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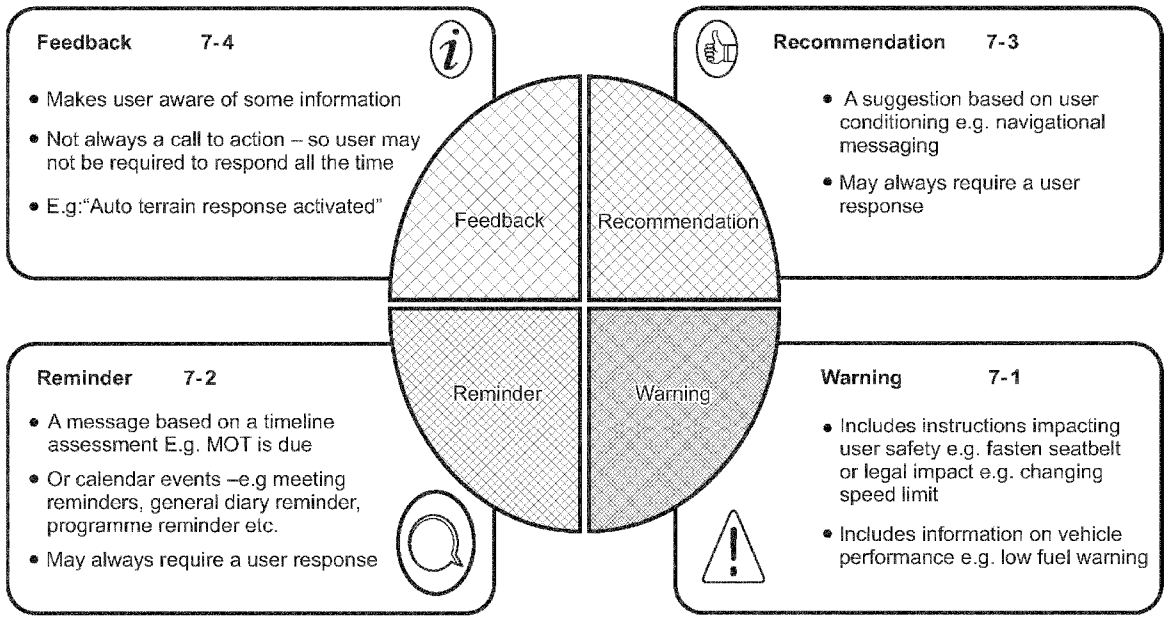

FIG. 2

(57) Abstract: The present disclosure relates to a communication controller (2) for controlling a vehicle dialogue including at least one dialogue component, The communication controller (2) includes at least one processor (3) configured to control the output of said at least one dialogue component; and a memory (4) connected to the at least one processor (3). The at least one processor (3) is configured to identify a dialogue component (7) to be output; and determine a driver workload. The at least one processor is configured to pause the output of the dialogue component (7) in dependence on detection of an increase in the determined driver workload. The present disclosure also relates to a vehicle incorporating a communication controller (2); and a related method of controlling a vehicle dialogue.

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COMMUNICATION CONTROL APPARATUS AND METHOD

TECHNICAL FIELD

The present disclosure relates to a communication control apparatus and method. In particular, but not exclusively, the present disclosure relates to a communication controller, to a vehicle and to a method.

BACKGROUND

It is known to incorporate a virtual agent into a traditional consumer device, such as a laptop, a tablet computer, a cellular telephone and a personal computer. It is also known to implement a virtual agent in a standalone device to function as a digital assistant. The device may provide a visual indication of the status of the agent, for example to indicate that the agent is active, listening or off. For example, an icon may be displayed on a display screen. The shape and/or colour of the icon may change to indicate different system states. With increasingly complex interfaces on vehicles, it is expected that agents will be incorporated into vehicle interfaces. However, it is envisaged that this will present unique challenges not encountered in existing consumer device applications. For example, the agent may be responsible for communicating critical information to the driver of the vehicle. Furthermore, the driver workload varies depending on the situation. The capacity of the driver to receive and comprehend new information may be limited if their workload is high at that time. Known agents do not assess a user's situation when communicating information. It is against this backdrop that the present invention(s) have been conceived.

SUMMARY OF THE INVENTION

Aspects of the present invention relate to a communication controller, to a method and a vehicle as claimed in the appended claims.

According to a further aspect of the present invention there is provided a communication controller for controlling a vehicle dialogue including at least one dialogue component, the communication controller comprising:

at least one processor configured to control output of said at least one dialogue component; and

a memory connected to the at least one processor;

the at least one processor being configured to:

identify a dialogue component to be output; and

determine a driver workload;

wherein the at least one processor is configured to control output of said dialogue component in dependence on the determined driver workload. The at least one processor may be configured to pause and/or resume output of said dialogue component in dependence on the determined driver workload. For example, output of said dialogue component may be paused when an increase in the determined driver workload is detected; and/or output of said dialogue component may be resumed when a decrease in the determined driver workload is detected.

According to another aspect of the present invention there is provided a communication controller for controlling a vehicle dialogue including at least one dialogue component, the communication controller comprising:

at least one processor configured to control output of said at least one dialogue component; and

a memory connected to the at least one processor;

the at least one processor being configured to:

identify a dialogue component to be output; and

determine a driver workload;

wherein the at least one processor is configured to control output of said dialogue component in dependence on the determined driver workload, wherein the at least one processor is configured to pause output of said dialogue component when the determined driver workload is greater than or equal to an upper workload threshold, and wherein the upper workload threshold is determined in dependence on a priority rating of the identified dialogue component.

According to another aspect of the present invention there is provided a communication controller for controlling a vehicle dialogue including at least one dialogue component, the communication controller comprising:

at least one processor configured to control output of said at least one dialogue component; and

a memory connected to the at least one processor;

the at least one processor being configured to:

identify a dialogue component to be output; and

determine a driver workload;

wherein the at least one processor is configured to control output of said dialogue component in dependence on the determined driver workload, wherein the at least one processor is configured to pause output of said dialogue component when the determined driver workload is greater than or equal to an upper workload threshold, and wherein the at

least one processor is configured to update the dialogue component prior to resuming output thereof.

The communication controller as described above, wherein the processor is a control unit and the output means is an electrical output for outputting electronic data, which may represent dialogue to be output to the one or more occupants of the vehicle.

The communication controller provides a communication interface between the driver and the vehicle. At least in certain embodiments, the communication controller may reduce distraction for the driver when the driver workload is high, for example while performing a vehicle manoeuvre. At least in certain embodiments the communication controller may provide a more natural communication interface. The communication controller may control output of the dialogue components in dependence on driver requirements and/or preferences and/or the current driver situation. The communication controller monitors the situation and if a high driver workload is detected, the dialogue session in progress is paused. The communication controller may establish if information is available to reduce the driver workload.

The vehicle dialogue may be a vehicle-initiated dialogue (VID). In this arrangement, the communication controller may initiate a driver dialogue, i.e. output a dialogue component without a driver prompt or input. The dialogue comprises one or more dialogue components. The dialogue components each comprise information to be communicated to the driver of the vehicle. Each dialogue component may comprise an audio and/or visual component for communicating with the driver. The dialogue may optionally comprise a haptic feedback, for example to provide a driver alert.

The communication controller may be configured to implement a pause before the dialogue component is output and/or during output of the dialogue component.

The at least one processor may determine the driver workload in dependence on one or more data signals received from vehicle systems. Alternatively, or in addition, the at least one processor may determine the driver workload in dependence on a signal received from a workload monitor.

The communication controller monitors the driver workload and may pause output of the dialogue component. A priority rating may be defined for each dialogue component. The priority rating may, for example, categorise each dialogue component as a high, medium or

low priority. A dialogue component which is categorised as a high priority may, for example, comprise information which is deemed critical to operation of the vehicle. The communication controller may be configured to convey any such critical information irrespective of the current driver workload or even if the additional information may further increase the driver workload. Thus, in certain embodiments, the communication controller may be configured to inhibit a pause function if the dialogue component to be output has a particular priority rating.

The communication controller may be configured to identify when an event is complete. If the communication controller determines that the paused dialogue component relates to an event which is complete, for example an event completed while output of the dialogue component is paused, the communication controller may be configured to cancel output of the dialogue component.

The communication controller may be configured to check the relevance of previous dialogues and proposed dialogue components. If the dialogue component is no longer relevant, the dialogue component may be discarded. A time threshold may be defined, for example in relation to diary events. A distance travelled threshold may be used, for example in relation to traffic events and/or points of interest and/or navigation instructions. The communication controller may be configured to resume output of all other types of dialogue components.

The at least one processor may be configured to pause output of said dialogue component when the determined driver workload is greater than or equal to an upper workload threshold. The upper workload threshold may be predefined. Alternatively, the upper workload threshold may be dynamic. For example, the upper workload threshold may be determined in dependence on a priority rating of the identified dialogue component. The lower workload threshold may be directly proportional to the priority rating of the identified dialogue component. The upper workload threshold may be higher for a dialogue component having a high priority than for a dialogue component having a low priority.

The at least one processor may be configured to resume output of said dialogue component when the determined driver workload is less than or equal to a lower workload threshold. The lower workload threshold may be predefined. Alternatively, the lower workload threshold may be dynamic. For example, the lower workload threshold may be determined in dependence on the priority rating of the paused dialogue component. The lower workload threshold may be inversely proportional to the priority rating of the paused dialogue

component. For example, the lower workload threshold may be higher for a dialogue component having a high priority than for a dialogue component having a low priority.

The at least one processor may be configured to update the dialogue component prior to resuming output of said dialogue component. For example, the dialogue component may be updated to include the current information or the latest available information. The updated dialogue component may, for example, indicate a revised speed limit information, updated navigation information or new vehicle system information. The communication controller may also be configured to control external communication, for example to control output of an electronic communication with a contact stored in an address book. The communication controller may be configured automatically to update a message, such as a Short Messaging Service (SMS) text message, for example to include an updated estimated time of arrival.

The communication controller may continue to identify one or more additional dialogue component to be output while the dialogue component is paused. When output of the paused dialogue component is resumed, the communication controller may schedule more than one dialogue component to be output. The communication controller may sequence said dialogue components in dependence on the priority rating. The dialogue component having the highest priority rating will be scheduled for output first.

The at least one processor may be configured to perform a validity test to determine the validity of the paused dialogue component prior to resuming output of the paused dialogue component. The validity test determines whether the dialogue component comprises information which is still relevant to the current situation. The dialogue component is classed as valid if it is still relevant; but invalid if it is no longer relevant. The at least one processor may be configured to cancel output of the paused dialogue component if the validity test determines that the paused dialogue component is invalid. The at least one processor may be configured to resume output of the paused dialogue component if the validity test determines that the paused dialogue component is valid. However, if the information is no longer relevant, the communication controller may be configured to clear the dialogue component. The communication controller may provide a driver update once the driver workload decreases. The communication controller may resume the dialogue when the driver workload decreases.

The communication controller may enable the driver to pause output of the dialogue component if the driver is not ready to receive information.

The at least one processor may be configured to update the dialogue component prior to resuming output thereof.

The at least one processor may be configured to receive one or more data signals from respective vehicle systems. The dialogue component to be output may be identified in dependence on one or more of said data signals.

According to a further aspect of the present invention there is provided a vehicle comprising a communication controller as described herein.

According to a still further aspect of the present invention there is provided a method of controlling a vehicle dialogue including at least one dialogue component, the method comprising:

identifying a dialogue component to be output; and

determining a driver workload;

wherein output of said dialogue component is controlled in dependence on the determined driver workload. The method may comprise pausing and/or resuming output of said dialogue component in dependence on the determined driver workload.

The method may comprise pausing output of said dialogue component when the determined driver workload increases. The method may comprise pausing output of said dialogue component when the determined driver workload is greater than or equal to an upper workload threshold. The upper workload threshold may be predefined. The upper workload threshold may be determined in dependence on a priority rating of the identified dialogue component.

The method may comprise resuming output of the paused dialogue component when the determined driver workload decreases. The method may comprise resuming output of said dialogue component when the determined driver workload is less than or equal to a lower workload threshold. The lower workload threshold may be determined in dependence on a priority rating of the paused dialogue component.

The method may comprise updating the dialogue component prior to resuming output thereof.

The method may comprise testing the validity of the paused dialogue component prior to resuming output of the paused dialogue component. Output of the paused dialogue

component may be cancelled if the test determines that the paused dialogue component is invalid. Output of the paused dialogue may be resumed if the test determines that the paused dialogue component is valid.

The method may comprise monitoring the status of one or more vehicle systems and identifying the dialogue component to be output in dependence on the status of said one or more vehicle systems.

According to a further aspect of the present invention there is provided a set of instructions which, when executed, cause a computational device to implement the method described herein.

According to a still further aspect of the present invention there is provided a non-transitory computer readable media comprising a set of computational instructions which, when executed, cause a computer to implement the method described herein.

Any control unit or controller described herein may suitably comprise a computational device having one or more electronic processors. The system may comprise a single control unit or electronic controller or alternatively different functions of the controller may be embodied in, or hosted in, different control units or controllers. As used herein the term “controller” or “control unit” will be understood to include both a single control unit or controller and a plurality of control units or controllers collectively operating to provide any stated control functionality. To configure a controller or control unit, a suitable set of instructions may be provided which, when executed, cause said control unit or computational device to implement the control techniques specified herein. The set of instructions may suitably be embedded in said one or more electronic processors. Alternatively, the set of instructions may be provided as software saved on one or more memory associated with said controller to be executed on said computational device. The control unit or controller may be implemented in software run on one or more processors. One or more other control unit or controller may be implemented in software run on one or more processors, optionally the same one or more processors as the first controller. Other suitable arrangements may also be used.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such

features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the present invention will now be described, by way of example only, with reference to the accompanying figures, in which:

Figure 1 shows a schematic representation of a vehicle incorporating a communication controller in accordance with an embodiment of the present invention;

Figure 2 shows the categories of the dialogue components to be output to a driver of the vehicle;

Figure 3 illustrates the prioritisation of each of the categories shown in Figure 2; and

Figure 4 shows a flow diagram representing operation of the communication controller according to an embodiment of the present invention.

DETAILED DESCRIPTION

A vehicle V incorporating a communication system 1 in accordance with an embodiment of the present invention will now be described with reference to the accompanying figures. The communication system 1 comprises a communication controller 2. The communication controller 2 in the present embodiment is adapted to control communication with a driver of the vehicle V, but it will be understood that communication with other occupants of the vehicle V is also possible.

The communication controller 2 is configured to provide an agent which implements a human machine dialogue for communicating information to the vehicle driver. In the present embodiment, the agent implements a vehicle-initiated dialogue (VID). The VID is operative to initiate communication with the vehicle driver, for example to start a dialogue with the vehicle driver to convey system information. The VID may, for example, be configured to convey one or more of the following categories of information to the vehicle driver:

- Warning (i.e. Major/Minor vehicle warning, external warnings, safety advance notifications);
- Recommendations (i.e. Help and guidance, recommendation to use some features);
- Feedback (i.e. confirmation of actions, External messages, status message, information); and

- Reminders (i.e. Configuration message, Events calendar reminder, scheduled maintenance or MOT and other external reminders).

At least in certain embodiments, the communication controller 2 implements a VID to interact with the driver to help improve vehicle performance, to improve the driving experience and to help reduce distraction.

With reference to Figure 1, the communication controller 2 comprises a first electronic processor 3 configured to execute a set of computational instructions stored on a non-transitory computer readable media. In the present embodiment, the computational instructions are stored in a first system memory 4 connected to the first electronic processor 3. The first system memory 4 may, for example, comprise a memory device. The first electronic processor 3 is configured to implement the VID function of the communication controller 2. The first electronic processor 3 is configured to identify information to be output to the vehicle driver and to schedule the output of that information. The first electronic processor 3 communicates with a plurality of vehicle systems 5-n over a communication network 6. The vehicle systems 5-n each publish one or more data signal S-n to the communication network 6. The data signals S-n each comprise information relating to an on-board vehicle system, for example vehicle speed data and/or fault data; or an external system, such as local traffic.

The first system memory 4 comprises a plurality of dialogue components 7 for communicating information to the vehicle driver. The dialogue components 7 may be adapted to convey information derived from one or more of said data signals S-n. The first electronic processor 3 is configured to select one or more of said dialogue components 7 in dependence on the data signals S-n received from the vehicle systems 5-n. The selected dialogue component(s) 7 is then output to communicate information to the vehicle driver. The first electronic processor 3 may select and output a plurality of said dialogue components 7, for example to be output in a sequence. In certain embodiments, the dialogue components 7 may be arranged in a dialogue tree which is traversed in dependence on one or more user inputs. The dialogue components 7 may each comprise or consist of an audio output and/or a visual output.

With reference to Figure 2, the dialogue components 7 are categorised as: a warning dialogue component 7-1; a reminder dialogue component 7-2; a recommendation dialogue component 7-3; or a feedback dialogue component 7-4. The warning dialogue component 7-1 may, for example, comprise one or more of the following: instructions relevant to safety, for example instructions to fasten a seatbelt; legal ramifications, for example a change in the

statutory speed limit; and information relating to vehicle performance, for example a low fuel warning. The reminder dialogue components 7-2 may, for example, comprise one or more of the following: a message based on a timeline assessment, for example a deadline for performing scheduled servicing, maintenance or testing of the vehicle (such as a Ministry of Transport (MOT) test in the United Kingdom); calendar events, for example to provide a reminder of a scheduled meeting, a reminder of a general diary entry, or a reminder of a programme or event. The recommendation dialogue components 7-3 may, for example, comprise one or more of the following: a suggestion based on user conditioning, for example messaging from a navigation system. The feedback dialogue components 7 may, for example, comprise one or more of the following: conveying information, for example to advise that a vehicle system, such as an off-road mode of Terrain Response®, has been activated. Some of the dialogue components may require a driver input, for example to acknowledge a reminder or a recommendation. Other components, may not require a driver input, for example it may not be necessary to acknowledge receipt of feedback.

A priority rating is defined for each of the dialogue components 7. The priority rating is determined in dependence on how quickly the driver must react to the information (the urgency); and how relevant the information is to a particular situation (the importance). A chart representing the relationship between urgency and importance of the information to be conveyed to the driver is illustrated in Figure 3A. The priority rating is not necessarily the order in which the dialogue components 7 are presented. The warning dialogue components 7-1 have the highest priority and the feedback dialogue components 7-4 have the lowest priority rating. With reference to Figure 3B, the warning dialogue component 7-1 is given a priority rating of one (1); the reminder dialogue component 7-2 is given a priority rating of two (2); the recommendation dialogue component 7-3 is given a priority rating of three (3); and the feedback dialogue component 7-4 is given a priority rating of four (4).

The communication controller 2 is connected to a workload monitor 8 comprising a second electronic processor 9 configured to execute a set of computational instructions stored on a non-transitory computer readable media. In the present embodiment, the computational instructions are stored in a second system memory 10 connected to the second electronic processor 9. The second system memory 10 may, for example, comprise a memory device. The second electronic processor 9 is configured to monitor driver workload. The second electronic processor 9 reads the one or more data signal S-n published to the communication network 6 by the vehicle systems 5-n. The second electronic processor 9 is configured to categorise driver workload in dependence on said data signals S-n. The second electronic processor 9 may determine the driver workload in dependence on one or

more dynamic vehicle parameters, such as vehicle speed and/or steering angle and/or brake pressure. One or more bands may be defined for each of said dynamic vehicle parameters and a workload value (for example an integer score) defined for each band. At any given time, the workload values may be determined for the current dynamic vehicle parameters and the total used to provide an indication of the driver workload. The second electronic processor 9 may categorise driver workload, for example as high, medium, or low. The total of the workload values based on current vehicle dynamic parameters may be compared to one or more workload thresholds. For example, an upper workload threshold may be defined to categorise a high driver workload; and a lower workload threshold may be defined to categorise a low driver workload. The second electronic processor 9 is configured to output a driver workload signal SWL to the communication controller 2. The driver workload signal SWL may comprise the total of the workload values based on current vehicle dynamic parameters and/or a categorisation determined in dependence on said workload values. In a variant, the second electronic processor 9 may analyse image data from a driver-facing camera (not shown) to determine the driver workload. Alternatively, or in addition, the second electronic processor 9 may analyse audio data to determine the driver workload, for example to identify when the driver is talking to a passenger in the vehicle. It will be understood that other factors may also be used to determine driver workload. By way of example, the workload monitor 8 may consider external factors, such as the local traffic and/or the time of day; and/or environmental factors, such as local weather conditions. The workload monitor 8 may also identify when the driver is making a telephone call.

The communication controller 2 is configured to control output of the dialogue components 7 in dependence on the determined driver workload. In particular, the communication controller 2 is configured to receive the driver workload signal SWL from the workload monitor 8 and to pause output of a dialogue component 7 when an increase in the driver workload is detected. In the present embodiment, the first electronic processor 4 is configured to pause output of the dialogue component(s) 7 when the driver workload signal SWL indicates that the sum of the workload values is greater than the upper workload threshold defining a high driver workload. The pause in output of the dialogue component(s) 7 may comprise postponing or delaying output of one or more of said dialogue components 7 that have been scheduled for output. In certain cases, it may be appropriate to interrupt output of a dialogue component 7, for example in dependence on detection of a spike in the driver workload.

The communication controller 2 is operative to resume output of the dialogue component(s) 7 when the workload monitor 8 identifies a decrease in the driver workload. For example, the

communication controller 2 may resume output of the dialogue component(s) 7 when the driver workload signal SWL indicates that the sum of the workload values is less than the lower workload threshold defining a low driver workload. The first electronic processor 4 is configured to perform a validity test to determine the validity of the dialogue component 7 prior to resuming output. In particular, when the determined driver workload decreases, for example below the lower workload threshold, the electronic processor 4 is configured to re-evaluate the data signals S-n received from the vehicle systems 5-n and to perform a check that the paused dialogue component 7 remains valid. If the paused dialogue component 7 is no longer valid, for example due to a change in the monitored parameters, the communication controller 2 will cancel output of that dialogue component 7 rather than resume output. If the paused dialogue component 7 is still valid, the communication controller 2 will resume output of that dialogue component 7

As outlined above, a priority rating is defined for each of the dialogue components 7. The communication controller 2 may be configured to define a plurality of workload thresholds for determining when to pause output of a dialogue component 7. For example, a different workload threshold may be defined for each of the priority ratings of the dialogue component 7. A low driver workload threshold may be applied to prompt a pause in output of a dialogue component 7 having a low priority rating, such as a recommendation dialogue component 7-3 or a feedback dialogue component 7-4. Conversely, a high driver workload threshold may be applied to prompt a pause in output of a dialogue component 7 having a high priority rating, such as a warning dialogue component 7-1 or a reminder dialogue component 7-2.

A flow chart 100 is shown in Figure 4 to illustrate the operating states of the communication controller 2. The communication controller 2 switches between an idle state ST1; an initiate communication state ST2; a communicating information state ST3; and a finish dialogue state ST4. The communication controller 2 defaults to the idle state ST1 when activated. The operating state of the communication controller 2 may be indicated to the driver. In the present embodiment, an icon (not shown) may provide a visual indication of the operating state of the communication controller 2. When in said idle state ST1, the first electronic processor 3 is configured to read the data signals S-n published to the communication network 5 and to identify information to be communicated to the vehicle driver. The first electronic processor 3 may identify information to be output to the vehicle driver based on predefined criteria. The first electronic processor 3 may monitor the data signals S-n published to the communication network 5 to determine operating conditions of that vehicle system 5-n outside predefined operating parameters, for example above an upper threshold and/or below a lower threshold.

Upon identification of information to be communicated to the vehicle driver, the operating status of the communication controller 2 changes to the initiate communication state ST2. The first electronic processor 3 identifies one or more dialogue component 7 for output in dependence on the data signals S-n. The first electronic processor 3 then schedules output of said one or more selected dialogue component 7. The scheduling may, for example, depend on the criticality of the information to be conveyed to the vehicle driver, as determined by the priority ratings defined for each of the dialogue components 7. The dialogue components 7 having a higher priority rating will be identified for output sooner than information having a lower priority rating. The communication controller 2 then changes to the initiate communication state ST2 and the first electronic processor 3 is configured to generate an advance notification signal ANS which provides a signal to the driver that the communication controller 2 is preparing to initiate a new dialogue.

The operating status of the communication controller 2 is held in the initiate communication state ST2 for a predetermined time period following output of the advance notification signal ANS. The predetermined time period can be calibrated, but a time period of between five (5) and eleven (11) seconds inclusive is envisaged. Other time periods are useful. The delay provides the driver an opportunity to delay output of the dialogue component 7, for example if they do not wish to receive new information due to current workload. During the predetermined time period, the first electronic processor 3 checks for a user input signal SIN and output of the dialogue component 7 may be controlled in dependence on any such user input signal. The user input signal SIN may be generated when the vehicle driver actuates an input device 13, such as a button, a switch, a capacitive sensor, or other suitable input means. The input device 13 may be disposed on a steering wheel, in a centre console, or a control panel. The user input signal SIN may, for example, comprise a cancellation request to cancel output of the dialogue component 7; and/or a postpone request to delay or postpone output of the dialogue component 7. Alternatively, or in addition, the user input signal may comprise an expedite request to reduce or remove any time period in output of the dialogue component 7.

When the predetermined time period expires, the communication controller 2 changes to the communicating information state ST3. In the communicating information state, the first electronic processor 3 is configured to output the dialogue component 7 and any subsequent dialogue components 7. The dialogue components 7 may comprise a visual output which is output to the display screen 14; and/or an audio output which is output over the audio entertainment system 15. While the communication controller 2 is in said communicating

information state ST3, the first electronic processor 3 may output additional dialogue components 7, for example to provide additional information or to provide updated information. The first electronic processor 3 may select and output additional dialogue components 7 in dependence on the user input signal SIN. The first electronic processor 3 may traverse a dialogue tree comprising multiple dialogue components in dependence on one or more user input signals SIN.

The communication controller 2 uses the driver workload signal SWL from the driver monitor 8 to determine the driver workload. The communication controller 2 monitors the driver workload signal SWL to detect changes in the driver workload. If the first electronic processor 3 identifies an increase in the driver workload, for example an increase in the driver workload above a predefined upper workload threshold, output of the dialogue component 7 is paused. The pause may be implemented before the dialogue component 7 is output, thereby delaying or postponing output of the dialogue component 7. Alternatively, the pause may be implemented during output of the dialogue component 7, thereby interrupting the dialogue component 7. The communication controller 2 continues to monitor the workload signal SWL to detect a decrease in the driver workload. When the driver workload decreases, for example below a lower workload threshold, the communication controller 2 performs a validity test to determine whether the paused dialogue component 7 is valid. If the communication controller 2 determines that the dialogue component 7 is still valid, output of the dialogue component 7 is resumed. If the validity test determines that the dialogue component 7 is no longer valid, the first electronic processor 3 is configured to inhibit output of the dialogue component 7.

The communication controller 2 remains in the information communicating state ST3 while communication with the driver is ongoing, including output of the dialogue components 7 and, if appropriate, waiting for a driver response. Once the driver has made a final decision, the communication controller 2 confirms this to the driver. The first electronic processor 3 may be configured to determine that the current dialogue is finished when one or more of the following conditions is identified: a time-out condition, for example after a predetermined time period has elapsed; a user request provided in a user input signal SIN; no further dialogue components 7 for output, for example upon completion of a traversal of a dialogue tree; and determination that the information relating to said one or more vehicle systems 5-n is no longer relevant, for example a speed limit warning may be removed when the vehicle speed decreases below the speed limit. The first electronic processor 3 determines that the current dialogue is complete and the communication controller 2 switches to the finish dialogue state

ST4. The first electronic processor 3 may optionally output a conclusion notification signal CNS.

It will be understood that various modifications may be made to the embodiment(s) described herein without departing from the scope of the appended claims. The communication controller 2 described herein resumes output of the dialogue component 7 when the determined driver workload decreases provided the paused dialogue component is still valid. In a variant, output of the dialogue component may be paused for a predetermined time period. Upon expiry of the predetermined time period, the communication controller 2 may determine the driver workload and also perform a validity test to determine whether the paused dialogue component is valid. If the driver workload remains above the driver workload threshold and the paused dialogue component is still valid, the communication controller 2 may pause output of a dialogue component for another predetermined period of time. If the driver workload is below the driver workload threshold and the paused dialogue component is still valid, the communication controller 2 will resume output of the dialogue component for another predetermined period of time. If the paused dialogue component is invalid, the communication controller 2 will cancel output of the dialogue component.

Furthermore, the communication controller 2 and the workload monitor 8 have been described herein as being implemented by first and second electronic processor 3, 9 respectively. It will be understood that the communication controller 2 and the workload monitor 8 could be combined into a single module which may be implemented by the same electronic processor.

CLAIMS:

1. A communication controller for controlling a vehicle dialogue including at least one dialogue component, the communication controller comprising:

at least one processor configured to control output of said at least one dialogue component; and

a memory connected to the at least one processor;

the at least one processor being configured to:

identify a dialogue component to be output; and

determine a driver workload;

wherein the at least one processor is configured to control output of said dialogue component in dependence on the determined driver workload.

2. A communication controller as claimed in claim 1, wherein:

the processor is a control unit; and

comprising an output means, the output means comprising an electrical output for outputting electronic data representing dialogue to be output to the one or more occupants of the vehicle.

3. A communication controller as claimed in claim 1 or claim 2, wherein the at least one processor is configured to pause output of said dialogue component when the determined driver workload is greater than or equal to an upper workload threshold.

4. A communication controller as claimed in claim 3, wherein the upper workload threshold is determined in dependence on a priority rating of the identified dialogue component.

5. A communication controller as claimed in claim 3 or claim 4, wherein the at least one processor is configured to resume output of the paused dialogue component when the determined driver workload is less than or equal to a lower workload threshold.

6. A communication controller as claimed in claim 5, wherein the at least one processor is configured to update the dialogue component prior to resuming output thereof.

7. A communication controller as claimed in claim 5 or claim 6, wherein the at least one processor is configured to perform a validity test to determine the validity of the

paused dialogue component prior to resuming output of the paused dialogue component.

8. A communication controller as claimed in claim 7, wherein the at least one processor is configured to cancel output of the paused dialogue component if the validity test determines that the paused dialogue component is invalid.

9. A communication controller as claimed in claim 7 or claim 8, wherein the at least one processor is configured to resume output of the paused dialogue component if the validity test determines that the paused dialogue component is valid.

10. A communication system comprising a communication controller as claimed in any one of the preceding claims.

11. A vehicle comprising a communication controller as claimed in any one of claims 1 to 9.

12. A method of controlling a vehicle dialogue including at least one dialogue component, the method comprising:

identifying a dialogue component to be output; and

determining a driver workload;

wherein output of said dialogue component is controlled in dependence on the determined driver workload.

13. A method as claimed in claim 12, wherein output of said dialogue component is paused when the determined driver workload is greater than or equal to an upper workload threshold.

14. A method as claimed in claim 13, wherein the upper workload threshold is determined in dependence on a priority rating of the identified dialogue component.

15. A method as claimed in claim 13 or claim 14 comprising resuming output of the paused dialogue component when the determined driver workload is less than or equal to a lower workload threshold.

16. A method as claimed in claim 15 comprising updating the dialogue component prior to resuming output thereof.

17. A method as claimed in claim 15 or claim 16, comprising testing the validity of the paused dialogue component prior to resuming output of the paused dialogue component.

18. A method as claimed in claim 17 comprising cancelling output of the paused dialogue component if the test determines that the paused dialogue component is invalid.

19. A method as claimed in claims 17 or claim 18 comprising resuming output of the paused dialogue component if the test determines that the paused dialogue component is valid.

20. A set of instructions which, when executed, cause a computational device to implement the method claimed in any one of claims 12 to 19.

21. A non-transitory computer readable media comprising a set of computational instructions which, when executed, cause a computer to implement the method claimed in any one of claims 12 to 19.

22. A communication controller substantially as herein described with reference to the accompanying figures.

23. A vehicle substantially as herein described with reference to the accompanying figures.

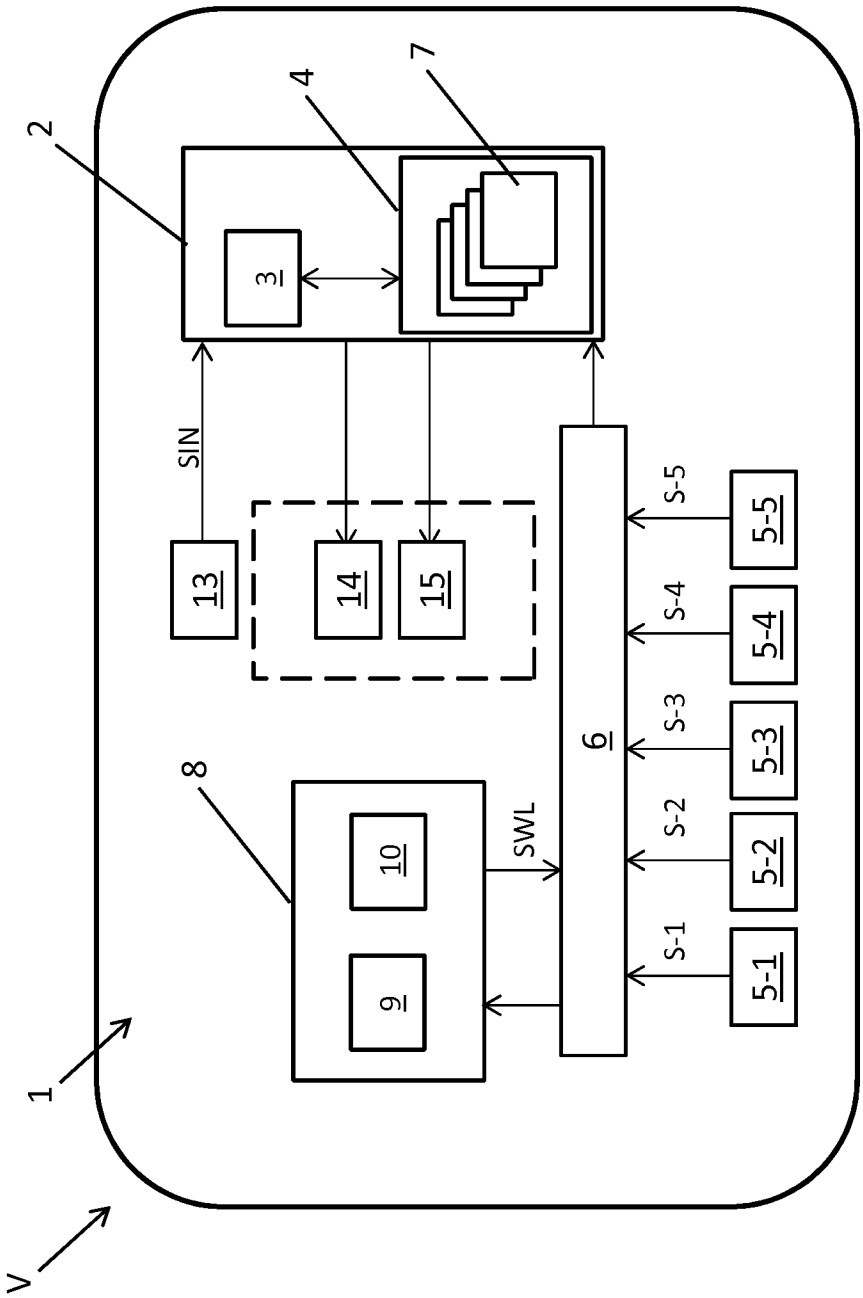


FIG. 1

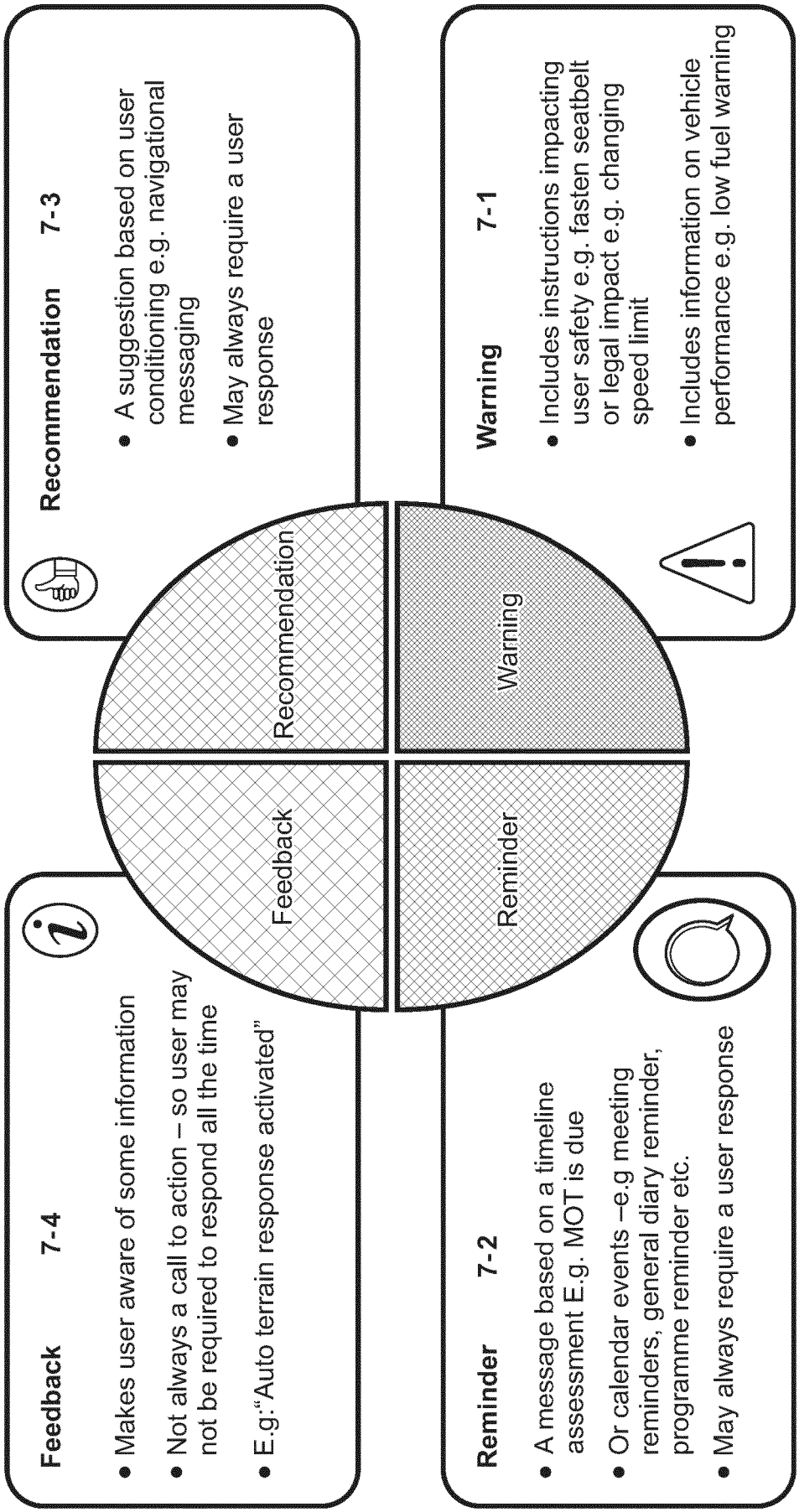

Feedback 7-4
Makes user aware of some information
Not always a call to action – so user may not be required to respond all the time
E.g:"Auto terrain response activated"
Recommendation 7-3
A suggestion based on user conditioning e.g. navigational messaging
May always require a user response
Reminder 7-2
A message based on a timeline assessment E.g. MOT is due
Or calendar events –e.g meeting reminders, general diary reminder, programme reminder etc.
May always require a user response
Warning 7-1
Includes instructions impacting user safety e.g. fasten seatbelt or legal impact e.g. changing speed limit
Includes information on vehicle performance e.g. low fuel warning
Feedback
Recommendation
Reminder
Warning

FIG. 2

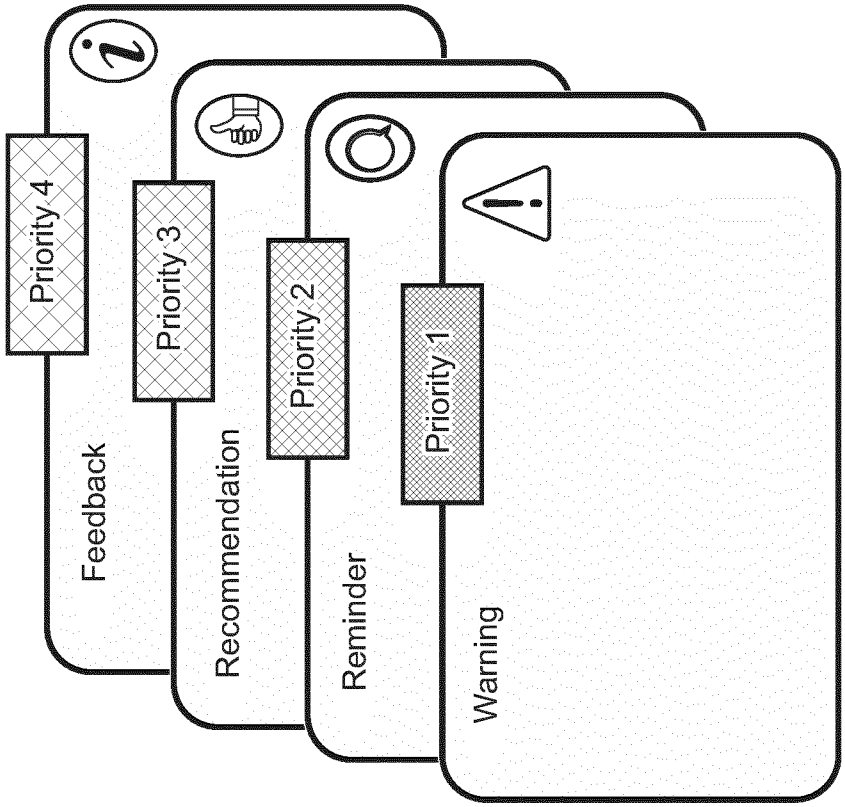
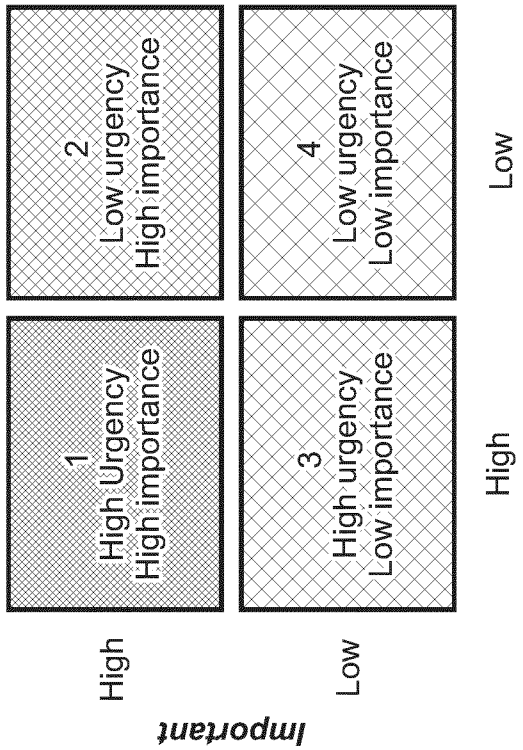


FIG. 3B



Urgency: *how quickly user must react to information*
Importance: *how relevant information is to particular user condition*

FIG. 3A

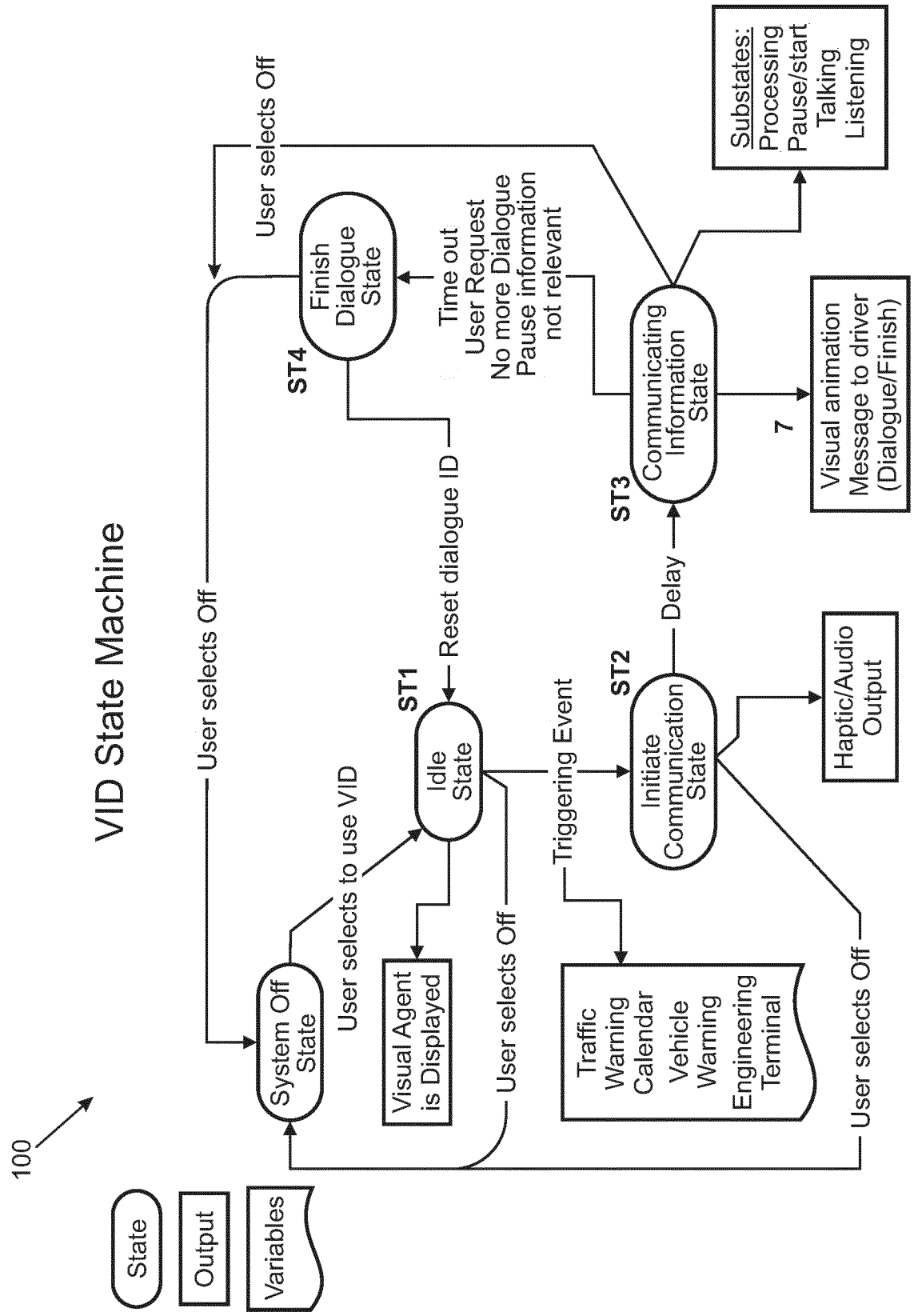

VID State Machine
100
State
Output
Variables
System Off State
Idle State
ST1
Initiate Communication State
ST2
Communicating Information State
ST3
Finish Dialogue State
ST4
User selects Off
User selects to use VID
Visual Agent is Displayed
Reset dialogue ID
Triggering Event
Traffic Warning Calendar
Vehicle Warning
Engineering Terminal
Delay
Haptic/Audio Output
Time out
User Request
No more Dialogue
Pause information not relevant
7
Visual animation Message to driver (Dialogue/Finish)
Substates:
Processing
Pause/start
Talking
Listening

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/051001

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60W50/00 B60W50/16 B60W50/14
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 100 07 169 A1 (RENAULT [FR]) 24 August 2000 (2000-08-24) column 2, lines 14-35 column 3, line 50 - column 7, line 17 -----	1-21
X	EP 1 914 106 A2 (VOLVO TECHNOLOGY CORP [SE]) 23 April 2008 (2008-04-23) paragraphs [0050] - [0053], [0064] -----	1-21
X	WO 2015/165811 A1 (JAGUAR LAND ROVER LTD [GB]) 5 November 2015 (2015-11-05) page 1 - page 5 ----- -/--	1-5, 10-15, 20,21

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 April 2018	04/05/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Elbel, Benedikte

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/182529 A1 (DOBLER GUENTER [DE] ET AL) 9 August 2007 (2007-08-09) paragraphs [0016], [0031], [0037] - [0039], [0048] - [0084] -----	1-5,10, 11, 13-15, 20,21
X	AMDITIS A ET AL: "Towards the Automotive HMI of the Future: Overview of the AIDE-Integrated Project Results", IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, IEEE, PISCATAWAY, NJ, USA, vol. 11, no. 3, 1 September 2010 (2010-09-01), pages 567-578, XP011312583, ISSN: 1524-9050, DOI: 10.1109/TITS.2010.2048751 section IV, B, C -----	1-5, 10-15, 20,21

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2018/051001

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 22, 23
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 22, 23

Claims 22 and 23 lack clarity to such an extent that no search is possible (Art. 6, Rule 6.2 PCT).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2018/051001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10007169 A1	24-08-2000	DE 10007169 A1	24-08-2000
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		GB 2529997 A	16-03-2016
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		WO 2015165811 A1	05-11-2015
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		EP 1625040 A1	15-02-2006
		JP 2007512989 A	24-05-2007
		US 2007182529 A1	09-08-2007
		WO 2004101306 A1	25-11-2004