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(54) **HAPTIC TACTILE PRECISION SELECTION**

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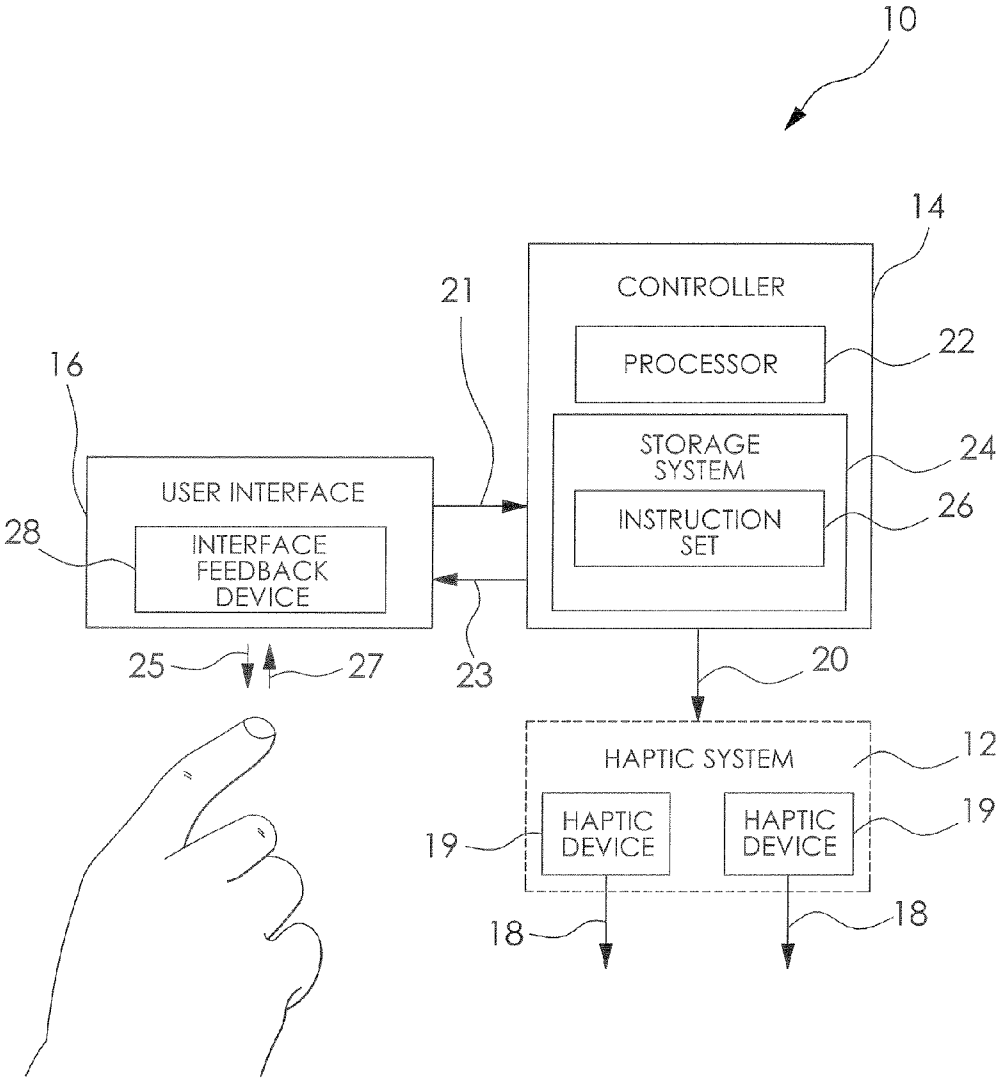
(57) **ABSTRACT**

A feedback control system and a method for controlling a tactile feedback are disclosed, wherein the feedback control system provides users with full precise control of infinite tactile feedback settings. The tactile feedback control system includes a user interface adapted to generate and transmit an information signal including data and information representing a user-provided input, wherein the user interface also generates a tactile sensation to the user, a controller adapted to receive the information signal, analyze the information signal, and generate and transmit a control signal for controlling a tactile feedback in response to the information signal, and a haptic system adapted to receive the control signal and generate the tactile feedback.



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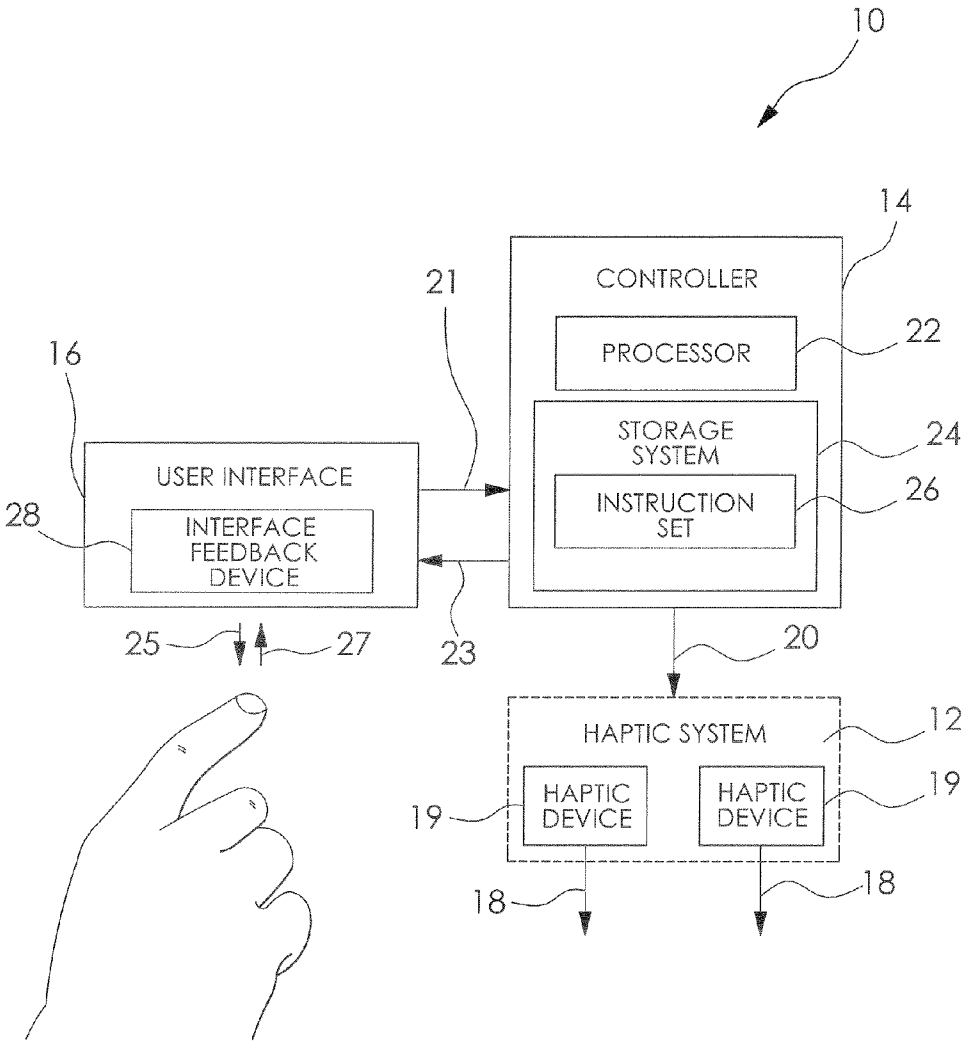
10
14
CONTROLLER
21
PROCESSOR
22
16
STORAGE SYSTEM
24
USER INTERFACE
INSTRUCTION SET
26
28
INTERFACE FEEDBACK DEVICE
25
27
23
20
HAPTIC SYSTEM
12
HAPTIC DEVICE
HAPTIC DEVICE
19
19
18
18

FIG.1

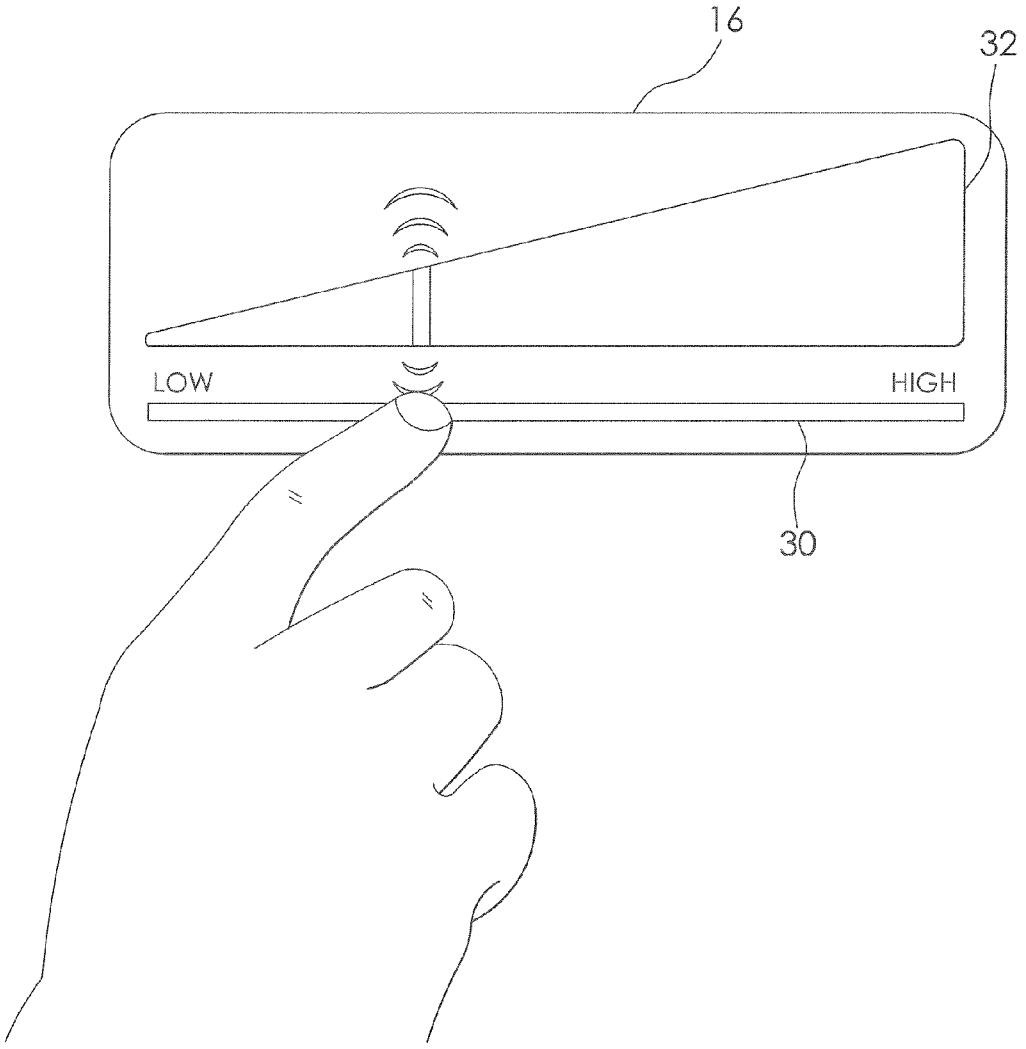

FIG.2

HAPTIC TACTILE PRECISION SELECTION

FIELD OF THE INVENTION

[0001] The present invention relates to haptics. More particularly, the invention is directed to a feedback control system and a method for controlling a tactile feedback.

BACKGROUND OF THE INVENTION

[0002] Currently, in Human Machine Interface (HMI), haptic tactile feedback sensitivity settings are limited to a predetermined number of presets. Each preset is programmed with a specific tactile feedback force, amplitude, and frequency. Once haptic products are programmed at the factory with the feedback presets, the end-user is limited to the pre-programmed feedback and is not able to directly change any undesirable presets. Typically, the only way to reprogram the haptic products is to return the products to the manufacturing location. Further, there is the possibility that the haptic products will be programmed with incorrect tactile feedback forces. If a large number of consumers complain about the predetermined forces, a team would have to be assembled to quickly address such concerns. This not only tarnishes the company's reputation, but also costs time and money. Also, much time and cost for various HMI studies are usually required to determine these presets.

[0003] In summary, tactile feedback forces generated by haptic products are typically pre-defined, pre-determined, and pre-programmed by the manufacturer prior to the end users' interaction. This leads to risks such as incorrect programming, choice limitation, and an undesirable tactile feedback for some consumers.

[0004] It would be desirable to have a tactile feedback control system and a method for controlling a tactile feedback, wherein the feedback control system provides users with full precise control of the infinite tactile feedback settings.

SUMMARY OF THE INVENTION

[0005] Concordant and consistent with the present invention, a feedback control system and a method for controlling a tactile feedback, wherein the feedback control system provides users with full precise control of the infinite tactile feedback settings, has surprisingly been discovered.

[0006] In one embodiment, a tactile feedback control system comprises a user interface adapted to generate and transmit an information signal including data and information representing a user-provided input, wherein the user interface also generates a tactile sensation to the user, and a controller adapted to receive the information signal, analyze the information signal, and generate and transmit a control signal for controlling a tactile feedback in response to the information signal.

[0007] In another embodiment, a tactile feedback control system comprises a user interface adapted to generate and transmit an information signal including data and information representing a user-provided input, wherein the user interface also generates a tactile sensation to the user, a controller adapted to receive the information signal, analyze the information signal, and generate and transmit a control signal for controlling a tactile feedback in response to the information signal, and a haptic system adapted to receive the control signal and generate the tactile feedback.

[0008] The invention also provides methods for controlling a tactile feedback.

[0009] One method comprises the steps of: receiving at least one user-provided input; generating an information signal including data and information representing the at least one user-provided input; analyzing the information signal; generating a control signal in response to the analysis of the information signal; and generating a tactile feedback to a user in response to the control signal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of the preferred embodiment when considered in the light of the accompanying drawings in which:

[0011] FIG. **1** is a schematic block diagram of a feedback control system according to an embodiment of the present invention; and

[0012] FIG. **2** is a front elevational view of a user interface of the feedback control system illustrated in FIG. **1**.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS OF THE INVENTION

[0013] The following detailed description and appended drawings describe and illustrate various embodiments of the invention. The description and drawings serve to enable one skilled in the art to make and use the invention, and are not intended to limit the scope of the invention in any manner. In respect of the methods disclosed, the steps presented are exemplary in nature, and thus, the order of the steps is not necessary or critical.

[0014] FIG. **1** shows a tactile feedback control system **10** according to an embodiment of the present invention. As shown, the tactile feedback control system **10** includes a haptic system **12**, a controller **14**, and a user interface **16**.

[0015] The haptic system **12** is adapted to generate a tactile feedback **18** to a user. As shown, the haptic system **12** includes a pair of haptic devices **19**, each haptic device **19** adapted to produce a tactile feedback **18** to the user. However, any number of the haptic devices **19** may be included, as desired. As a non-limiting example, each of the haptic devices **19** may be a haptic generator integrated with at least one of a vehicle surface, a steering wheel, a touch screen, a shifter, a control button, and a rotary knob. Other surfaces and devices may be adapted to produce the tactile feedback **18**, as desired. It is further understood that the tactile feedback **18** generated by each of the haptic devices **19** of the haptic system **12** may include a variable frequency, a variable amplitude, and a variable pulse pattern, for example. Other dynamic tactile feedback **18** sensations may be provided to the user by the haptic system **12**, as desired. As a non-limiting example, the haptic system **12** may be installed in a vehicle during a manufacturing process of the vehicle. It is further understood that the haptic system **12** may be installed in the vehicle by a post-production process. As shown, the haptic system **12** is in communication with the controller **14**. As such, the haptic system **12** is adapted to receive a control signal **20** from the controller **14** for managing, regulating and controlling the tactile feedback **18** generated by the haptic devices **19** of the haptic system **12**.

[0016] The controller **14** is adapted to receive an information signal **21**, analyze the information signal **21**, and transmit

a control signal **20** to the haptic system **12** in response to the analysis of the information signal **21**. The information signal **21** represents a user-provided input **27** for modifying the tactile feedback **18** generated by the haptic system **12**. Specifically, the information signal **21** may include data and information related to a desired tactile feedback **18** to be generated by the haptic system **12**. The controller **14** is further adapted to transmit an interface feedback control signal **23** to the user interface **16**. The interface feedback control signal **23** includes information and data that is received by the user interface **16** for controlling a tactile sensation **25** of the user interface **16**. The controller **14** may be any device adapted to receive the information signal **21**, analyze the vehicle information signal **21**, and transmit the control signal **20** and the interface feedback control signal **23** such as a microcomputer, for example. Other devices may be used, as appropriate. It is understood that the analysis of the information signal **21** by the controller **14** may be pre-determined. It is further understood that the analysis of the information signal **21** may by modified, as desired. In certain embodiments the controller **14** may be adapted to provide individual control of the tactile feedback **18** of a particular haptic device **19**. For example, the controller **14** may include individualized control signals **20** for selectively controlling the tactile feedback **18** of each haptic device **19** of the haptic system **12**.

[0017] In certain embodiments, the controller **14** includes a processor **22** and a storage system **24**. The processor **22** is adapted to analyze the information signal **21** based upon an instruction set **26**. The instruction set **26**, which may be embodied within any computer readable medium, includes processor executable instructions for configuring the processor **22** to perform a variety of tasks. As a non-limiting example, the processor **22** may be adapted to generate and transmit the control signal **20** and the interface feedback control signal **23** in response to the analysis of the information signal **21**. The storage system **24** may be a single storage device or may be multiple storage devices. Portions of the storage system **24** may also be located on the processor **22**. Furthermore, the storage system **24** may be a solid state storage system, a magnetic storage system, an optical storage system or any other suitable storage system. It is understood that the storage system **24** is adapted to store the instruction set **26**. Other data and information may be stored in the storage system **24**, as desired. As a non-limiting example, user-defined presets may be stored on and retrieved from the storage system **24**.

[0018] The user interface **16** is in communication with the controller **14** and adapted to transmit the information signal **21** to the controller **14** in response to the user-provided input **27**. The user interface **16** is also adapted to receive the interface feedback control signal **23** for controlling the tactile sensation **25** of the user interface **16**. The user interface **16** includes an interface feedback device **28** adapted to generate and transmit the tactile sensation **25** directly to the user as the user engages the user interface **16**. For example, where the user is in contact with the user interface **16**, the interface feedback device **28** of the user interface **16** generates a vibratory sensation to the user's hand. It is understood that the interface feedback device **28** may be adapted to directly receive the interface feedback control signal **23** for controlling the tactile sensation **25**. It is further understood that the user interface **16** may include an internal processor (not shown) for directly receiving at least one of the user provided input **27** and the interface feedback control signal **23** for controlling the interface feedback device **28**.

[0019] In one embodiment, shown in FIG. **2**, the user interface **16** is a touch screen window slider. Specifically, the user interface **16** is a touch sensitive screen having a slider **30**, an audio output (not shown), and a display **32**. As the user moves his/her finger across the slider **30**, the tactile sensation **25** of the user interface **16** varies in response to the slider **30** motion.

[0020] Referring to FIGS. **1** and **2**, for example, the tactile sensation **25** generated by the interface feedback device **28** may increase in one direction of the slider **30** motion and decrease in the other direction. The variation of the generated tactile sensation **25** may be modified, as desired. As the slider **30** moves, the tactile sensation **25** varies and the user interface **16** transmits new information and data to the controller **14** through the information signal **21**. As a non-limiting example, the information signal **21** represents the user-provided input **27**, wherein the user-provided input **27** is embodied by the slider **30** motion.

[0021] In use, the user engages the user interface **16**. In certain embodiments, as shown in FIG. **2**, the user may "slide" his/her finger across the slider **30** of the user interface **16**. Other user interfaces **16** may be used such as a touch screen having dedicated increase and decrease buttons and a rotary knob, for example. Once the user engages the user interface **16**, the information signal **21** is generated and transmitted to the controller **14**. The controller **14** receives the information signal **21**, analyzes the information signal **21**, and generates the control signal **20** in response to the analysis of the information signal **21**. The control signal **20** is received by the haptic system **12** for managing, regulating and controlling the tactile feedback **18** generated by the haptic devices **19** of the haptic system **12**. It is understood that the controller may also generate the interface feedback control signal **23** in response to the analysis of the information signal **21**. The interface feedback control signal **23** is received by the interface feedback device **28** for managing, regulating and controlling the tactile sensation **25** of the user interface **16**. It is understood that the tactile sensation **25** of the user interface **16** is consistent with the tactile feedback **18** generated by the haptic system **12**. For example, the tactile sensation **25** that a user feels on the user interface **16** is substantially the same sensation of the tactile feedback **18** generated by the haptic devices **19** of the haptic system **12**. As the user provides the user-provided input **27** to the user interface **16**, and thereby modifies the tactile feedback **18** generated by the haptic system **12**, the tactile sensation **25** of the user interface **16** is adjusted in real-time and transmitted to the user. Therefore, the user has control of the desired "feeling" they would like to receive from the haptic devices **19** of the haptic system **12** by the real-time interface feedback transmitted from the user interface **16** in the form of the tactile sensation **25**. As a non-limiting example, where the user-provided input **27** represents an increase in the amplitude of the desired tactile feedback **18**, the information signal **21** transmitted to the controller **14** also represents the desired increase in amplitude and the controller **14** therefore increases the amplitude of the tactile feedback **18** of the haptic system **12**. Simultaneously, the amplitude of the tactile sensation **25** of the user interface **16** increases to mirror the tactile feedback **18** generated by the haptic system **12**. It is understood that the user interface **16** may be adapted to provide individual control of the tactile feedback **18** of a particular haptic device **19**. For example, the user interface **16** may include a menu function, wherein the

user may selectively control the tactile feedback **18** of each haptic device **19** of the haptic system **12**.

[0022] The feedback control system **10** provides the user the ability to easily program and vary infinitely the tactile feedback **18** generated by the haptic system **12** using various user interfaces **16**, such as a window slider, shown in FIG. **2**. The feedback control system **10** and the method for controlling the tactile feedback **18** addresses and substantially eliminates the concerns and limitations of the predetermined and preset haptic technology currently manufactured. Now, the control is in the users' hands rather than preprogrammed by the manufacturer. The feedback control system **10** provides greater flexibility for both the users and the manufacturer. All the HMI studies and associated costs required to predetermine the forces can be eliminated.

[0023] From the foregoing description, one ordinarily skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit and scope thereof, make various changes and modifications to the invention to adapt it to various usages and conditions.

What is claimed is:

1. A tactile feedback control system comprising:

a user interface adapted to generate and transmit an information signal including data and information representing a user-provided input, wherein the user interface also generates a tactile sensation to the user; and

a controller adapted to receive the information signal, analyze the information signal, and generate and transmit a control signal for controlling a tactile feedback in response to the information signal.

2. The tactile feedback control system according to claim **1**, further comprising a haptic system adapted to receive the control signal and generate the tactile feedback in at least one of a plurality of haptic devices.

3. The tactile feedback control system according to claim **2**, wherein the user interface provides individual and selective control of at least one of the haptic devices.

4. The tactile feedback control system according to claim **1**, wherein the controller generates an interface feedback control signal for controlling the tactile sensation of the user interface in response to the information signal.

5. The tactile feedback control system according to claim **1**, wherein the tactile sensation of the user interface is substantially similar to the tactile feedback.

6. The tactile feedback control system according to claim **1**, wherein the user interface is a touch screen slider window.

7. The tactile feedback control system according to claim **1**, wherein the controller includes a processor adapted to analyze the information signal.

8. The tactile feedback control system according to claim **7**, wherein the controller includes an instruction set having processor executable instructions for configuring the processor to perform the analysis of the information signal.

9. The tactile feedback control system according to claim **1**, wherein the controller includes a storage system for storing data and information.

10. A tactile feedback control system comprising:

a user interface adapted to generate and transmit an information signal including data and information representing a user-provided input, wherein the user interface also generates a tactile sensation to the user;

a controller adapted to receive the information signal, analyze the information signal, and generate and transmit a control signal for controlling a tactile feedback in response to the information signal; and

a haptic system adapted to receive the control signal and generate the tactile feedback.

11. The tactile feedback control system according to claim **10**, wherein the haptic system generates the tactile feedback in at least one of a plurality of haptic devices.

12. The tactile feedback control system according to claim **11**, wherein the user interface provides individual and selective control of at least one of the haptic devices.

13. The tactile feedback control system according to claim **10**, wherein the controller generates an interface feedback control signal for controlling the tactile sensation of the user interface in response to the information signal.

14. The tactile feedback control system according to claim **10**, wherein the tactile sensation of the user interface is substantially similar to the tactile feedback.

15. The tactile feedback control system according to claim **10**, wherein the user interface is a touch screen slider window.

16. A method for controlling a tactile feedback, the method comprising the steps of:

receiving at least one user-provided input;

generating an information signal including data and information representing the at least one user-provided input;

analyzing the information signal;

generating a control signal in response to the analysis of the information signal; and

generating a tactile feedback to a user in response to the control signal.

17. The method according to claim **16**, wherein the information signal is generated by a user interface adapted to receive the user-provided input.

18. The method according to claim **17**, wherein the user interface is adapted to generate a tactile sensation in response to the user-provided input.

19. The method according to claim **18**, wherein the tactile sensation generated by the user interface is substantially similar to the tactile feedback.

20. The method according to claim **16**, wherein the tactile feedback is generated by a haptic system adapted to receive the control signal.

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