

Analysis of Intruder Detection Probability of a Mobile Sensor Network in a Belt Region

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ABSTRACT

A belt region can be used to describe a border area, which has the characteristic as a long strip area. Intruders may want to trespass this region without authorization. To prevent this illegal border crossing, a mobile sensor network can be deployed in the region. Mobile sensors can move throughout a region looking for an intruder, while the number of mobile sensor nodes can be kept at the minimum. However, there are some design factors that impact the intruder detection probability of a mobile sensor network. These factors are environment model, intruder arrivals, intruder mobility, sensing capability of a sensor node, and sensor selection mechanism. By understanding the impacts of these factors to the intruder detection probability, a mobile sensor network can be designed for better performance. This paper presents a decent method to derive the intruder detection probability and analyzes the effects of the design factors to the intruder detection probability. The result will guide the way to design a mobile sensor network in a belt region with improved intruder detection probability.

Keywords

mobile sensor network; border surveillance system; decision theory; intruder detection

1. INTRODUCTION

A border separates countries from each other, which is established and maintained by a nation-state enforcement. Border area is defined as an area extended from borderline to some extent depending on countries' agreement. Illegal border crossings can cause many consequential problems [1]. The vast area requires a lot of human efforts to prevent illegal border crossing. To reduce human efforts, sensor technologies have been deployed in a border area. However, there are still open research issues in this field in order to reduce cost and improve performances of the sensor system.

The problem environment can be modelled as a belt region [2] as depicted in Figure 1, where the area is very long and has limited width. Intruders from the one side want to move across the region to the other side without being caught, while there are sensors inside the region trying to detect intruders before the intruders exit to

the other side. The problem of intruder detection in a belt region is to find the sensor node deployment strategies (i.e., a node placement, a node selection, and a node movement), that are capable of detecting the intruders before they exit an area to the other side. A success detection is defined as the condition that a sensor is able to sense an intruder inside its coverage before an intruder exit the area.

There have been many researches on the intruder detection in a belt region, in which they consider different aspects of the problem. The first aspect considers stationary sensor node, in which its main challenge is to place sensors such that their coverages can cover most fractions of the area as in [3] or cover intruders' paths as in [4]. This seems to be very efficient method, however a large number of stationary nodes are needed to be deployed in a large border area. Thus, some researchers have studied on how to move robots or unmanned vehicles equipped with several types of sensors in such a way that they can dynamically cover most parts of an area and increases the chance of an intruder detection, while keeping a number of sensor nodes at the minimum.

While there are many researches on the intruder detection of a mobile sensor network in a belt region, their analysis have been setup to solve intruder detection problems by neglecting some realistic aspects of the problems. Many researches employ the simplest sensing models, which neglects some crucial aspects of a sensor's capability in the real world. Some researches neglect the environment's characteristics and the intruders' behaviors that could affect the practical intruder mobility. This paper will consider the realistic aspects that are crucial to the intruder detection probability of a mobile sensor network, and make the reasonable assumptions on the parameters that will impact the intruder detection probability. By providing the decent analysis method, this paper will contribute to the field of a mobile sensor network as the framework for designing the mobile sensor network with the aim to increase the intruder detection probability.

This paper is organized as follows. In section 2, the related works in the field of intruder detection analysis are presented. Section 3 will describe the models and assumptions that influence the designing of a mobile sensor network. Then, section 4 will provide step-by-step method on how we derive the intruder detection probability as the measure for the performances of the mobile sensor network in a belt region. Section 5 will evaluate the parameters that have the impacts on the intruder probability. Lastly, section 6 will conclude this study.

2. RELATED WORKS

This paper presents the analysis of the intruder detection probability for the mobile sensor network in a belt region. There are some other researches that have done analyses on the intruder detection,

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