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In-Vehicle Infotainment (IVI) System User Interface (UI) Enhancement

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Abstract:

This publication describes an application software that may be used in an in-vehicle infotainment (IVI) system with its associated user interface (UI) or a portable computing device such as a smartphone. The application software distinguishes a driver's touch from that of a front-seat passenger's touch by evaluating the angle of the user interacting with the UI. The ability of the application software to correctly interpret the user's touch allows for optimal interaction with the UI and, in the case of the driver, helps reduce distracted driving. To conserve resources, machine learning (ML) may train the application software's model remotely off-line.

Keywords:

In-vehicle infotainment (IVI), in-car entertainment (ICE), head unit (HU), user interface (UI), automotive navigation system, driver, passenger, vehicle occupant, machine learning (ML), neural network, deep learning, artificial intelligence (AI), smartphone, tablet, user equipment (UE).

Background:

Automotive makers, processor, memory, and embedded computing device manufacturers, software, and operating system (OS) developers, and the like are creating increasingly sophisticated in-vehicle infotainment (IVI) systems. The ubiquitous use of smartphones helps fuel a consumer's appetite for an IVI that offers more than a radio and a music player. The automotive industry in cooperation with the high-tech industry has responded to such a demand by creating IVI systems with an integrated user interface (UI) capable of offering a vehicle occupant (e.g., driver, passenger) an interactive experience with the IVI.

Figure 1 illustrates an example IVI with its associated UI.

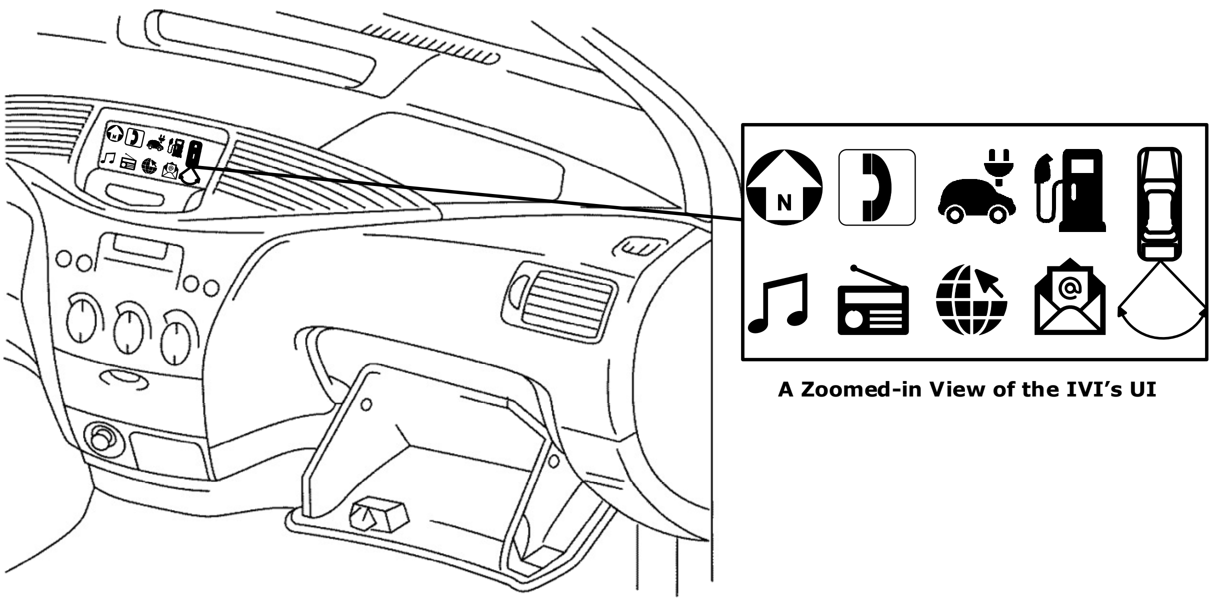

Figure 1

The automotive industry and its high-tech partners design IVI systems with UIs that, among other things, help the driver focus on the main task at hand, which is driving. As illustrated in Figure 1, the IVI's UI may display application software that enhance the driving experience by incorporating features, such as a rear dashcam to aid the driver reverse the vehicle, parking assistance, navigation, energy level (e.g., fossil fuel, electric charge), direction to the nearest charging/fuel station, hands-free email (may be read out loud on the vehicle's speakers), hands-free phone, radio stations (e.g., amplitude modulation (AM), frequency modulation (FM), satellite), and other features. Nevertheless, safe driving is still an important goal of the automotive industry. As the industry evolves and adds more useful features to the IVI, the automotive industry is also mindful not to overwhelm the driver by inviting him or her to spend an excessive amount of time manipulating the UI.

As Figure 1 illustrates, it is desirable for the driver to have an optimal interaction with the UI so that the driver can reap the benefits of the IVI's features, while still practicing safe driving. Nonetheless, touch screens, as in the case of the IVI's UI or a smart phone, require a considerable amount of cognitive ability for meaningful interaction. The cognitive task becomes even more challenging for the driver to reach for the UI, successfully touch the intended button that is off-centered from him or her, as in the case of the IVI's UI, and still focus on the road.

Description:

Vehicle interior engineers and designers integrate a user interface (UI), which is often found in the middle of the driver and the front-seat passenger, when designing in-vehicle infotainment (IVI) systems. In addition, the automotive industry may integrate many controls at the steering wheel, such as cruise control, signals, windshield wipers, headlight beams, sound system, phone answering, embedded device networking (Bluetooth™), amplitude modulation (AM), frequency modulation (FM), and satellite radio. This invention, however, focuses on a user’s experience (UX) with the UI often found between the driver and the front-seat passenger.

The addition of the IVI’s UI is a normal progression to the controls that a vehicle occupant may have already used. In legacy car models, the location of the controls for features like heating, air-conditioning (AC), air flow, AM/FM radio, airbags, and emergency lights button, are increasingly being replaced by a touchscreen UI. In addition, modern cars integrate other useful features in the UI, such as a rear dashcam to aid the driver to reverse the vehicle, parking assistance, navigation, energy level (e.g., fossil fuel, electric charge), direction to the nearest charging/fuel station, hands-free email (may be read out loud on the vehicle’s speakers), hands-free phone, and AM, FM, and satellite radio. In some respects, the automotive industry has added many features to the IVI, while being mindful of the dangers of distracted-driving. To this end, the automotive industry, in collaboration with the high-tech industry, wants to find additional ways to help limit the time the driver interacts with the UI.

Engineers understand the inherent added burden for the vehicle occupant to successfully take the intended action on the UI, while interacting with it at an angle. Consider a driver who is driving a vehicle with a steering wheel at the left of the cabin reaching for a button on the UI, which is located to the right of the driver. The driver tends to touch closer to him or her than he or she intends to do.

To illustrate the driver's challenge in touching the intended button while driving, consider the illustration in Figure 2.

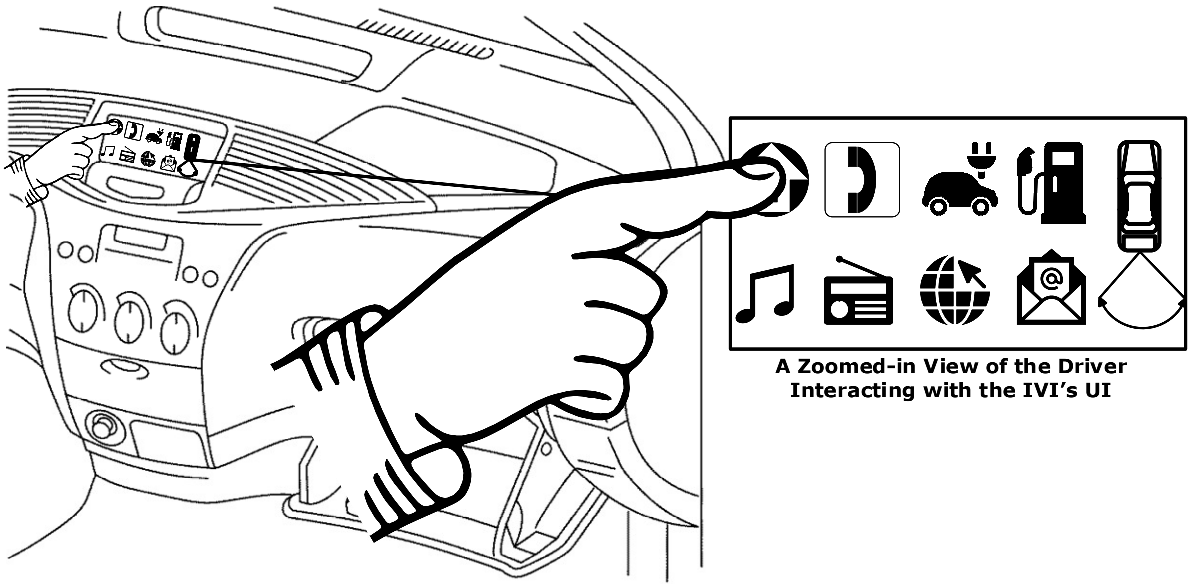

Figure 2

Consider the driver in Figure 2 reaching for the navigation button using his or her right-hand index finger. The driver is aiming for the middle of the navigation button — however, the pad of the index finger touches the UI to the left of the intended target (refer to Figure 1 for comparison). Moreover, when the driver intends to swipe up, he or she swipes up with a lower-left to upper-right angle. Differently said, the driver tends to push away while swiping up and pull towards while swiping down.

In contrast, a front-seat passenger would have an opposite intended-target to actual-touch effect, because the passenger is manipulating the UI from the opposite side of the driver. The aim of the application software is to infer the driver's or the front-seat passenger's intended-action and respond accordingly, while minimizing the need for the user to make a correction, thus, spending less time manipulating the UI. In addition, the application software makes an adjustment depending on whether the driver or the front-seat passenger is manipulating the UI and accounts for the fact that not all cars have the steering wheel to the left of the cabins.

To determine whether the car has a steering wheel to the left of the cabin or the right of the cabin, the application software may use several markers, such as car model, one-time user input, various car sensors, the frequency of reaching the UI from the left versus from the right, and global positioning system (GPS) to determine whether the driver drives on the right side of the road (most of the World) or the left side of the road (e.g., the United Kingdom, Australia, Hong Kong, New Zealand, Japan). The application software may use the same markers to determine whether the driver or the passenger is manipulating the UI. In addition, however, the application software compares the coordinates of each displayed button to the touch on the UI. If the touch is on the left of the target, the user is most-likely reaching from the left of the UI. And, vice-versa, if the touch is to the right of the intended target, the user is most-likely reaching from the right of the UI.

To determine which user manipulates the UI, and to determine the needed adjustment, the application software uses a model that leverages machine learning (ML), as shown in Figure 3.

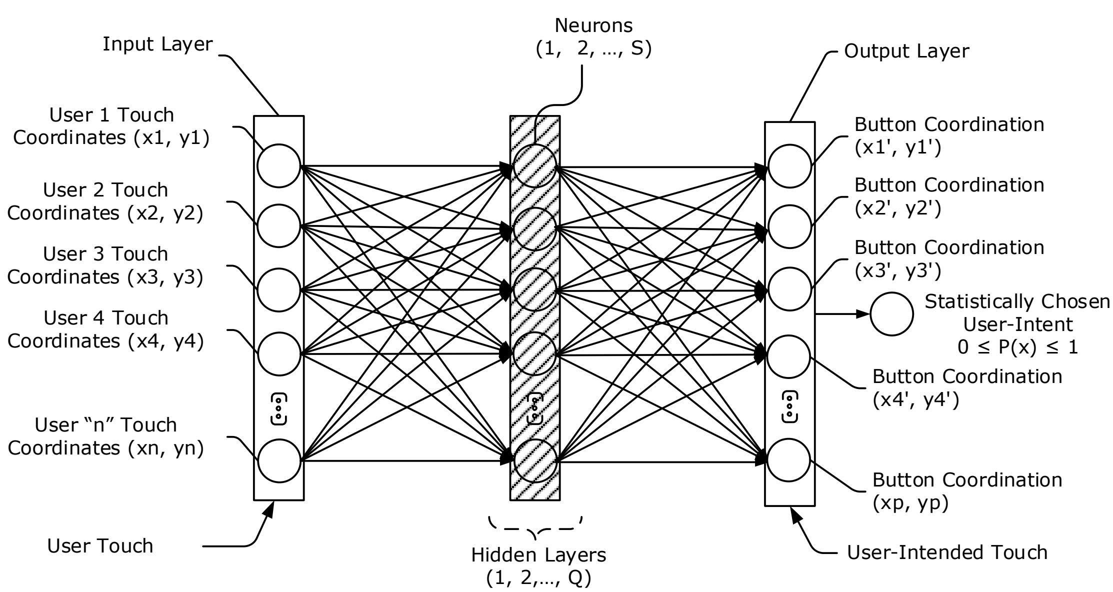

Figure 3

Figure 3 demonstrates a neural network used for translating the user's touch to his or her intended action (e.g., touch button, swipe) and making the necessary adjustment. The neural network in Figure 3 illustrates an input layer, several hidden layers, and an output layer. The input layer includes user-initiated touch from "n" number of users, which are captured by the UI. There are "Q" number of hidden layers with up to "S" number of neurons in each layer. There can be a different quantity of neurons in each hidden layer. The output layer includes "p" number of bins with different probabilities on the user-intended action. The bin with the closest probability to one (1) is interpreted as the correct output. In this scenario, the number of outputs "p" is different from the number of inputs "n", because there can be different possible outcomes for different inputs.

Given the large computational power that machine learning can use to train a model to make the necessary adjustment for a large number of possible inputs, the model training can be performed on a cloud, server, or other capable computing device or system. Periodic model updates are sent to each car's IVI or a user's smartphone, which allows the IVI or the smartphone to execute the model even if that IVI or smartphone do not have the resources to update the model itself.

Further to the descriptions above, a user 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 (e.g., a user's preferences or current location), and if the user wants content or communications from a server. 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, 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 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.

The application software may also be used in car models without sophisticated IVI systems with their associated UIs, such as when the vehicle occupant uses a smartphone with downloaded application software.

Figure 4 illustrates how the user may mount a smartphone inside a vehicle's cabin.

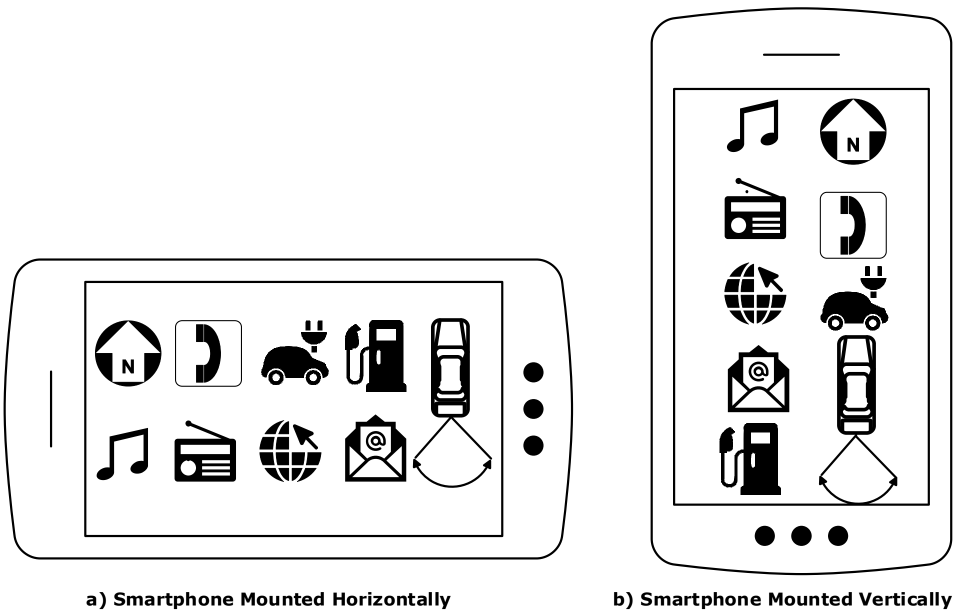

Figure 4

Figure 4 illustrates two exemplary positions that the driver may mount the smartphone with the proper OS that supports this invention (mounting brackets not shown). Nevertheless, Figure 4a shows only one of the two possible horizontal mounting positions — the vehicle occupant may flip the smartphone 180 degrees. Similarly, Figure 4b shows only one of the two possible vertical mounted positions — again, the vehicle occupant may flip the smartphone 180 degrees. While using a smartphone, one may have already noticed the smartphone's "auto-rotate" capability based on the smartphone's screen orientation. With a smartphone, this invention works effectively, because the smartphone may use accelerometers, magnetometers, or other means to keep track of what is up, down, left, and right, as well as its location to the driver and the front-seat passenger.

In summary, the application software allows for an in-vehicle infotainment (IVI) system with its associated user interface (UI) or a smartphone to respond differently to the driver's versus the front-seat passenger's touch and infer the user's intended-action and respond accordingly.