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Implicit aggressive driving detection in social VANET

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Abstract

Human errors are the main reason for traffic accidents. Detection of aggressive driving, e.g. speeding and driving with smaller safety distance than recommended, is currently in the domain of law enforcement services. We propose a novel approach for aggressive driving detection using received signal strength indicator value measurement in vehicular ad hoc networks. We present an introduction to vehicular social networks, cluster formation and a short description of our method. Proposal is critically discussed in terms of implementation and privacy issues, and is followed by guidelines for future work in that field.

Keywords: VANET; aggressive driving; RSSI measurement; distributed detection

1. Introduction

Every year more than a million people die in traffic accidents, and an average driver wastes more than 30 hours annually in traffic congestions. Considering the rapid development and improvement in communication and sensor technologies, IoT is more and more ubiquitous in everyday life. Vehicles' manufacturers aimed to improve safety to lower the number of injured and deaths, and nevertheless to improve safety ratings and gain competitive advantage. Therefore, they put a huge effort in new safety-related technologies. In addition to typical vehicular sensors, such as rain sensors, blind spot detection, proximity warnings, etc., active safety technologies are becoming the norm rather than an exception.

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With technology tightly involved in driving, drivers' behavior is most often the reason for accidents. Thus, driving assistance helps drivers to concentrate on human controlled aspects of driving, while the environment is monitored by technology. Built-in driving assistance systems provide drivers with useful information about the vehicle parameters and the environment. Traditionally, only vehicle-related information was displayed, e.g. speed, gear, and lights status. Today, drivers' interface is enhanced with safety-related information systems, which display information about blind spots, distance to the vehicle in front and warnings about lane changing conditions. Even though all these systems enable additional safety, it is driver's choice whether to take them into account or not. Intentionally ignored warnings can lead to dangerous situations. Even though advanced safety systems can limit driver's acts to some limit, drivers can override them. Some prominent examples of such systems are speed limitation and safety distance mechanisms. Intentionally aggressive drivers can also disable many systems. In-vehicle technology thus cannot guarantee safety for other drivers. Therefore, we propose a mechanism for aggressive driving detection that runs on nearby vehicles.

2. Related work

Similar to the Internet of Things, vehicular networks followed the same evolutionary stages. From sensing networks, through mobile cloud to the fog computing in recent years. Participatory sensing and crowdsourcing are a novel but commonly used mechanism in smart city applications. [1] Among first applications in Vehicular Ad hoc Networks (VANETs) were Vehicular Sensor Networks. Communication among vehicles was extended to communication between vehicles and roadside units (RSU), in which case vehicular networks can act as an extension to the fixed network or as a sensor network that offloads data via RSUs. [2], [3] Routing in VANETs differs from routing in mobile ad hoc networks (MANETs) and static ad-hoc network in terms of node mobility. Whereas node mobility is constrained by the road network, speed is several orders of magnitude grater, and thus causes frequent changes in topology. Even though nodes' power consumption is not an issue as important as in wireless sensor networks, researchers presented numerous energy-efficient routing protocols. Many of them rely on radio link quality measurements, often the Received Signal Strength Indicator (RSSI) value. [4]–[6] Participatory sensing is one of the applications that could build on existing sensor data and add the ad-hoc communication capabilities. We can classify VANET applications into several categories, namely active safety, public service applications, applications for improved driving, and business and entertainment services. [7] Data communication underneath application layer is based on well-established communication patterns.

Driving style assessment methods evolved from self-assessment and self-reports, which have to be done before or after the driving, to the driving style assessment based on physiological parameters or vehicular sensor data. Real-time observation of drivers' physiological parameters or gathering of vehicle data requires special permissions and special equipment, which might not be available in most vehicles. In fact, intentionally aggressive drivers can disable these systems altogether, which can lead to dangerous situations for other people involved in traffic.

2.1. Vehicular social networks

Vehicular traffic typically follows patterns related to the human mobility. Most obvious are the density and distribution during work days and weekends, which also are also influenced by seasonal patterns on a greater time scale. On a smaller scale, there are prominent heavy traffic peaks in the morning and in the afternoon, when people are driving to and from work. While patterns differ from city to city, a generalization can be applied to the obtained data, and thus researchers proposed many models for predicting mobility patterns in the cities. [8] In terms of user experience, roads should and often are constructed upon people demands. This allows their daily commute to be more comfortable and time efficient. Analyzing New York City taxi and Uber datasets, taxi usage patterns and popular neighborhoods for some subcultures were found. [9] If we look at these patterns on a smaller scale, we can as well focus on per-street or per-lane mobility. In dense morning and evening traffic, distances between vehicles are relatively small, speeds are occasionally getting slower, therefore both spatial and temporal dependency between neighbor vehicles increase. Obviously, ephemeral social network can be formed in-between vehicles on the same street driving in the same direction. Using information from higher communication layers or contextual information about drivers, we can gather and determine their destinations. As mobility in road network is limited by the network