이동경로에 기반한 이상감지를 통한 도난 방지 연구

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Towards Theft Protection Using Trajectory Based Anomaly Detection

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Abstract

The growth in number and capacity of smart devices such as GPS enabled smart phones and PDAs present an unparalleled opportunity for diverse areas of life. In this paper we propose an approach for vehicle theft protection using GPS based trajectory anomaly detection. The detailed methodology of the proposed system is briefly described in this paper.

1. Introduction

GPS is a commendable technology to find location related activities. Presently a huge number of devices are enabled with this technology and getting more common with rapid speed. Currently more of these technologies are used for advancement of overall society and mankind. Like how to control traffic in a better way, finding peaks and low rush hours and movement behavior of people of a particular area.

A recent study used trajectory information of people for finding people attractive areas and their related movement patterns, which can lead to instructive insight to transport management, urban planning and location-based services (LBS) [1]. Similarly recent years have witnessed an increasing interest in the trajectory anomaly detection [2,3,4]. However, while several aspects of abnormality of moving objects have been investigated, there are very few works on discovering anomalous driving patterns by mining GPS traces with practical applications examined [5]. In this study, we aim to focus on anomalous private vehicle driving trajectory detection with the theft protection scenario.

While performing daily life activities, we use our private vehicles to visit a couple of places. The traces of these locations articulate our interest towards places and also spectacle movement behavior i.e. average vehicle speed, time of visiting particular places and area of the most visited places. Detection of anomaly using these parameters can infer the theft scenario for us.

In our study we formulate the trajectory of vehicles using the parameters of speed, movement time and area of location. These trajectories are then compared with each other to find anomaly. Complete methodology and working of the proposed system is described in the following sections.

This paper is organized as follows. In the 2nd section related work is discussed. The methodology of the proposed system and conclusion is exploited in 3rd section and 4th section respectively.

2. Related Work

Recently, innovations in GPS enabled smart device technologies and low-cost internet availability has tiled the way for development vital movement related services. Literature discusses a lot of solutions for trajectory outlier detection. In [2] a partition-and detect framework for detection of outlying sub-trajectories are proposed. They partition the complete trajectory into sub trajectories and applied distance and density based approaches to detect anomaly. Anomaly detection over the continuous trajectory stream is discussed in [3]. They used the approach of building local clusters upon trajectory stream and on the basis of cluster join mechanism outlier is detected. In [6] a temporal outlier detection approach for vehicle traffic data is developed, which discover the abnormal traffic change in the road network. In contrast, we define a different trajectory anomaly problem from previous ones, i.e., given all the trajectories between a certain source-destination cell-pair, we subdivide trajectory into road links, used to complete trajectory. Our objective is to discover anomaly trajectories on the basis of “few” and “different” approach.

3. Methodology of Proposed System

A vehicle's GPS trajectory is consists of a sequence of visited points i.e., t: {p1, p2 ,…., pn} Where; pi = (xi, yi, ti, Si) , xi and yi, shows latitude and longitude of trajectory respectively , ti is time at which point i is recorded and Si is the speed of moving object at point i. The speed of an itinerary is acquired by measuring distance and movement time between two consecutive GPS points and given by Si= (pi – pi-1) / (ti – ti-1).

For detection of anomaly we used a three step approach. Firstly trajectory with all of the above mentioned parameters are recorded and each of trajectories is drawn on real maps of visited area (city). Secondly, all of the link roads which are used for trajectory are extracted as shown in Figure 1.

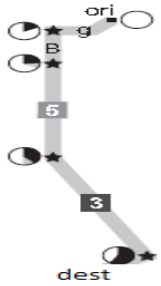

Figure 1: Road links in trajectory

In the above figure trajectory of a moving object is shown in the form of link of different roads. Trajectory starts from the origin "ori" and ends at destination "dest". Road links which are used by moving object are g, B, 5 and 3 respectively. Table 1 covers the detail of the recorded parameters of trajectory, where Column Stree Tag shows all the road links. Average speed, start and end time of each of corresponding road links are also provided in Table 1. Road links of the trajectories are evaluated on the parameters of speed, start time, end time and on the probability of using this road link and stored in the database repository. Weight of each road link is given by following equation.

$$W_T = \{1 - \sum_{i=0}^{i=n} (L + S + T)\} \quad (1)$$

Where; L is the probability of using this road link
S= average speed on this street
T= movement time on this street

Table 1: Road Link's required parameters (Street Tag, Average Speed, Start Time, and End Time)

Street Tag	Average Speed (km/h)	Start time	End time
g	60	10:25	10:30
B	55	10:30	10:38
5	58	10:38	10:50
3	62	10:50	11:05

On starting of every new trajectory (movement of the object) each GPS coordinate is drawn on the real map of the area and road link (tag) of movement area is fetched. Then the analogous road link information from the repository is procured and compared with current trajectory. If the irregularity of the current trajectory with historic values exceeds than a particular threshold T_t i.e. ($W_T \geq T_t$), it is termed as anomalous trajectory.

4. Conclusion

In this paper we presented a trajectory based real time vehicle theft protection model using. Anomaly in the movement of the vehicle is detected using parameters of Speed, time and probability of visiting particular location. The trajectory is drawn on real map of visited places and split in road links used for one complete trajectory. Anomaly is detected on the basis of comparison of these split roads trajectories. To the best of our knowledge, this is the first work that provides a trajectory based real time theft protection model.

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