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SAFER AUDIO CONSUMPTION WHILE DRIVING

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ABSTRACT

A computing device (e.g., a smartphone, a laptop computer, a tablet computer, a smartwatch, etc.) may monitor audio streams and adjust non-navigational audio streams based on a detected real-life context. The computing device may evaluate the real-life context and identify situations requiring reduced distractions. The computing device may determine, based on the evaluation of the audio streams, whether a user may be focused on an activity and should not be distracted from potential hazards. The computing device may additionally evaluate the audio streams and identify navigational and non-navigational streams. Based on the identified real-world context and audio streams, the computing device may pause non-navigational audio and censor potentially distracting sounds and words. The computing device may pause or modify audio streams while a user of the computing device is engaged in any number of activities such as running, walking, driving, biking, etc. as well as alert a user to potential hazards. For example, a driver may approach a section of road with multiple tight turns while distracting audio streams like music or podcasts are playing. The computing device may improve safety by pausing the distracting audio streams. In another example, an assistant on the computing device is reading a book to a listener while the listener is approaching a sidewalk. The computing device may pause reading the book so the listener can hear vehicles approaching the sidewalk. The computing device may alert the listener of the oncoming traffic in addition to pausing the audio.

DETAILED DESCRIPTION

FIG. 1 below is a conceptual diagram illustrating a system 24 that includes a computing device 2. In accordance with the various techniques described in this publication, computing device 2 may use a context module 8 to pause audio based on context.

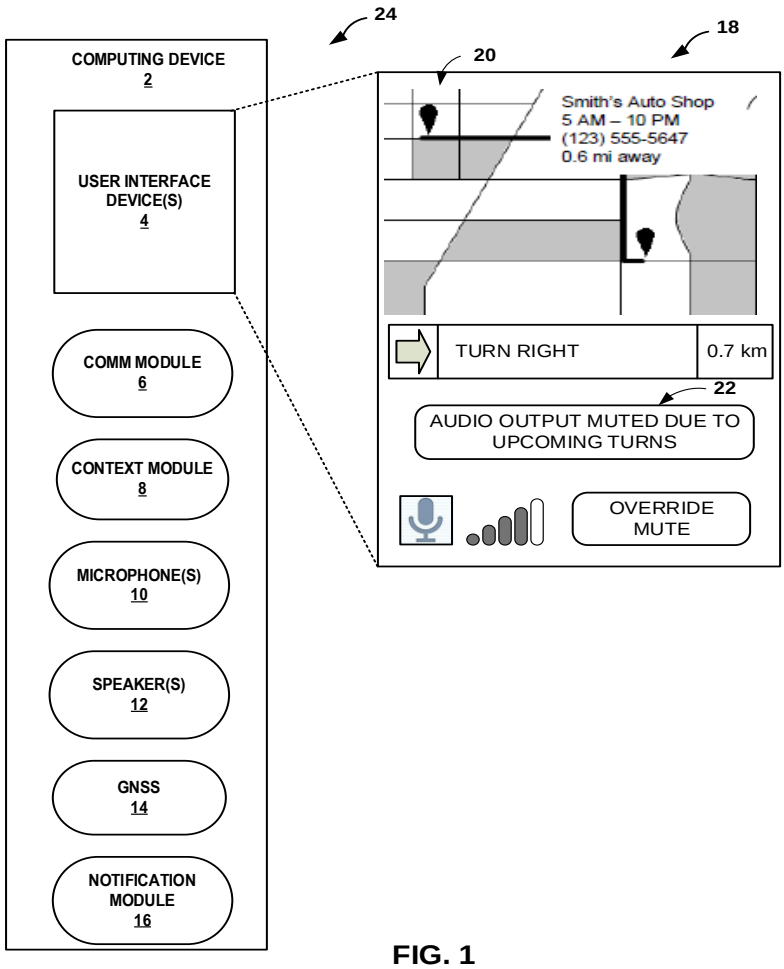

FIG. 1

As shown in FIG. 1, computing device 2 may include user interface device(s) 4, COMM module 6, context module 8, microphone(s) 10, speaker(s) 12, GNSS 14, and notification module 16. Computing device 2 may be any mobile device such as a cellular phone, a smartphone, laptop computer, tablet computer, a portable gaming device, a portable media player, an e-book

reader, a watch (including a so-called smartwatch), and/or the like as well as an automotive computing device such as a head unit, infotainment unit, integrated navigation system, and/or the like. Computing device 2 may be a representation of a combination of any one or more of the above computing devices, for example a smartphone and automotive infotainment system connected via wireless communication.

As shown in FIG. 1, user interface device(s) 4 may be implemented using various interface device hardware. User interface device(s) 4 may function as an input device using a presence-sensitive input component, such as a presence-sensitive screen or touch-sensitive screen that receives tactile input from a user of computing device 2 and/or as physical buttons such as a selector button on a steering wheel. The presence-sensitive input component may determine a contact location (e.g., an (x,y) coordinate) of the presence-sensitive input component at which the object was detected.

User interface device(s) 4 may display GUI 18. GUI 18 may include elements such as navigation 20 that provides a visual navigation map and navigation instructions to the user of computing device 2. GUI 18 may include audio indicator 22 that indicates to the user of computing device 2 that the audio has been adjusted due to the context.

COMM module 6 may include wireless communication devices capable of transmitting and/or receiving communication signals using network 108, such as a cellular radio, a 3G radio, a 4G radio, a 5G radio, a Bluetooth® radio (or any other PAN radio), an NFC radio, or a WIFI radio (or any other WLAN radio). Additionally, or alternatively, COMM 6 may include wired communication devices capable of transmitting and/or receiving communication signals via a direct link over a wired communication medium (e.g., a universal serial bus (“USB”) cable).

Various aspects of the techniques described in this publication enable context module 8 to adjust audio stream(s). Context module 8 may use microphone(s) 10, GNSS 14, and/or notification module 16 to detect the context of the user's activity. Context module 8 may determine the context of the user's activity based on one or more factors such as time of day, current weather conditions, location, speed, whether the user is operating an automobile, upcoming navigation directions, and other factors.

Context module 8 may categorize audio streams based on the context of an audio stream. Context module 8 may determine that an audio stream is navigational or non-navigational in nature based on the application generating the audio stream (e.g., a navigation app on a smartphone), the type of audio stream, and the content of the audio stream. Context module 8 may determine whether an audio stream will be audible to a driver by determining whether the audio stream is being played through a vehicle's audio system or through the headphones of a passenger. Context module 8 may use data from COMM 6 to determine whether computing device 2 is connected via one or more wireless connections to headphones, earbuds, hearing instruments, or other listening devices that may make the audio streams audible only to a passenger of the vehicle. Context module 8 may enable a user of computing device 2 to configure whether an audio stream will be heard by the user of computing device 2 or by a person other than the user of computing device 2.

Context module 8 may determine when it would be beneficial to the user of computing device 2 to pause non-navigation audio streams. Context module 8 may utilize data from one or more components to determine if it would be beneficial to pause non-navigational audio streams. Context module 8 may utilize navigation data from GNSS 14 (global navigation satellite services such as GPS, GLONASS, and Galileo) to determine that the driver of an automobile is

approaching a section of road that requires greater focus on the operation of the automobile such as a twisty section of road or a section of road with multiple turns in a short section of distance, in addition to estimating the delivery time of the navigation instructions based on speed and traffic conditions. Context module 8 may additionally utilize data regarding upcoming navigational instructions to determine whether non-navigational audio streams should be paused. Context module may additionally use data from GNSS 14 to determine whether a hazardous section of road is ahead even if a navigational application is not executing on computing device 2. Context module 8 may additionally utilize data regarding upcoming navigational instructions to determine whether non-navigational streams can be resumed. Context module 8 may utilize data regarding previous navigational routes to determine routes regularly taken by a driver and to preemptively determine upcoming turns even if a navigational app is not being used. Context module 8 may then cause computing device 2 to pause the audio of non-navigation audio streams. Context module 8 may generate a visual or audio notification to the user of computing device 2 to indicate that the audio stream will be paused so that the user is not confused or surprised by the change in audio.

Context module 8 may determine a disturbance threshold metric that indicates an acceptable level of disturbance for a user. Context module 8 may determine a disturbance threshold based on the focus required by the user of computing device 2 to conduct their current activity. Context module 8 may enable the user to adjust the disturbance threshold to suit their preferences. Context module 8 may determine that a distraction risk is lower for certain activities such as walking than activities that require greater focus such as driving. Context module 8 may determine whether an audio stream needs to be paused based on whether a potential disturbance such as loud music would exceed the determined disturbance threshold.

Context module 8 may determine that sounds may need to be filtered/altered/tweaked from the audio content to ensure that the user of computing device 2 is not distracted in light of the context. Context module 8 may apply a machine learning (ML) model to determine if sections of audio content should be removed or altered to avoid distracting the user of computing device 2. Context module 8 may modify the audio content to remove distracting sounds (e.g., road traffic sounds, 'disturbing' content that may elicit an emotional reaction like crying from a listener, content that may elicit a reaction from a listener such as a sporting team scoring a goal, loud accident-like sounds, abrupt increases in volume) from the audio content. Context module 8 may also ensure that the content presented remains acceptably understandable by not removing too much of the non-distracting audio of the media presentation. Context module 8 may determine the type of audio stream and pause the audio stream instead of muting or ducking so that the user does not miss any of the content of the stream. Context module 8 may additionally determine the volume of the audio stream and whether the audio is sufficiently low in volume that potentially distracting sounds would be too quiet to distract the driver. In the case of pre-recorded audio files, the computing device 2 may pre-process the pre-recorded audio files to identify the start and end times of audio snippets to be modified. In the case of a live audio stream, the computing device 2 may cache a few seconds of audio to do this processing.

In an exemplary case, a driver drives their car while listening to a podcast and navigation through the infotainment system of their car. Context module 8 determines, based on data from the navigation app, that the driver is approaching a series of turns one shortly after another and that the driver will need to place greater focus on the navigation instructions and driving their car. The context module 8 may pause the audio of the podcast to ensure the driver can better focus on the road and the navigation instructions. The context module 8 may alert the driver with

a spoken notification that the podcast has been paused until after the series of turns have been completed.

In a further example, the driver drives their car while listening to a podcast. The podcast includes sections that cover disturbing and emotionally charged topics as well as sudden loud noises. The context module 8 of computing device 2 determines that, considering the user's context, that the user should not be disturbed by sections that may upset or spook the user. The computing device may then selectively modify the audio of the podcast (e.g., by muting or lowering the volume) such that the user still hears much of the podcast except for the sections that could interfere with driving.

In a similar example, a driver drives his car while listening to his favorite podcast. The podcast includes a short advertisement about the best engine oil accompanied by racers racing with car drifts, revs, and other traffic sounds and honks. The context module 8 may determine that, considering the user's context, the user should not be disturbed by these sounds as they may be confused with real-life traffic. The context module 8 may selectively replace these distracting sounds with alternatives like background music or remove them. The context module 8 may retain the voice-over, so the user still gets the context of the advertisement.

In another example like the above, the driver drives his car but is listening to music when he encounters sudden heavy rain. The context module 8 may utilize data from the car such as the current speed of the car in addition to the wiper blade settings to determine that there is heavy rainfall outside the vehicle, as opposed to the driver increasing the speed of the wipers due to driving faster. The context module 8 may determine that the threshold for requiring greater focus on the road should be adjusted due to the current weather conditions. The context module 8 may pause the user's music until it determines that the heavy rain has abated, and that the user no

longer requires increased focus on the road. The context module 8 may adjust the threshold for requiring greater focus on the road once it has determined the weather conditions have abated such as by a reduction in wiper speed or by weather data received from weather stations.

Conversely, a driver is driving his car along a congested section of roadway while context module 8 has already paused his music. The context module 8 may determine that the driver is reaching the end of the congested section of roadway and that the driver no longer requires increased focus on driving their car. The context module 8 resumes playing the driver's music.

In an example with a vehicle capable of autonomous operation, a driver is riding in their car while the car drives itself. Context module 8 may determine that the driver requires less focus on the road due to the autonomous operation of the car and adjust the disturbance threshold while the car is in autonomous mode to allow a wider range of audio streams to play.

In an example of volume context, a driver is driving their car while having forgotten that they are listening to a podcast with multiple loud noises and shouting by the podcasters as the audio is turned down in their car. The context module 8 may determine that while the podcast contains sounds that could distract the driver, the driver is listening at a low enough volume that the audio stream is likely inaudible by the driver and therefore unlikely to distract the driver.

Computing device 2 may manage phone calls to reduce distractions for the driver of the automobile. Context module 8 may determine that while the user of the computing device 2 is in a phone call that the user requires greater focus on a road. Context module 8 may additionally generate audio for the phone call to indicate that the call is being placed on hold.

In an exemplary case, a driver drives their car while speaking on their smartphone with another person over a phone call. While driving, the driver approaches a series of turns that they

will have to complete one shortly after another based on the directions from their navigation app. The context module 8 determines that the driver could benefit from greater focus on the road due to the upcoming series of turns. The context module 8 causes the computing device 2 to mute the user's call and generate audio played to the other participant(s) of the phone call to indicate that the call has been temporarily muted. The computing device 2 may generate audio such as "This is an assistant, the call has been placed on hold for the next few turns."

Context module 8 may pause an audio stream while the user of computing device 2 is walking. Context module 8 may determine that a user of computing device 2 is walking while listening to an audio stream. Context module 8 may additionally determine the context of the user based on additional factors audio data from microphone(s) 10 (e.g., the noise of oncoming traffic, audio generated by accessible crosswalk indicators, etc.). Context module 8 may additionally cause computing device 2 to change the audio settings of an audio device (e.g., headphones, hearing aids, wireless earbuds, etc.) communicatively coupled to computing device 2 (e.g., disable active noise cancellation, activate an audio transparency mode, etc.).

In an exemplary case, a user is walking along a street while listening to music using their wireless earbuds. While walking along the street, the user approaches a crosswalk that they intend to cross. The context module 8, utilizing data from GNSS 14 and other sources, determines that the user is approaching a crosswalk and intends to cross to the other side of the road. The context module 8 determines that the user should be able to hear oncoming traffic and pauses the music audio stream to ensure that the user can better hear oncoming traffic at the crosswalk.

In similar example case, a user is walking along a street while wearing ear buds in a noise canceling mode. As the user approaches a crosswalk, a fire truck is also approaching the

crosswalk. The context module 8 may obtain location data from GNSS 14 and determine that the user is approaching the crosswalk and intends to cross the road. The context module 8 may 'listen' for oncoming traffic using microphone(s) 10. The context module 8 may determine that the user would benefit from being alerted to and hearing the approaching fire truck. The context module 8 may cause computing device 2 to change the settings of the user's hearing aids from a noise canceling mode to a transparency mode so the user can hear the fire truck approaching.

Context module 8 may utilize the components of computing device 2 to assist a user of computing device 2 with a disability. Context module 8 may utilize a component such as a flashlight integrated into computing device 2 (e.g., the flash of a camera integrated in computing device 2) to alert others to the presence of the user.

In an exemplary case, a user with limited eyesight is walking on a sidewalk and approaches a crosswalk that crosses a busy street. The user's limited eyesight makes it difficult for them to see oncoming traffic before crossing the street. The context module 8 may determine that the intent of the user of computing device 2 is to cross the street using the crosswalk. The context module 8 may activate the flash integrated into computing device 2 to increase the visibility of the user to drivers and make it safer for the user to cross the busy street.

It is noted that the techniques of this disclosure may be combined with any other suitable technique or combination of techniques. As one example, the techniques of this disclosure may be combined with the techniques described in U.S. Patent Application No. 2022/0206650. In another example, the techniques of this disclosure may be combined with the techniques described in U.S. Patent Application Publication No. 2018/0024627. In yet another example, the techniques of this disclosure may be combined with the techniques described in U.S. Patent Application Publication No. 2015/0105960.