# Chapter 34
# Efficient Data Reporting in a Multi-Object Tracking Using WSNs

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## ABSTRACT

*Object tracking is one of the most important applications in wireless sensor networks (WSNs). Many recent articles have been dedicated to localization of objects; however, few of these articles were concentrated on the reliability of network data reporting along with objects localization. In this work, the authors propose an efficient data reporting method for object tracking in WSNs. This paper aims to achieve both minimum energy consumption in reporting operation and balanced energy consumption among sensor nodes for WSN lifetime extension. Furthermore, data reliability is considered in the authors' model where the sensed data can reach the sink node in a more reliable way. This work first formulates the problem as 0/1 Integer Linear Programming (ILP) problem, and then proposes a SWARM intelligence for solving the optimization problem. Through simulation, the performance of proposed method to report information about the detected objects to the sink is compared with the previous works related to the authors' topic, such as LR-based object tracking algorithm, SEB, EPWSN, and ACO.*

## 1. INTRODUCTION

A wireless sensor network (WSN) is a network of large number of low-cost, battery operated, multifunctional, and small sized nodes. Nodes in this network can monitor real-world physical conditions such as temperature, and humidity, perform computations, and communicate with each other over a wireless media. They report the collected data to a base station called sink node (Ilyas, et al., 2005).

The design of WSN faces several challenges; one of the major challenges is the energy efficiency. Indeed, the sensor nodes suffer from the limitations of several resources (Kumar, et al., 2014), such as battery power (or energy), bandwidth, and storage resources. Energy is the most crucial resource because it not only determines the lifetime of the sensor nodes, but also the lifetime of the entire network (Ammari, 2009). The energy consumption in communication has been identified as the major source of energy consumption and costs significantly more than computation in WSNs (Pottie, et al., 2000). Consequently, the energy conservation should be the most important performance objective when designing routing protocols in WSNs (Ilyas, et al., 2005; Ammari, 2009; Pottie, et al., 2000; Akyildiz et al., 2002).

Network reliability is an essential aspect, always taken into consideration. Due to the usage of multi-hop routing techniques in WSNs, data packets are forwarded from a node to another (intermediate nodes) until reaching the sink node. Unexpected node failure or unstable wireless communication link (radio links behavior unpredictably varies over time and space) is common at each hop (Kim, et al., 2008; Baccour, et al., 2009); thus the packet drop occurs. On the other hand, the loss of important information prevents the sensor network from achieving its primary purpose which is data transfer (Joseph, et al., 2006). Hence, routing techniques should give priority to reliable transmission. At the same time, it is critical to reduce the number of lost packets in WSNs which will improve the network throughput and energy-efficiency.

In the last decade, optimization techniques inspired by swarm intelligence have become increasingly popular (Blum, et al., 2008). They are characterized by a decentralized way of working that mimics the behavior of swarms of social insects like ants, flocks of birds, or schools of fish (Blum, et al., 2008). Swarm intelligent systems are robust, scalable, adaptable, and can efficiently solve complex problems through simple behavior (McCune, et al., 2014) such as the shortest path finding. One of the most notable swarm intelligence techniques which can provide approximate solutions to optimization problems in a reasonable amount of computation time is Ant Colony System (ACS) (Blum, et al., 2008).

ACS (Gunes, et al., 2002) has been inspired from the food searching behavior of real ants which can be used to find the shortest path in WSNs. This paper focus on ACS which uses two artificial ant agents that is, Forward ant agent which travels from source to destination and find out information about quality of the path. Backward ant agent travels from destination to source and collect information about pheromone deposited. In contrast to other routing approaches (Rocca, et al., 2009), the ant colony optimization meta-heuristic proposed in the literature for WSNs is based only on local information of sensor nodes. That's to say, no routing tables or other information blocks have to be transmitted to neighbors or all nodes of the network (Gunes, et al., 2002).

The potential applications of WSNs involve object tracking, which have become one of the major usage of WSNs. The object tracking has many real-life applications such as wildlife animal monitoring and military area intrusion detection (Eswari, et al., 2013). However, there are plenty of works in this area (Demigha, et al., 2013). The object tracking process consists of two critical operations. The first is monitoring, where sensor nodes are used to detect and track the movement states of the mobile object. The second operation is reporting, where nodes detecting the object report their observations to the sink node (Chen, et al., 2013).

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