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Driving Quality Evaluation and Advice Integrated in Navigation Application

ABSTRACT

This disclosure describes techniques, implemented with specific permission from drivers, to measure and evaluate driver performance when operating a vehicle. Driving actions performed by the driver are evaluated based on the current context of traffic flow, weather, and other driving conditions. Recommendations are output based on driver performance. The techniques can improve measurement of driver performance and can enable comparisons with cohorts. The techniques can be used to generate a driving performance score, detection of road segments that are potentially unsafe, generation of alerts, and/or custom insurance offers.

KEYWORDS

- Driver performance
- Driver evaluation
- Driver safety
- Accident risk
- Navigation assistance
- Real-time traffic

BACKGROUND

Evaluating driver performance is of interest to drivers themselves to improve their driving habits, and to other entities such as insurance companies to properly estimate accident risk, offer rewards to good drivers, and offer advice, course recommendations, and/or incentives to drivers who seek to improve. Many insurance companies seek more detailed and more accurate information on the quality of driving displayed by an individual insured driver. Some companies provide custom-made mobile apps that log certain driving attributes such as speed,

acceleration, location, etc. Some technology has been focused on evaluating individual driving behavior based on certain activities detected with statistical analysis, such as distracted driving, or on metrics amenable to gamification or social networking aspects. However, existing technology provides only approximate estimates of driver accident risk.

DESCRIPTION

This disclosure describes measurement and evaluation of the quality of driver actions and behavior when driving a vehicle. The techniques are implemented with specific permission from the driver. With permission to conduct data analysis, the quality of driving can be measured in the context of current traffic flow, weather, and other driving conditions, and driving behavior over time can be evaluated in terms of safety.

The described techniques enable measurement of driving performance as a generic and comprehensive real-time mechanism for scoring driving performance in the context of the performance of other drivers, e.g., on the same road segment and under similar conditions, within the scope of a navigation application (or other similar application) running on a device in the vehicle. Use of data relating to other driver's decisions as well as more comprehensive map data available in the context of the navigation application, allows more precise estimation of an individual driver's accident risk as well as better targeted driving advice and tracking of the improvement in their driving behavior.

In addition, these techniques can be used for driving awareness and training, including issuance of targeted warnings, driving advice, and/or recommendations. Also, navigation applications can determine alternative navigation routes that are more suitable for a particular driver based on evaluated driver actions. Incentives for achieving driving targets can be provided, including calculating performance scores based on driver behavior. With user

permission, the scores can be provided to prospective insurance companies for better insurance rates, etc. Furthermore, in some cases, techniques can use integrated assisted driving functions to influence or alter driver decisions based on evaluated driver actions.

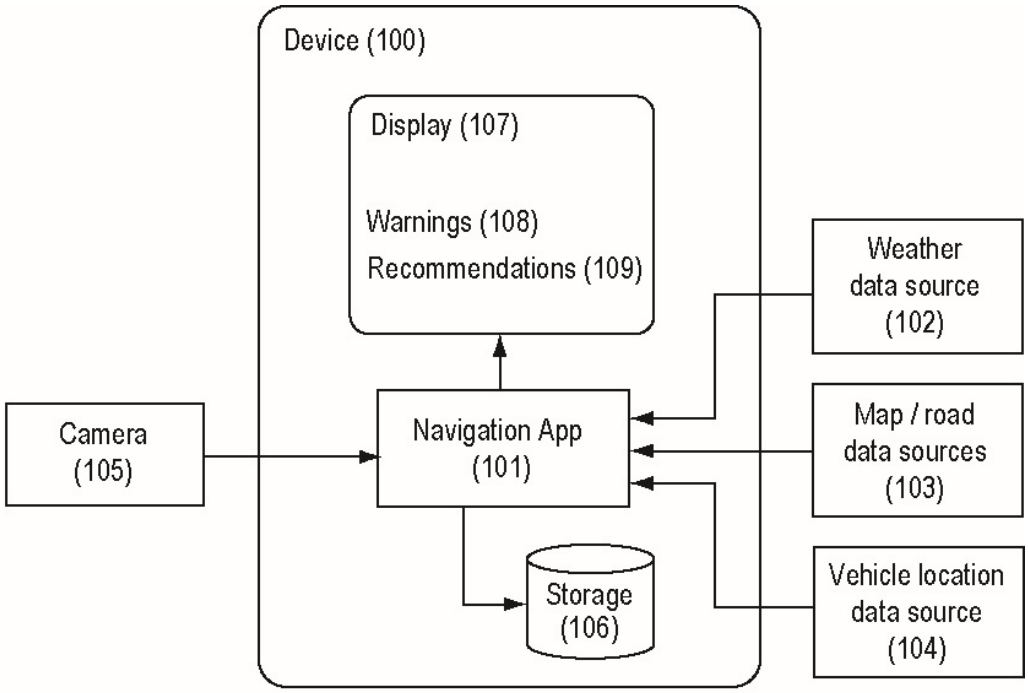

Fig. 1: Navigation System for Evaluating and Advising Driver Behavior

Fig. 1 shows an example navigation system that can use the described techniques to detect and evaluate driver behavior and provide advice to the driver. A device (100) can run a navigation application (101) that includes a user-activated driver evaluation mode that uses the described techniques. The device can be a vehicle navigation device (e.g., part of a vehicle system) or can be a portable user device, e.g., a smartphone. The user is provided with options to enable or disable the described techniques, and are provided with information about the type of information that is obtained and/or utilized for data analytics to evaluate driver performance. The user can permit specific types of data to be utilized and can deny use of other types of data.

The navigation application can receive a variety of user-permitted data for use in driver evaluation. Weather data can be received from a weather data feed offered by a weather data source (102), which describes the current weather for the region surrounding the driver. The navigation application also can receive map and road data from one or more map/ road data sources (103) to determine a current speed limit in the driver's road segment and/or other traffic rules, road conditions, etc. in the driver's area.

In addition, the navigation application receives vehicle location data from a vehicle location data source (103) that describes locations of vehicles and traffic on the same road segment (and can also include vehicle speed data). For example, the vehicle location data can be derived from other vehicle devices (with permission from respective users of such devices) that send vehicle locations, such as smartphones, in-dash vehicle navigation systems, etc. Such location data includes no other information about the vehicles and drivers. The vehicle location data can be updated frequently such that speeds and trajectories of the vehicles and other vehicle behavior can be determined over time.

The vehicle location data is filtered to the same time interval as the driver's driving activity, e.g., taking place concurrently with the driving activity. Weather data and vehicle location data can be obtained in close to real-time, allowing real-time or near real-time evaluation of the driver's actions, driving conditions, and/or comparisons to other drivers in the same area. For example, statistics on live traffic in the area nearby and surrounding the vehicle and specifically on the current road segment can be used.

In some cases, the vehicle location data can be filtered across different time intervals, e.g., time intervals from days, weeks, months, etc. in the past, during which weather conditions and other conditions (e.g., day/night) existed similar to the current conditions. Such conditions

can be, for example, an icy road segment on a weekday morning, heavy fog with low visibility on a weekend night, etc. This data can be used to establish a baseline of average driver behavior in similar conditions, and/or can be used to assist evaluation of driver behavior, e.g., if data for the current time interval is unavailable or scarce.

If permission is obtained from the driver, a camera (105) onboard the vehicle can be used to provide images of the road surrounding the driver's vehicle. This can provide additional data that can be used in the measuring and/or evaluation of driving actions. For example, road conditions surrounding the vehicle can be determined at the time of driving for improved accuracy in evaluation.

If driver permission is received, the navigation application can measure the individual driver's performance, and record how well the driver observes traffic signs, driving rules, speed limits, etc. With user permission, the application can also compare a driver's performance with the performance of other drivers who are driving with similar conditions as the driver.

For example, if a driver has given permission, the actions taken by the driver are compared with actions that other drivers took at the same time, on the same road, and/or under the same driving conditions as the driver (such data is obtained with permission from the respective other drivers), as determined based on the received vehicle location data indicating traffic flow and other vehicle behavior. Traffic flow and/or behavior by other drivers in the same area as the driver can indicate how most other drivers were driving under the same driving conditions.

Comparisons with other drivers can thus indicate unusual or potentially unsafe driving actions by the driver such as too fast a speed or unsafe maneuvers, and/or can indicate whether actions taken by the driver are likely to be compliant with traffic rules or were dictated by road,

traffic, weather conditions, etc. For example, traffic patterns in the traffic data may reveal a non-working traffic light that operated as a four-way stop, thus the driver could not cross it as part of a general traffic flow. In another example, a vehicle moving at just under the speed limit on a 55 mile-per-hour road segment but under icy road conditions could be an indication of dangerous driving. Some examples are described below for detecting certain unsafe driving behaviors or dangerous driving situations with the incorporation of driving measurements and traffic flow data into the navigation application.

In some cases, with permission, the driver's actions can be scored based on comparison with other driver's actions, e.g., an average of other driver's actions that establishes a baseline or standard to measure a score against. For example, an overall performance score of the driver can be calculated and stored in local storage (106). In some cases, the overall performance score may be adjusted periodically, as the driver takes any of particular types of driving actions, and/or is determined to have made an unsafe or illegal driving action. For example, a driving action is evaluated (e.g., compared to other drivers/vehicles, speed limits, or other data) and assigned an individual score, and the overall performance score is adjusted based on the individual score. In some cases, driver actions and/or relevant traffic data, weather condition data, and other data associated with those actions can be temporarily stored in the local storage of the device (e.g., encrypted), and then the actions evaluated at a later time to calculate a score, after which the driver action data and other data are deleted from storage.

In some cases, when the performance score of the driver falls below a target threshold, live warnings (108) and/or recommendations (109) on what steps should be taken can be issued to the driver, e.g., on a display (107) that is connected to the device and/or via other output components such as audio. Such warnings and recommendations can include indications to slow

the vehicle by a particular amount, apply brakes earlier to avoid running a red light, avoid passing a car on a 2-lane road, change lanes to let another vehicle pass, etc.

In some cases, when permitted by local regulations, and if the driver has given prior permission and if the driver's vehicle includes assisted driving features, overriding safety actions can be performed when a performance score of the driver (calculated in near real time) falls below the target threshold. Drivers are provided with opportunities to correct driving performance and alerts that overriding actions may become necessary. Overriding actions are only performed in limited contexts, e.g., to ensure the safety of the driver's vehicle and of the traffic nearby. The assisted driving features that are utilized to perform overriding actions are evaluated and approved for performance of such actions in the context in which the actions are performed. For example, such safety actions can override the driver's current action and cause the vehicle to safely perform actions such as causing the vehicle to lower its speed, safely pulling over the vehicle to the road shoulder, or aligning the motion of the vehicle with that of the main traffic flow. Thereafter, if safe driving behavior is detected, certain overridden driving features can be restored to the driver, such as faster acceleration or an increased top speed. Also, these driving features can be re-enabled when the vehicle's location signal confirms that the vehicle is located in certain special areas, such as a track or test facility.

The navigation application can additionally function as a driving training system. As indicated above, the navigation application can output warnings, driving advice, and recommendations based on determination of where the driver has violated rules or strayed from the general, rule-compliant traffic behavior. The navigation app can also output a rank of the driver in terms of their performance relative to known drivers in their geographic area. This information may be output in real time or after a particular trip is completed.

The driver can enable or disable any of the various features of the techniques described herein, and/or can enable all or some features for particular periods of time (e.g., a vacation trip, commute to work, etc.).

In some cases, as the data about the driver's performance accumulates, the driver can give permission for the navigation application to communicate with third-parties, e.g., insurance companies to indicate that the user is a good driver to qualify for lower insurance rates or other benefits. In some cases, performance goals for the driver can be set that need to be fulfilled and communicated before the driver is eligible for certain insurance rate discounts or promotions. In some cases, only a final overall performance score is relayed to the insurance company and particular evaluated driving actions taken by the driver are not retained or revealed. Thus, if receiving driving performance data from the navigation application, an insurance company only receives a rating, and does not have the ability to record driving behavior. For example, an insurance company can subscribe to data feeds from a service that runs on top of the navigation application and request ratings for an insured driver or prospective driver based on various driving tasks or contexts.

As a driving history of drivers is measured with appropriate consent of the drivers and privacy of driver identities, a set of data may be created that can be utilized to advertise, e.g., insurance options, or other offers. These described techniques provide a finer granularity of information than existing methods for matching drivers of particular driving behaviors with appropriate insurance options. A deeper understanding of potential customers can enable insurers to provide advertisements or offers, and can potentially enable real-time quotes for insurance.

Examples of detecting unsafe driving behavior or dangerous driving situations

Measuring the running of a stop light

As the aggregate movement of many vehicles is sampled at a sufficient rate, it can be possible to measure whether a particular traffic signal is red or green based on current traffic flow. Since almost all users will stop at a red light, any vehicle that proceeds while the other nearby vehicles are stopped can be considered likely to have violated a red light signal. This is not a perfect measurement, but over time it can indicate drivers who are more likely to violate a signal based on past occurrences.

Measurement of unsafe passing

Real-time data can be used to detect when one car overtakes another on, e.g., a two lane highway. If an oncoming car is too close, or if the current section of road forbids passing, such a passing maneuver can be flagged as dangerous.

Measurement of driving too fast for conditions

A road's speed limit applies under general safe conditions, and a vehicle's speed should be reduced for safety reasons when more dangerous conditions are present. If a stretch of road is detected to have most drivers travelling at a certain speed, then vehicles travelling faster may be flagged for driving faster than conditions warrant. Current weather conditions, as obtained from weather services, may indicate snow, ice, rain, fog or other adverse road conditions. Over time and after several occurrences of unsafe high speeds, a driver can be warned regarding the dangers of such unsafe driving.

In general, the overall traffic flow rate can be aggregated and any drivers which deviate significantly from the norm can be measured. This can be a better measure of reckless driving

than exceeding a posted speed limit. Furthermore, in certain locales there may not be a posted speed limit, in which cases the average traffic flow rate can be used to determine a safe speed.

Measurement of unsafe intersections

Another use of the described techniques is to obtain analytics that can make roads safer. Real-time measurements provided by these techniques can be used to measure a vehicle accident rate at particular locations and determine that the accident rate is high, or determine a pattern of bad driving behavior that is clustered in a specific area. This data can then be used to flag sections of the local road network that are dangerous and/or in need of improvement. Such data can be shared with the municipality in charge of the roads. The navigation application can be updated with information about unsafe road segments and intersections so that navigation routes can be provided that avoid these places, e.g., potentially removing these places from the road network when planning routes.

Drivers in Special Circumstances

For beginning drivers learning how to drive vehicles, or drivers with a record of unsafe driving, driver participation in described techniques for determining driver performance can be required in some cases, e.g., for a particular amount of time, if the driver wants to drive a particular vehicle, obtain driving insurance, or utilize some other driving-related service. In some cases, only a final overall performance score can be relayed to the service requiring participation to allow the service to compare or rank the driver to other drivers. The particular evaluated driving actions taken by the driver are not retained or sent to the service.

In some cases, commercial drivers can be mandated to participate in driver performance measurement, e.g., to limit the liability of a parent company. For example, driving a semi-truck (or other heavy vehicle) in the mountains can be dangerous if the speed of the truck is not

carefully maintained on steep downhill segments. Not all truck drivers know this, and bad accidents can occur due to runaway trucks. These described techniques can provide real-time driving advice based on topography and weather conditions to prevent costly accidents.

The described techniques can be implemented in a separate app running on a device, or can be built into existing applications, such as a navigation app, a digital map app, a road conditions app, etc. Features can be implemented in vehicle dashboard devices, in a vehicular device with a global positioning sensor (GPS), or in standalone user devices (e.g., smartphones, wearable devices, etc.).

Users are provided with options to grant permissions to and/or to disable described features entirely. The various features of the system are implemented only with user permission to access user information that serves as input to the system (e.g., user driving actions and driving conditions, camera input, a user's location, user context information, a user's preferences, etc.). Users may be provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein may enable collection of user information, and if the user is sent content or communications from a server. Certain techniques are not implemented if users deny permission. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques, implemented with specific permission from drivers, to measure and evaluate driver performance when operating a vehicle. Driving actions performed

by the driver are evaluated based on the current context of traffic flow, weather, and other driving conditions. Recommendations are output based on driver performance. The techniques can improve measurement of driver performance and can enable comparisons with cohorts. The techniques can be used to generate a driving performance score, detection of road segments that are potentially unsafe, generation of alerts, and/or custom insurance offers.