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Driver Training Using an Advanced Driver-Assistance System (ADAS)

Abstract:

A driver-training assistant that accesses features of an Advanced Driver-Assistance System (ADAS) to train drivers is described. The driver-training assistant uses detection capabilities of the ADAS to determine a performance of the driver and indicate a correction to the driver. Such an indication may be provided to the driver through a visual, audible, or haptic aide.

Keywords:

driver training, advanced driver-assistance system (ADAS), smart car, self-driving car

Background:

An advanced driver-assistance system (ADAS) installed in a vehicle today offers many features that enhance or automate driving tasks. The ADAS system may combine controller feedback with detection capabilities, such as image sensing or radar sensing, to offer a driver an enhanced or automated function that alleviates a burden that the driver might otherwise manage. Examples of such an enhanced or automated function include adaptive cruise control, lane centering, navigating, and vehicle parking.

In certain circumstances, it may be necessary for a driver to manually perform and override the function that the ADAS is performing. If the driver has historically relied on the ADAS to perform the function and has not learned to perform the function himself, it is possible that the driver will fail to perform the function upon being called to do so. Techniques to train a driver to perform the task, combining detection capabilities of the ADAS with a driver-training assistant that includes a controller, are described herein.

Detailed Description:

Fig. 1 illustrates an example advanced driver-assistance system (ADAS) that includes a driver-training assistant. Although Fig. 1 illustrates the elements integrated into an example vehicle, one or more of the elements may be partitioned to other systems that are not part of the vehicle, such as a server that is part of a cloud environment, a mobile application, a mobile device, such as a smart phone, or other complementary mechanism.

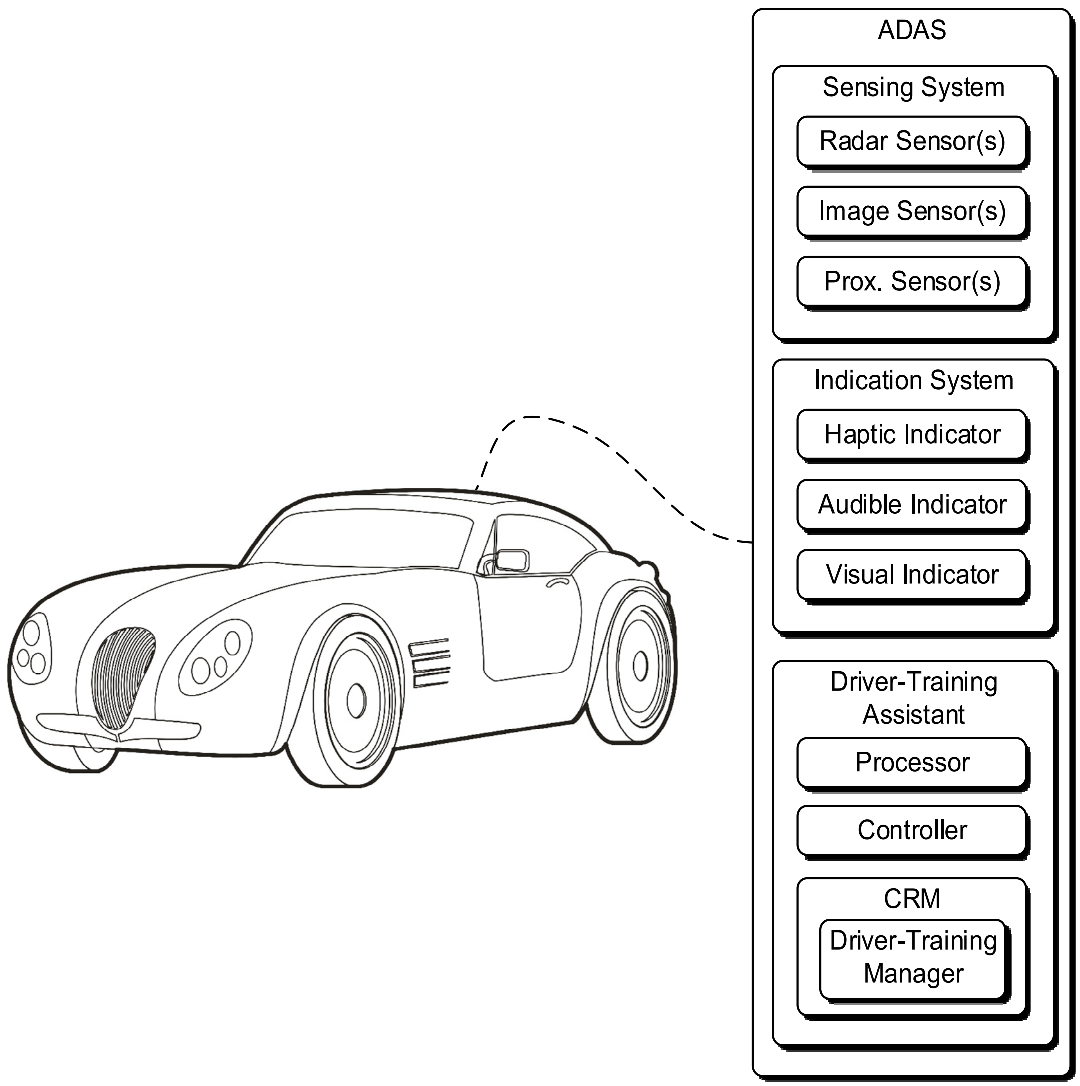

Figure 1

The example ADAS includes a sensing system that includes one or more radar sensors, one or more image sensors, and one or more proximity sensors. The sensing system may detect objects and distances of the objects relative to the vehicle (*e.g.*, another vehicle or a curb) as well as characteristics of a driving surface (*e.g.*, a painted line associated to a driving lane, a slope or geometry associated with the driving surface, or a condition of the driving surface). The ADAS also includes an indication system that includes a haptic indicator (*e.g.*, a vibrating mechanism that may be felt by a driver), an audible indicator (*e.g.*, an audio speaker that may be heard by the driver), and a visual indicator (*e.g.*, a display that may be viewed by the driver).

The ADAS also includes a driver-training assistant that includes a processor, a controller, and a computer-readable storage medium that contains executable code or instructions in the form of a driver-training manager. In some instances, the controller may be a proportional integral derivative (PID) controller while in other instances the controller may be a model predictive control (MPC) controller. In general, the processor executing the code or instructions of the driver-training manager may direct the controller to (i) receive data from the ADAS sensing system, (ii) determine a performance of a driver, and (iii) determine a corrective action for the driver-training assistant to indicate to the driver.

In the instance where the controller is a PID controller, this may include the PID controller comparing data from the ADAS sensing system against driver performance thresholds to compute a weighted sum that accounts for a cross-track-error (CTE) (*e.g.*, a proportionate term), a difference in timesteps/sampling rates (*e.g.*, a derivative term), and an accumulation of CTEs over time (*e.g.*, an integral term) to yield a corrective action that might be indicated to the driver. As an example, if a path of the vehicle, as guided by the driver and monitored by the PID controller, does not meet a performance threshold (*e.g.*, the path of the vehicle is "offline" by a threshold percentage), the driver-training assistant will provide an indication that the driver needs to take a corrective action.

In the instance where the controller is an MPC controller, algorithms may take into account additional variables (*e.g.*, braking or throttle information, historical patterns of the driver, and so forth) to formulate a predictive model and optimize or partially implement a corrective action. As an example, if vehicle is traveling at an excessive rate of speed that is not optimal for a particular function (such as parallel-parking a vehicle), the MPC controller may initiate functions that control the speed of the vehicle as the driver is performing the operation (*e.g.*, trigger computer-controlled actuators that either regulate the throttle or apply a braking function).

In some instances, a convolutional neural network may augment or replace functions performed by the PID or MPC controller. For example, the convolutional neural network may take inputs in the form of images from multiple cameras included on the vehicle as well as brake and throttle information to initiate functions that control the vehicle as the driver is performing the operation.

The driver-training assistant is configurable to provide training that corresponds to an expected driver performance or skill level. For example, a vehicle fleet provider, a training service, or the driver himself may configure the driver-training assistant to provide training that corresponds to a novice skill level, an intermediate skill level, or an expert skill level. Such configuring may include adjusting values associated with driver performance thresholds that may be stored within the driver-training manager. The configuring may also include adjusting levels or gradations of controller feedback, effective to correlate a "degree" of a corrective action, as provided by the driver-training assistant, to an expected performance or skill level.

The driver-training assistant may also collect data associated with skill levels across multiple drivers, manage skill level certifications, and so forth. Such data may be stored in a computer-readable medium (CRM) that includes the driver-training manager or wirelessly communicated to another entity, such as a centralized server used to manage training a workforce.

Fig. 2 illustrates an example of an ADAS that includes a driver-training assistant training a driver to parallel-park a vehicle.

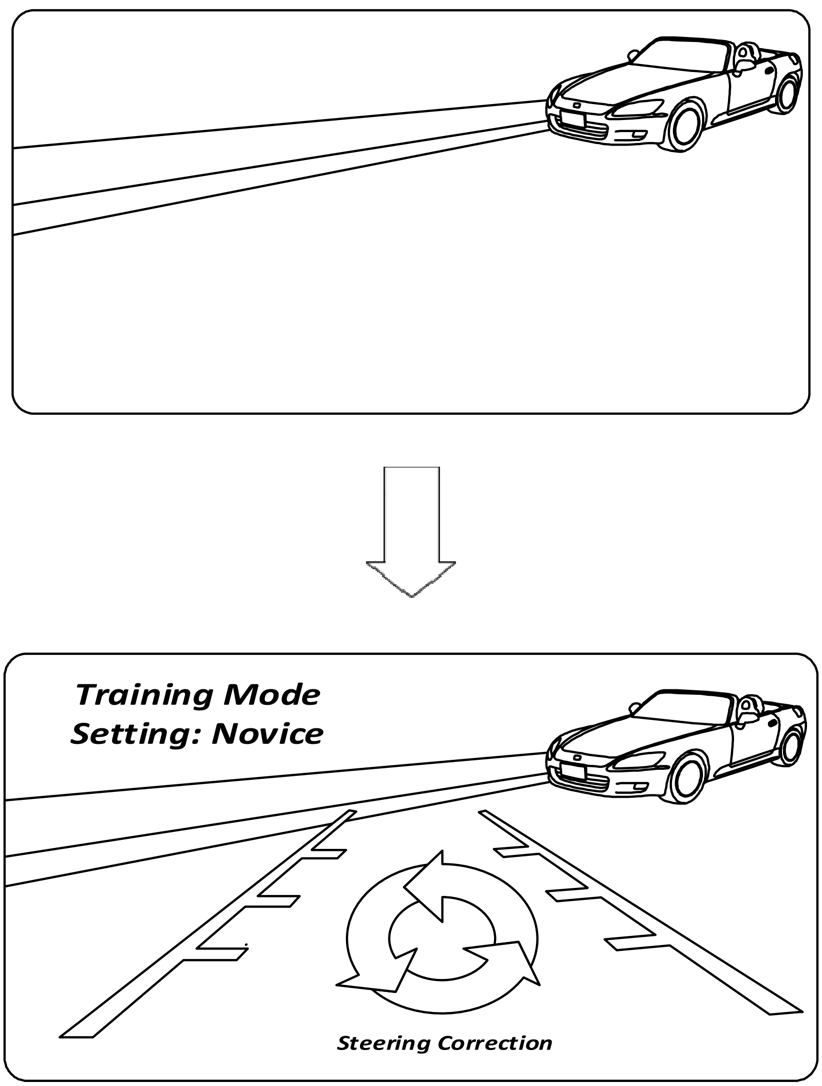

Figure 2

As illustrated by the top illustration of Fig. 2, an image sensor with a line-of-sight to the rear of the vehicle presents, through the display, a view of a rear area of the vehicle as the driver is performing a parallel-parking task. As illustrated, the view of the rear area of the vehicle includes another vehicle parked next to a curb. In this instance, an autonomous parallel-parking function of the ADAS is disabled and the driver-training assistant is in an active training mode, having thresholds set to train the driver to perform to a novice skill level.

While the driver is performing the parallel-parking task, the processor executes the instructions of the driver-training manager, causing the ADAS sensing system to detect positioning data that corresponds to a parking entry angle, a position of the vehicle relative to a curb, and a position of the vehicle relative to the other vehicle. Upon receiving the positioning data, the controller determines that the driver's performance does not meet the novice skill level, as the positioning data violates thresholds associated with the novice skill level. The controller further determines that the driver needs to perform a corrective action. As illustrated by the bottom illustration of Fig. 2, the driver-training assistant transitions the indication system (*e.g.*, the display) to present the corrective action. In this example instance, the visual aids include parallel-parking guidelines and an immediate steering correction for the driver to perform. Also, and as illustrated by the bottom illustration of Fig. 2, the display may indicate the training mode and corresponding skill-level setting.

The driver-training assistant may utilize a variety or combination of indicators. For example, in addition to a visual indicator (*e.g.*, the display of the present example), a haptic indicator (*e.g.*, vibrations through a steering wheel or seat of the vehicle) may indicate that the driver needs to make a correction while an audio indicator (*e.g.*, an audible command through a speaker) may instruct that the driver needs to make a correction.

In general, the driver-training assistant may provide indications in different gradations or degrees. For example, a visual indication may be bright, dim, or semi-transparent, and may also appear or disappear based on the driver's ability to meet a performance threshold. An audible indication may be at a high or low volume. A haptic indication may correspond to a strong vibration or even be directional in nature.

The driver-training assistant may include controls allowing a driver to make an election as to both if and when systems, programs or features described herein may enable collection of driver information, and if the driver information is stored or sent to another entity such as a centralized server that manages a workforce or is associated with an insurance company. In addition, the driver-training assistant may treat information 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, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the driver may have control over what information the driver-training assistant gathers about the driver and what portions of that information the driver-training assistant provides to another entity.

The aforementioned techniques are not limited to the described examples and are applicable to many variations. As a first example, the aforementioned techniques may apply to training a NASCAR driver to drive a racing line he might not otherwise see or choose. As a second example, the aforementioned techniques may apply to training a driver to manage more-aptly a vehicle in non-optimum driving conditions based on detected road conditions such as snow or ice. The aforementioned techniques may apply to vehicles other than automobiles, including vehicles used in fields of aviation (*e.g.*, airplanes and helicopters), construction (*e.g.*, excavators, cranes, graders, and front-end loaders), and marine (*e.g.*, boats) to name but a few. Furthermore, portions of the techniques may be performed using mobile platforms (*e.g.*, smart phones, tablets, and wearable devices) or mobile applications (*e.g.*, navigation applications or training-specific applications).