

[0044] According to the present embodiment, the status of the vehicle can be indicated to the driver through his or her sense of touch without recourse to his or her sense of vision. In addition, different patterns can be generated by the haptic interface device 2 according to information to be provided, thereby providing the advantage that the number of operating switches on on-vehicle devices can be reduced.

[0045] Second Embodiment

[0046] The first embodiment has been described with respect to the apparatus for indicating a detected state of the vehicle to the driver. A second embodiment will be described below with respect to an apparatus capable of detecting circumstances outside a vehicle and indicating this information to a driver. A state sensor unit 4 according to the second embodiment is provided as state sensing means for sensing circumstances outside a vehicle. Other components of the present invention are the same as those of the first embodiment as described above with reference to FIGS. 1 to 5.

[0047] The term "circumstances outside a vehicle" refers to phenomena or current circumstances such as the direction and force of wind, the angle of incline of a road, conditions of a road surface, an obstacle in the vehicle path, and lane deviation external to the vehicle, and which should preferably be indicated to the driver. They are essentially phenomena at an alert level or higher. For example, the state sensor unit 4 may include an anemometer and an anemoscope for sensing the force and direction of wind in order to supply data on the velocity and direction of wind. The state sensor unit 4 may also comprise a vehicle inclinometer for sensing the inclination of a sloping road in order to supply data on inclination direction and angle of the inclination.

[0048] An operation according to the present embodiment is the same as that of the first embodiment. That is, when data on circumstances outside a vehicle as measured by the state sensor unit 4 is received via the connection line 6, a control section 40 determines whether or not it should generate haptic information. When the control section 40 determines that haptic information should be generated, the control section 40 generates the appropriate haptic information corresponding to the received information regarding the state outside the vehicle, and controls a driving section 20 based on the haptic information to cause an operating member 12 to operate to provide a predetermined haptic stimulus to a driver who is in contact with the operating member 12.

[0049] For example, when wind velocity and wind direction data is sent from the state sensor unit 4, the control section 40 controls the driving section 20 to generate vibration stimulus with amplitude proportional to the wind velocity in a direction corresponding to the wind in the positive direction of the X-axis corresponding to the travel direction of the vehicle. When inclination direction and inclination angle data is sent from the state sensor unit 4, the control section controls the driving section 20 to generate a haptic stimulus according to the direction and angle. A sensor installed in the vehicle senses a lane marker provided on the surface of a road to obtain information about the position of the vehicle in the lane. The control section controls the driving section 20 so as to generate vibration stimulus moving from side to side for indicating lane deviation of a vehicle. The detection of the position in the lane may be achieved by detecting a lane marker by means of an on-

vehicle camera or by detecting a magnetized lane marker by means of a magnetometric sensor on the vehicle body.

[0050] Thus, the driver, using their knowledge about the meaning of various stimuli, can understand the state outside the vehicle through his or her sense of touch based on the type of the haptic stimulus provided. Therefore, the driver can obtain information, such as the velocity of wind, that he or she cannot obtain from inside the vehicle. The haptic stimulus provided to the driver through the operating member 12 is not limited to vibration. It may be any other motion that can be represented by two-dimensional figures such as a circle, square, or triangle.

[0051] Information about a state outside the vehicle may be obtained not only on-vehicle sensors but also equipment provided outside the vehicle. For example, if the state sensor unit 4 includes a receiver for receiving information from a system such as an Advanced Cruise-Assist Highway System (AHS) that has a cruise assist function for providing information to the vehicle, providing an alert, and assisting the operation of the vehicle, a road infrastructure sensor senses an obstacle such as a parked car or a fallen object and sends information through an AHS beacon. The state sensor unit 4 uses the receiver to receive the obstacle data sent from the beacon, upon receipt of which the control section 40 controls the driving section 20 to generate haptic information that provides a predetermined vibration stimulus in the direction that imitates the travel direction of the vehicle. When road surface conditions such as icy road conditions are indicated to the vehicle, the control section 40 controls the driving section 20 to generate haptic information for providing a predetermined vibration stimulus in a long elliptic motion, in the travel direction of the vehicle. In this way, an information receiver for receiving traffic information sent by a service provider as a state outside the vehicle may also be provided to obtain information about the conditions outside the vehicle besides an on-vehicle sensor.

[0052] According to the present embodiment, conditions outside the vehicle can be indicated to the driver through their sense of touch without help of vision. Haptic information generated for providing information to the driver can be presented to him or her in an intuitive and clear manner by moving the operating member 12 in the direction corresponding to a phenomenon or information to be indicated to him or her to produce a stimulus such as a stimulus moving back and forth for indicating the presence of an obstacle ahead or a stimulus moving from side to side for indicating lane deviation.

[0053] While the first embodiment was described with respect to the detection of a state of the vehicle and the second embodiment has been described with respect to the detection of conditions outside the vehicle, means for detecting the states of both of the state of the vehicle and conditions outside the vehicle may be provided in combination to allow the device to address either or both.

[0054] Third Embodiment

[0055] Some events or conditions, such as hard braking, a sharp turn, or a crash, require that the driver grip the steering wheel to take action or support themselves. When a haptic interface device 2 is provided at a position on a steering wheel where a driver as shown in FIG. 4, to the device may interfere with the driver's gripping of the steering wheel 8