Chapter 6

Conclusion and Discussion

This thesis comprises four major research contribution to target tracking and connectivity problem using deterministically deployed directional sensor nodes. The main objective of this study on target tracking was to estimate the exact location of the target, with quality enhancement of tracking, and by using a minimum number of the sensors. This process must be an energy efficient process with the use of homogeneous directional sensors.

In chapter 2, we present the existing work on monitoring of the FoI and sensor connectivity in WSNs. Depending upon the requirement of FoI to be monitored for a target, coverage can be classified into three categories area coverage, point coverage, and barrier coverage. Our work mainly focuses on the exploration of related work in area coverage of the FoI. The research in the earlier work for estimation of sensing coverage in FoI using the deployed sensor nodes in WSNs has studied and summarised in this chapter. This chapter also covers issues and challenges for designing the coverage and connectivity preserves computation geometry and probabilistic-based approaches. This chapter also covers the essential designing issues such as the type of sensor nodes, the region of deployment, shape of FoI, and the border effects in the sensor node. A brief discussion on the impact of sensing models binary and probabilistic for sensing the FoI is also covered in this chapter.

In chapter 3, we have covered one of the important issues of target tracking in WSNs *i.e.,* k-target tracking problem using directional wireless sensor nodes on m-connected WSNs. Above problem of target tracking has properly explained and solved in this chapter. Triangle, square, and hexagonal, regular patterns for deployment of nodes in the FoI is used in the proposed approach. The main emphasis in this chapter is to cover important parameters *i.e.,* orientation of tracking region, deployment with a minimum number of directional nodes, the optimal side length of deployment pattern, and location of the nodes for solving the problem of target tracking in WSNs. We have validated our approach through numerical and simulation analysis. For designing of a Target Tracking System (TTS) we have demonstrated an application in this chapter. The TTS is deployed in our departmental computer lab, the corridor of the department towards the computer lab, and along the roadside in front of the Computer Science and Engineering department for tracking the target and gathering information. It does not involve excavation of the surface and also it reduces the effort in planning for WSNs.

In chapter 4 we formulate a problem nearly similar to that of chapter 3. In which a directional sensor node deployment problem for tracking of moving target inside the FoI is solved using the energy efficient methodology. The objective is to estimate locations with selected regular deployment pattern. Here, Fuzzy Logic System (FLS) is used for estimation of the route selection metric. The input to the fuzzy system is transmission energy, neighbour energy consumption, hop count, and residual energy. In this chapter, we have also use multiclass logistic regression for predicting the quality of tracking by supplying distance from target and duration of tracking as input to the regression model. An energy efficient routing algorithm by using the estimated route section metric is proposed. The algorithm will select the shortest path for reducing the energy consumption, consider the residual energy for providing the stability of the selected path and using tracking percent for maintaining the quality of tracking. We demonstrate an application of the proposed energy-efficient routing algorithm in the deployment of a Moving Target

Tracking System based on directional wireless sensor Network called MTS. We consider indoor and outdoor Scenarios for validation of our work. Using the directional tracking devices regularly deployed in such Scenarios for estimating the energy consumption, the lifetime of the network, and stability of the network.

Finally, in chapter 5, we focus on the effects of different mobility models on target tracking in directional WSNs. The mobility model of the target signifies, how their location, velocity, direction, and acceleration changes over time. We have first considered the time-related aspects such as pause time and return time. In the second part of this chapter, we have discussed target trajectory related characteristics such as velocity, the directional angle change, arrival at the destination and moving region inside the FoI. In this chapter, we also consider some aspects of the FoI *i.e.,* shape or boundary of the FoI. Through simulation analysis, we try to find out the impact of pause time on energy consumption of the network, the impact of velocity on the accuracy of the target tracking system, and impact of direction angle change on the accuracy of target tracking system.r

Future Directions

This thesis gives rise to a number of important research directions for coverage and connectivity of WSNs. Here we list some extensions to the work in this thesis.

- The target tracking through static sensor nodes is an easier task in comparison of the mobile sensor node for monitoring the dynamic target. It is a challenging problem to be addressed in the future.

- We discuss the scenarios of two-dimension FoI in case of tracking of a target, but we can track a target in three-dimensional space which could be the future work in this area.

- We have only considered the directional sensor nodes which are homogeneous, but in several cases, the sensor nodes may be heterogeneous; it could be the part of future work.

- In our approach of target tracking in WSNs, we use a binary coverage model for sensing the FoI which requires high accuracy and does not reflect the real behaviour of the sensing unit which must be replaced with probabilistic coverage model in future.