CHAPTER 1
INTRODUCTION

A brute force way to track the dynamic boundary is to make the sensors sample the contour points at regular intervals of time. The measurements have to be communicated to the sink at the rate of measurement by the sensors. The sink interpolates using the received measurements. Since the boundary may change at different rates in different sections, the refresh rate will be determined by the fastest part of the boundary and can hence result in significant wastage of battery energy, in a severely resource challenged system.

Therefore a good contour tracking algorithm minimising the number of measurements reported to the sink and ensuring the contour estimate is acceptably accurate at all times need to be developed.

1.1 MOTIVATION

The problem of dynamic boundary tracking is addressed by Nowak and Mitra (2003), Savvides et al. (2004), Duttagupta et al. (2008), Jin and Bertozzi (2007) and Joshi et al. (2009). Different aspects in contour tracking is dealt by each of them. Contour tracking is one of the interesting and challenging problem in sensor networks as the system needs to continuously monitor the phenomenon and at the same time the network life time need to be prolonged. Observing sensors reports to the sink. To prolong the lifetime of the network, the communication cost of the observing sensors can be reduced by the solution.

Reducing the communication cost in dynamic boundary estimation is the main aim of Nowak and Mitra (2003). The estimation algorithm is based
on multiscale partitioning of the sensor domain. Each cluster has a cluster head which reports the estimate to the sink at regular time intervals i.e., in-network processing is carried out by each cluster head. Thus, the reporting rate is independent of the rate of boundary change. A tree-based boundary estimation scheme with hierarchical cluster head reduces the number of transmissions.

Duttagupta et al. (2011) combined spatial and temporal estimations. They estimated the front and stored at the sink. Kalman filter-based temporal estimation technique tracks the change in the location of the front and these changes are transmitted by the observing sensors to the sink, to fix upper and lower bounds of the front. The front is measured when the estimation is outside of the bounds previously obtained.

The issues discussed in these works and the introductory section of this thesis have provided the motivation to work on reducing the communication cost of the sensors tracking the dynamic boundaries.

1.2 OBJECTIVES OF THE THESIS

Based on the issues mentioned above, the objectives of this work are formulated as follows:

- To develop contour tracking algorithm for dynamic contour estimation.
- To track the dynamic boundaries in a network of range sensors.
- To reduce the measurements to sink by adaptively refreshing each section of the boundary at the rate of its change.
- To construct statistical models to efficiently track and estimate dynamic boundaries.
• To develop a prediction model to exploit temporal correlation between the successive sensor observations.

• To develop a prediction model to exploit the spatial and temporal correlation between the observing and the successive observations of the sensors.

• To develop a distributed push algorithm to adaptively refresh the boundary points and compare the performance with the centralized model.

• To study the performance of the models using the percentage of queries made by the sink and error in sensor data and contour estimation.

• To model the contour evolution using Brownian motion with drift and correlated Brownian motion.

1.3 OUTLINE OF THE THESIS

Based on the objectives stated above, the work has been carried out and presented in the thesis as given below.

Chapter two covers the literature on tracking dynamic boundaries in wireless sensor network. The different approaches for dynamic contour tracking are presented. Survey on conservation of energy in wireless sensor network with respect to data acquisition by adaptive and model based active sampling are covered.

Simulation models used in testing the performance of the estimation algorithm is given in chapter three. The representation of contour and dynamic
contour is explained. The sensor sensing model and the measurement of a contour point on the dynamic boundary by the sensors is presented.

Chapter four explains the details about modeling the contour using Brownian motion with drift. The estimation algorithm for exploiting the temporal correlation of the sensor observations is explained. Evidence is given for achieving the objective of efficiently tracking the dynamic boundaries by adaptively refreshing the boundary points and thereby reducing the communication cost.

In chapter five the dynamic contour is modeled using correlated Brownian motion with drift and a new estimation algorithm is used for exploiting the spatial and temporal correlation. The boundary points are adaptively refreshed and tracked.

An adaptive refresh distributed model is covered in chapter six. In a centralized system all the sensors communicate directly to the sink and hence consume more energy in forwarding the data to the sink. The prediction algorithm exploits the spatial and temporal correlation between the sensors to estimate the time to push the data to the sink.

Chapter seven concludes with a summary of the work done and suggests a few topics for future work that could be carried out in continuation of this research.