A Simulation Study of Mobility Management for Target Tracking in Wireless Sensor Networks

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Abstract --Of late, there has been increasing usage of Wireless Sensor Networks (WSNs) in real time applications including study of wildlife habitat, video surveillance and target tracking in healthcare and military fields. Thus the WSN became ubiquitous as it can be used in every field including the monitoring of adult house hold activities and mentally disordered people. Out of all such applications, target tracking is one of the most important applications of WSN. Many researchers contributed to the study of target tracking as found in the literature focusing on various approaches to solve the problem of target tracking. Recently Xu et al. proposed mechanisms for mobile sensor navigation and target tracking where target is assumed to be signal omitting target. Time of Arrival is the measurement employed by them to know the location of target through min-max approximation besides semi-definite programming relaxation. In this paper we used NS2 simulations to demonstrate the target tracking with focus on target tracking, throughput, and packet delivery ratio and delay performance. The results revealed that the proposed target tracking mechanism.

Index Terms–Wireless Sensor Network, sensor navigation, time of arrival,target tracking

I. INTRODUCTON

Wireless Sensor Network (WSN) is a collection of nodes that can collect data or sense data and send to base station or sink. The network is made up of the nodes in two or three tiers based on the configurations. WSNs became very popular in the real world applications. The data is sent from all nodes to sink or base station. Therefore it is known as many to one communication. Very important application area of WSN is target tracking. Before going to actual details about target tracking Figure 1 shows an overview of a typical WSN used for target tracking. A collection of sensor nodes linked to sink. In turn sink is made accessible to authorized people who interact with sink through wide area network like Internet.

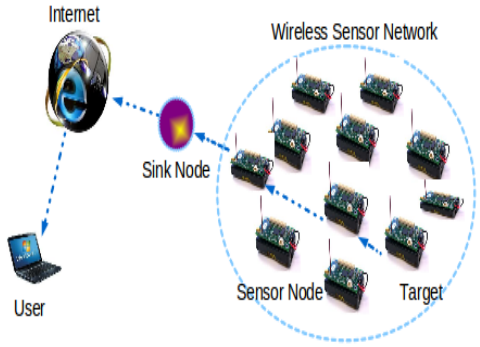

Figure 1 – Wireless sensor network

As can be shown in Figure 1, wireless sensor network is a collection of sensor nodes that can sense the unknown objects' data and send to the sink node. The sink node is there in between the Internet and sensor network. The authorized users can make queries on the sensed data through Internet.

Recently the world witnessed rapid growth in wireless networks including WSN. Tracking is one of the very important uses of sensor network [1]. There are many applications on mobile target tacking such as surveillance, wildlife monitoring, search and rescue, and robotic navigation. These applications can span to both civilian and military areas. When sensor nodes sense noisy data, they are supposed to predict the positions of target and make use of measurements in order to take decision to move or not to move. It does meanthat the nodes can track from their current positions or they can move to a new location in order to track target object. The goal of the nodes is to estimate the position of target in order to have planning for accurate tracking. Many techniques came into existence in target tracking as explored in related works section.

In this paper we consider both mobile sensor navigation and target tracking based on the TOA measurement approach. Weighted tracking algorithm is used in order to achieve this. Additionally we give some additional

mobility freedom to mobile nodes so that they can compute and move accordingly. It reduces the tracking time. This will improve the overall tracking performance of WSN nodes. In this paper our contribution is the simulation model built to demonstrate the tracking of targets by sensor nodes. The remainder of the paper is structured as follows. Section II reviews literature about target tracking in WSN. Section III presents the proposed target tracking approach. Section IV presents the experimental results while section V concludes the paper besides providing future directions.

II. RELATED WORKS

There are many techniques found in the literature for target tracking problem in WSN. Sensor node navigation also attracted many researchers. Effective navigation methods played an important role in accurate target tracking as observed in literature. Sequential location estimation is the way in which target tracking problem is understood [3]. As explored in [2] and [3] there are plethora of models for measuring the location of the target in WSN. The models includeSignal Angle of Arrival (AOA), Time Difference of Arrival (TDOA), Time o Arrival (TOA) and Received Signal Strength (RSS) and the combination of two or more models [3], [2]. In [4] a filter known as Kalman filter was proposed where predictive location tracking algorithm appeared effective. In [5] extended Kalman filter was employed for TOA measurement for target tracking. In [6] high accuracy is achieved by using RSS measurement model. Distributed mobility managementwas studied in [7] where trade off among parameters like coverage, loss of connectivity and target tracking quality improvement are considered. The cost of node communications and movement were considered in [8] besides the performance tradeoff.

A proportional navigational strategy was explored in [10] and [9] with mobile sensors having prior knowledge about target motion. A periodically time-varying algorithm was proposed in [11]. Robot and kinematics were employed in [12] for target tracking. Similar kind of approach was followed in [13] with simple cubic navigation approach. Recently Xu et al. [21] presented the combined approach where mobile sensor navigation and mobile target tracking are considered for solving the problem of target tracking.

III. PROPOSED SOLUTION

We consider a WSN where sensor nodes work for the intended use. However, they are able to track targets. They need to estimate the location of target and compute navigation requirements so as to move to different location in order to track accurately. Thus the tracking of target is subjected to the movement of mobile sensor node to different location. Here the cost of moving to different location is also considered. The cost of moving to another location and the cost of tracking are combined considered. For more details of the core functionality reader can read [21].

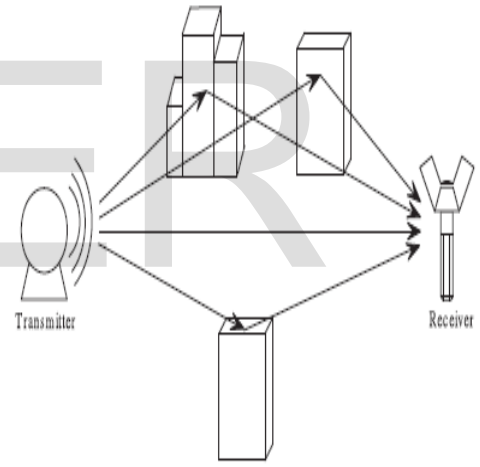

Figure 2 – Illustrates signal transmission path between transmitter and receiver

As can be seen in Figure 2, it is evident that there are transmitter and receiver. Based on this conceptual diagram the TOA measurement approach is used to know the position of target nodes for tracking effectively. When mobile sensor gets target signal (target is a signal emitting thing) it makes use of TOA measurement model in order to compute the position of the target object. Thus the connection between the target location and sensor location is established. The localization of sensor nodes is not unconditional as it depends on sensor geometry. Both the location of target and

determination of the location of mobile sensor node are important for accurate target tracking.

IV. EXPERIMENTAL RESULTS

Experiments are made with NS2 simulations. The environment used is NS2 running in Ubuntu operating system in a PC with 2GB RAM and core 2 dual processor. The simulations show the nodes creation as part of WSN and then target tracking.

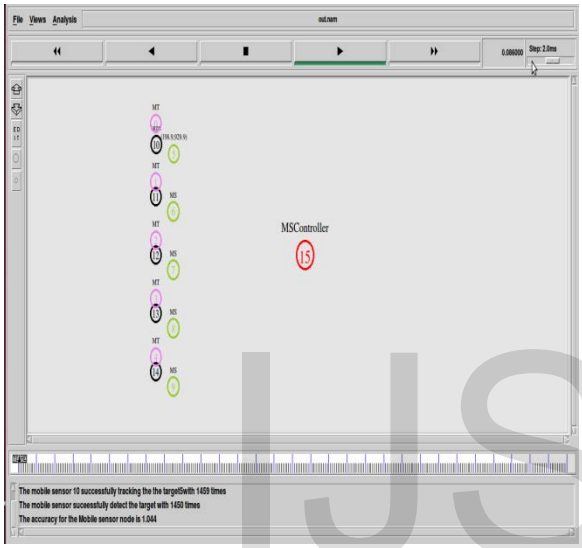

Figure 3 –Shows WSN with sensor nodes

As can be seen in Figure 3, it is evident that the sensor nodes were created along with target nodes and mobile sensor controller node. Node 15 is acting as target node while others play the respective roles such as target and mobile sensors.

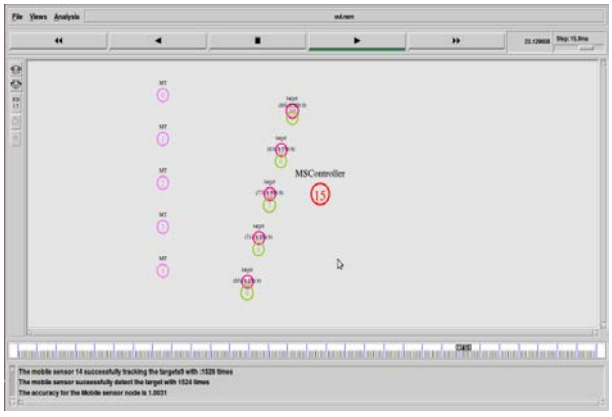

Figure 4 –Target tracking at work

As can be seen in Figure 4, it is evident that the sensor node 14 is able to track the target node 9 successfully. The sensor node is capable of detecting the target node.

Figure 5 –Routing protocol propagation

As seen in Figure 5, propagation of routing protocol is visible. The formal protocol hand shaking and general propagation of protocol is shown with respect to normal communication scenario.

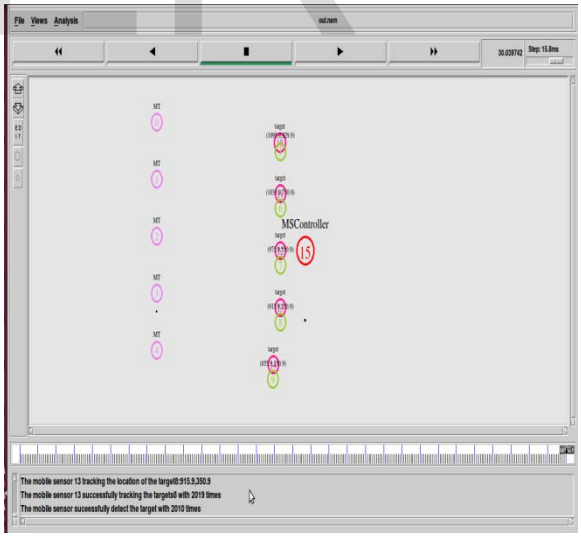

Figure 6 –Sensor node 13 tracks target

As shown in Figure 6, it is evident that the sensor node 13 is able to track target node 8 successfully.

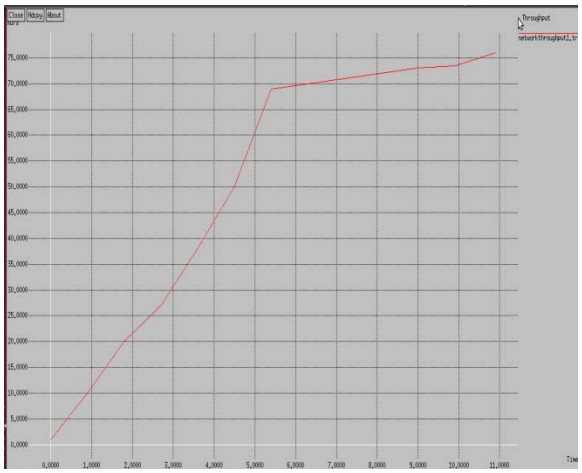

Figure 7 – Throughput performance

As shown in Figure 7, the throughput performance is shown. The simulation time is represented in horizontal axis while the vertical axis represents the number of packets received in bytes. As the time goes on the throughput is increased and maximized gradually.

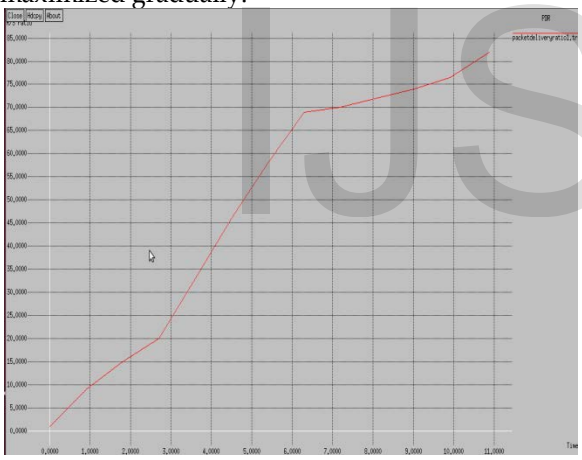

Figure 8 –Shows packet delivery ratio

As can be seen in Figure 8, it is evident that the horizontal axis represents simulation time while the vertical axis shows the packet delivery ratio. As the simulation time increases the packet delivery ratio increases towards maximizing the ratio.

V. CONCLUSONS AND FUTURE WORK

In this paper we studied the problem of target tracking in WSN. Target tracking is one of the most important researches with respect to tracking objects in real world applications. Time of Arrival is the measurement employed by many researchers in literature to know the location of target through min-max approximation besides semi-definite programming relaxation. In this paper we used NS2 simulations to demonstrate the target tracking with focus on target tracking, throughput, and packet delivery ratio and delay performance. The results revealed that the proposed target tracking mechanism. One important research direction for future work is to apply the mechanisms in real world application rather than simulation.

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