DSDCS: Detection of Safe Driving Via Crowd Sensing

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Abstract. Traffic safety plays an important role in smart transportation, and it has become a social issue worthy of attention. For detection of safe driving, we focus on the collection, processing, distribution, exchange, analysis and utilization of information, and aim at providing diverse services for drivers and passengers. By adopting crowdsourcing and crowd-sensing, we monitor the extreme driving behavior during the process of driving, trying to reduce the probability of traffic accidents. The smartphones are carried by passengers, which can sense the driving state of the vehicles with our proposed incentive mechanism. After the data is integrated, we are able to monitor the driving behavior more accurately, and finally secure the public transit. Finally, we developed a safe driving App for monitoring and evaluation.

Keywords: Crowd Sensing, Detection of Safe Driving, Crowdsourcing Incentive

1 Instruction

As we know, public transport plays a very important role in life. With the increase in the use of shuttle buses, the frequency of accidents is getting higher and higher. As almost every accident can cause major casualties and property losses, the security of public transport is of great significance. The road safety situation in China is very serious. The number of deaths due to road traffic safety accidents exceeds 200,000 each year. Statistics on traffic accidents in China indicate that more than 90% of accidents are caused by human factors and dangerous driving behavior. The driver is the manipulator of the car. If we can train the driver's driving literacy by detecting extreme driving behavior, many accidents will be avoided. Traditional technical means used professional equipment to detect extreme driving behavior. This method costs a lot and is

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difficult to popularize. Some researchers proposed to detect the driver's eye fatigue by installing a camera to detect the driver's eye movement. However, the image captured by the camera is not accurate enough and thus may easily lead to misjudgment. The sensor on the smartphone has high accuracy and no additional cost, and thus can be applied to traffic detection scenes. In addition, we also integrate the ideas of crowdsourcing. Drivers and passengers jointly sense data, and each cell phone can only be equivalent to one sensor node. Using the cooperative advantages of group perception, the data detected by crowd-sensing data can improve the sensing precision and enhance the credibility of the data through cleaning and fusion. In addition, due to differences in the location of the vehicle and the location of the smartphone, exploring the complementary relationship between the data in each group can further reduce the data error.

Crowdsourcing is a distributed problem-solving mechanism open to the public on the Internet. It integrates computers and public on the Internet to accomplish tasks that are difficult for computers to accomplish. According to the different forms of public crowdsourcing, crowdsourcing is divided into collaborative crowdsourcing and competitive crowdsourcing. The task of collaborative crowdsourcing is the need for public collaboration to complete, and the people who complete the task usually don't get rewards; and the task of competitive crowdsourcing is usually done by the individual independently, and the individuals who complete the task will receive corresponding rewards (such as money Remuneration) [1]. At present, there are many successful applications which use crowdsourced methods to solve image recognition and entity analysis which is difficult for computers to accomplish. The multi-sensing capabilities (geolocation, light, movement, audio and visual sensors, among others) of smartphones, provide a new variety of efficient means for opportunistic data transfer new crowdsourcing applications. A macro crowdsourcing task needs to be subdivided into many microscopic tasks, and the microscopic task is highly accepted by the user, so that the user is willing to assume the task. In this project, after the vehicle is over, the data obtained by each sensor node will be uploaded through the network. After that, the user needs to evaluate or label the trip. Since crowd-sourced data perception is based on human beings, crowd-sourced data collection can not only provide large-scale data for analysis, but also acquire subjective perceptions of passengers when detecting extreme driving behavior. Comprehensive objective data and subjective perceptions make the test results more accurate and user-friendly.

2 Related Work

2.1 Extreme driving behavior detection system

Guo et al [2] proposed "crowdsafe", which is a mobile crowd sensor system that utilizes the cooperative ability of bus passengers to improve detection of extreme driving behavior. In particular, they proposed the basic idea of solving the following three problems and made corresponding experimental results, including recognition of the passenger environment (for example, locating a passenger in a bus, detecting the position of a smartphone, such as a hand or a pocket), based on Multi-sensor fusion of extreme driving behavior detection, and strategies for investigating conscious behavior based on group collaboration and conflict resolution.Wathanyoo Khaisongkram et al. [3] studied the impact of the development of automotive autopilot assist systems and sensor technology on personal driving behavior. Therefore, the data stored by the on-vehicle device can be analyzed based on the driving state described by the driver's maneuver and driving environment. The precondition is that the classifier that identifies the driving state is modeled by the push sequence mark method (BSLM). By analyzing the recognition accuracy of each driving state, the BSLM-trained classifier is verified. As a result, the accuracy of recognizing the braking and deceleration conditions is normal, but the cruising accuracy of the parking state is high.

2.2 Incitation Mechanism of Mobile Crowd Sensing

R.I. Ogie[4] proposed that mobile crowd sensing is an emerging concept that allows intelligent cities to utilize the sensing capabilities of mobile devices and ubiquitous features to capture and mark phenomena of common interest.Therefore, whether or not it is possible to fully and effectively motivate participants to determine the most appropriate incentive mechanism is a major challenge for whether mobile crowdfunding applications can be widely used and adopted.

In addition to the existing work, researchers also studied complex event processing methods based on driving behavior detection which is based on smart phones[5], using five-factor models to predict driving behavior[6], and integrated driving behavior model[7], Bayesian network model scenarios and non-situation driving behavior assessment[8]. With regard to the practical application of crowdsourcing ideas, they studied a crowdsourcing perception-improving network model based on the incentive game[9], based on the study of the duration of the weighted scheduling framework for mobile sensor data acquisition[10], dynamic data-driven crowd sensing tasks assignment[11], a blacklist based on mobile crowd sensing anonymous authentication scheme[12] and a dynamic and quality-enhanced incentive mechanism for mobile crowd-sourcing[13]. Therefore, under the consideration of the idea of crowdsourcing and the adoption of a long-term incentive mechanism, we study the detection of extreme driving behavior based on crowdsourcing ideas.

3 Safe Driving Model of Sensing Fusion

3.1 The basic concept of crowdsourcing

“Crowdsourcing” was first proposed by the American journalist Jeff Howe. He believes that crowdsourcing is the act of a company or organization that has outsourced its tasks to its indefinite public network. When work is synergistic, crowdsourcing or mass production occurs; but crowdsourcing is often undertaken by individuals. Crowdsourcing is an important prerequisite for open call-to-action and potentially broad labor networks. To be precise, crowdsourcing is based on network technology and is a publicly called way to make full use of the Internet's individual user resources to outsource activities to the public's practice model.

Spatio-temporal crowdsourcing is based on the Internet of Things as a platform and individual terminal equipment as a unit. It gathers crowd-sourced participants on the Spatio-temporal platform, distributes various tasks through the crowdsourcing platform's engine, and controls the quality of crowd-sourced participants so that they can complete tasks in the spacetime of the physical world and receive certain rewards. Among them, the physical Spatio-temporal position of crowd-sourced participants generally has to meet the time-space constraints of crowd-sourcing tasks. Spatio-temporal crowdsourcing aims to use the Internet of Things platform to find people who are free, have a certain amount of knowledge and related skills, have a certain interest, and have corresponding computing capabilities and battery capacity. Spatio-temporal crowdsourcing uses their human intelligence and the terminal's meta-computing capabilities to organize their online offline physical world to complete some of the challenges that are too challenging for the machine and to make effective use of online and offline resources.

Extracting the features described above, we conclude that crowdsourcing is a distributed problem solving model. It assigns a work task to the mass network in a free and voluntary form through decomposition, which is a group of wisdom.

3.2 Extreme Driving Behavior Detection Based on Position Correlation

Differences in the location of passengers in the car will have an impact on the collection of data on the driving of the smartphone. The top view of the vehicle is shown in Fig 1, when the shuttle is turning left, the centrifugal force felt by passengers in Area C is greater and the sensor accuracy is the highest. For the right turn, the sensor accuracy of the D-zone passenger's smartphone is the highest. When the shuttle changes lanes, since the front wheels turn more than the rear wheels when turning, the accuracy in the front area of the shuttle is higher than that in the rear area, so the accuracy of the mobile phones in the front areas is the highest. For emergency braking and rapid acceleration, the accuracy of the mobile phone at the rear of the vehicle will be higher. In order to detect the driving condition of the vehicle, it is necessary to use data provided by a plurality of passengers sitting at different positions. In order to determine the position of the passengers, the passengers need to select the area before the start of the driving test to label the journey accordingly. In addition, these data are collected from multiple sensors and require the fusion of different characteristics of the data. Here, we use the tri-axis gyroscope sensor and tri-axis acceleration sensor configured in most smartphones. The tri-axis gyroscope sensor measures the angular velocity in six directions (xθ+, xθ-, yθ+, yθ-, zθ+, zθ-), tri-axis acceleration sensor is used to sense the linear acceleration in six directions (xa+, xa-, ya+, ya-, za+, za-). The data of the two sensors respectively reflect the different vehicle states. Crossover comparisons and compensations have been implemented to achieve the detection of extreme driving behaviors with multi-sensor fusion.

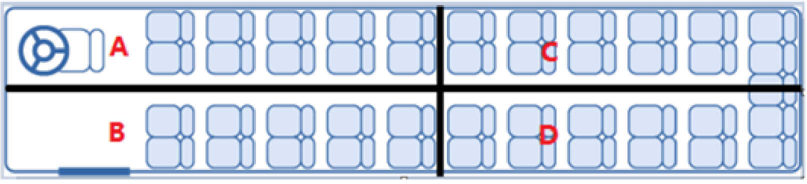

Fig. 1. Schematic Diagram of Space Distribution in bus

It is easier to judge the extreme driving behavior by using single sensor data. After collecting the data, it is judged that the overall angular velocity and linear acceleration are within the limited range, and the angular velocity is the same.

To solve this problem that the detection results obtained from different locations. In various decisions, we summarizing the previous papers can get Bayesian decision theorem to have higher accuracy, so the Bayesian formula is adopted[3]. Assume that n passengers {u1,u2,u3,...,un} have detected a driving behavior with an accuracy of {a1,a2,a3,...,an}. The probability that the detected final result r∈R is correct can be calculated as：

$$P(r|\Omega) = \frac{\mathrm{P}(\Omega|\mathrm{r})\mathrm{P}(\mathrm{r})}{\mathrm{P}(\Omega)} = \frac{P(\Omega|\mathrm{r})P(r)}{\Sigma_{ri\epsilon R}P(\Omega|\mathrm{r}_i)P(\mathrm{r}_i)}$$

The distribution of the detection result is represented by Ω, and r_i indicates each result within the area of the result w represents the user's usage coefficient. In this way, we can Calculate the weight of the result provided by each passenger:

$$c_j = w * \ln\frac{a_j}{1 - a_j}$$

As a result, we can calculate the weight of each result provided by passengers and use the highest credibility result as the final result. $f(u_i)$ indicates the result of passenger u_i detection：

$$P(r) = \mathrm{P}(\mathrm{r}|\Omega) = \frac{e^{\Sigma_{f(u_j)=r}c_j}}{\Sigma_{ri\epsilon R}(e^{\Sigma f(u_j)=r_i c_j})}$$

3.3 Decision Tips Based Machine Learning

In fact, crowd-based extreme driving behavior detection often encounters the following situation: For the same extreme driving behavior, we may use mobile phones at different locations in the vehicle to obtain different results. There are systematic errors in the data of passengers, including instrumental errors, operational errors, etc. of the sensors. Since the systematic error is always too large or too small, it cannot be reduced by averaging over many experiments. Crowdsourcing can solve this problem. After taking into account the data differences caused by location factors, we can compare the data uploaded by all passengers on a journey and use the fusion of data to compensate to reduce systematic errors in the stage of data preprocessing. It is especially important when using crowdsourced data to analyze driving behaviors. Based on the characteristics of the data collected by the two sensors, the passenger's evaluation was quantified, and the neural network algorithm was used to train the machine learning model using the preprocessed data. Then use Bayesian voting theory to make group decisions, and give appropriate weights based on the results given by the previous model. The final result is given considering the number of votes for each extreme driving behavior and the passenger's position information.

We assume that each passenger has uploaded all crowd-sourced data for the trip and given accurate evaluation tags and scores. The evaluation tag matrix is [AssessLabel] and the evaluation score matrix is [Score]. We set up the sensor to collect data once every 0.2 seconds. In the experiment, one trip is about 30 minutes. The uploaded 9000 sets of data contain the time matrix [Time] and the two sensor's triaxial parameters, which are respectively recorded as the acceleration parameter matrix [Acc] and angular velocity parameter matrix [Ang], the three matrices are combined into [data] matrix. This matrix of 9000*7 size was passed to the neural network for training after invalid data and null data were removed. In addition, after the ride is over, the tags and scores given by the passengers are combined into a [Label] matrix as an index to reduce the loss function.

$$Acc = [AccX, AccY, AccZ] \quad Ang = [AngX, AngY, AngZ] \quad Time = [T]$$

$$Data = [Acc\ Ang\ T] \qquad Label = [Score\ AssessLabel]$$

This neural network includes an input layer, an output layer, and three hidden layers. The first two hidden layers learn the change of the [Acc] matrix, the [Ang] matrix in one travel time series, and the third hidden layer learns the [Time] matrix changes in the multiple travels. All three hidden layers use a Gradient Descent algorithm to reduce the loss function and optimize the model parameters. Gradient Descent algorithm is a kind of iterative method, which is used to iteratively solve the minimum value of loss function to get the minimum loss function and model parameter value. Its iteration formula is:

$$A_{k+1} = A_k + P_k S^{(k)}$$

$S^{(k)}$ represents the negative direction of the gradient, P_k represents the search step length in the gradient direction, and gradient direction can be obtained by deriving the function. We determine the step size by a linear search algorithm. The closer to the target value, the smaller the step and the slower the progress.

3.4 Incentive measures

Incentive measures are important tools of crowdsourcing data acquisition. There are many ways to motivate the situation, including entertainment games, rewards, virtual points, social relationship incentives, and so on. How to improve the availability and efficiency of crowdsourced data. This requires designing appropriate incentives for crowdsourced awareness task requirements. Combined with relevant counts, it also satisfies the core issues of maximizing the respective benefits of the platform and the participants. For example, maximum incentives and top-k incentives have differences advantages and disadvantages. They differ in different situations.

We consider taking the passengers' uploading data as a condition to obtain the right to use the free Wi-Fi in the car and giving reward cards after the evaluation interface is completed, which can be used to redeem travel codes. First of all, we use anonymity to ensure the privacy of passengers. The incentive condition is that for each upload of good ride data, we give a reward card with a ride code, which can be used to offset the shuttle ride cost. The higher the level, the higher and lower the limit of the ridership code attached to the reward card, which can inspire the user to use the cycle. In order to introduce new users, we can make greater rewards to new users. When uploading the first good data, you can directly redeem a larger number of ride codes. In addition, if there is a condition for on-vehicle Wi-Fi in the shuttle, it can also provide the right to use Wi-Fi after the user uploads crowdsourced data.

4 Implementation of the platform

The Fig.2 show the gyroscope data and acceleration sensor data during the ride. The horizontal axis is time and the longitudinal axis is the value perceived by the sensor. And we can check shuttle bus information like the Fig.3, Departure location, arrival location, departure date for your choice, and then you can check the corresponding bus information. The Fig.4 is a reward card with a different amount of travel code, which can be used to offset the ride cost.

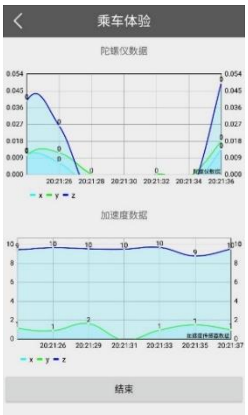

Fig.2 Sensor Data

Fig.3 Bus information

Fig.4 Reward code

5 Conclusion and Future Work

Crowdsourcing is one of the most efficient ways to obtain data and process data so far. Both of these are crucial to the time with information explosion. In this paper, we try to build a safe driving platform based on crowdsourcing, using the smart phone sensors of passengers to achieve real-time detection of driving and implementing incentive mechanisms for passengers. However, it remains to be seen whether there will be problems in the implementation process or whether the incentive mechanism is effective. We plan to apply our methods to intelligent car like unmanned driving in the future.

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