proposed for clustering is Particle Filter [15] which assigns a particle to the node that first detects the object. This technique is based Monte Carlo method which treats target as dynamic state estimation problem. Two widely used approaches are Herd Based target tracking [16] and hybrid Cluster Based target tracking [17].

### *3.2 Power Management in target tracking*

The main idea of power management is dynamic getting nodes to prolong sleep time of sensor nodes in order to reduce energy consumption of WSN. Power management consider various factors to reduce energy dissipation which include getting sensor node awake on time, information of neighboring nodes, distance between current node and neighbor nodes so that exact sleep state and sleep period of a node can be determined. This section includes two policies: Dynamic power management and Adaptive Cooperative power management.

### *3.2.1 Dynamic Power Management*

This policy is based on periodically sleeping and activating the sensor nodes. The node is provided with a timer which is used to record time of how long no event has been detected. When timer goes out, node goes to sleep state and then again return to active state after a fixed sleep time.

### *3.2.2 Adaptive cooperative Power Management*

This policy is based on the relative position of sensor nodes and target. Based on these positions sensor nodes are made on and off. Sensor node follow self decision policy that is sensor node make its own decisions for sleep state and interval.

## 5. CONCLUSIONS

In this paper we have studied different communication methods and some of the most recent tracking techniques whose goal is to conserve network energy and maintain data accuracy. It has also been realized that how power consumption can be reduced using ACPM policy. Energy dissipation is one of the critical issues that is still an active research and needs greater importance. Tracking schemes presented here depends on computation of sampling interval such that prediction is likely to succeed and tracking is continuous. This paper reviews how collaborative signal processing plays an effective role in tracking and preserving the energy as well.

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