



European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME UNI

Date

29.04.21

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1203 / 2126667
Applicant/Proprietor Immersion Corporation	

Communication regarding the expiry of the time limit within which notice of opposition may be filed

You are hereby informed that on expiry of the nine-month time limit from the publication of the mention of the grant of European patent No. 2126667 no notice of opposition had reached the files.

The entry in the Register of European Patents will be automatically generated by the electronic data processing system.

For the Examining Division



EPPU 02: 24.06.20 1203



European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME UNI

Date
06.07.20

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1203 / 2126667
Applicant/Proprietor Immersion Corporation	

Transmission of the certificate for a European patent pursuant to Rule 74 EPC

The certificate for a European patent is herewith transmitted.

The European patent specification can be downloaded from the EPO publication server
<https://data.epo.org/publication-server/> (see OJ EPO 2005, 126).

Note:

A corrected title page of the European patent specification will be published, if the bibliographic data have been changed after completion of the technical preparations.

For the Examining Division





European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME UNI

Date

28.05.20

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1203 / 2126667
Applicant/Proprietor Immersion Corporation	

Decision to grant a European patent pursuant to Article 97(1) EPC

Following examination of European patent application No. 07863260.1 a European patent with the title and the supporting documents indicated in the communication pursuant to Rule 71(3) EPC (EPO Form 2004C) or in the information (EPO Form 2004W, cf. Notice from the EPO dated 8 June 2015, OJ EPO 2015, A52) dated 16.01.20 is hereby granted in respect of the designated Contracting States.

Patent No. : 2126667
Date of filing : 27.12.07
Priority claimed : 27.12.06/USP 877333

Designated Contracting States
and Proprietor(s) : AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU
LV MC MT NL PL PT RO SE SI SK TR
Immersion Corporation
50 Rio Robles
San Jose CA 95134/US

This decision will take effect on the date on which the European Patent Bulletin mentions the grant (Art. 97(3) EPC).

The mention of the grant will be published in European Patent Bulletin 20/26 of 24.06.20.

Examining Division

Baldan, Marco

Ballerstein, Jens

Arranz, José



ANMERKUNG ZUR ENTSCHEIDUNG ÜBER DIE ERTEILUNG
EINES EUROPÄISCHEN PATENTS (EPA Form 2006)

1. **EPA Informationsbroschüre "Nationales Recht zum EPÜ"**
Diese Broschüre enthält nützliche Informationen zu den formalen Erfordernissen und den Handlungen, die vor den Patentbehörden der Vertragsstaaten vorzunehmen sind, um Rechte in diesen Staaten zu erlangen. Da diese Handlungen einem ständigen Wandel unterworfen sind, sollte immer nur die neueste Ausgabe der Broschüre benutzt werden. Nachträgliche Informationen werden im Amtsblatt veröffentlicht.
2. **Übersetzung der europäischen Patentschrift nach Artikel 65 (1) des Europäischen Patentübereinkommens**
Sie werden erneut darauf hingewiesen, dass bestimmte Vertragsstaaten nach Artikel 65 (1) EPÜ eine Übersetzung der europäischen Patentschrift verlangen; hierauf wird in der Mitteilung gemäß Regel 71 (5) EPÜ verwiesen. Die Nichteinreichung dieser Übersetzung kann zur Folge haben, dass das Patent in dem betreffenden Staat/in den betreffenden Staaten als von Anfang an nicht eingetreten gilt. Weitere Einzelheiten entnehmen Sie bitte der oben genannten Broschüre.
3. **Zahlung von Jahresgebühren für europäische Patente**
Nach Artikel 141 EPÜ können "nationale" Jahresgebühren für das europäische Patent für die Jahre erhoben werden, die an das Jahr anschließen, in dem der Hinweis auf die Erteilung des europäischen Patents im "Europäischen Patentblatt" bekanntgemacht wird. Weitere Einzelheiten entnehmen Sie bitte der oben genannten Broschüre.

NOTE RELATING TO THE DECISION TO GRANT A
EUROPEAN PATENT (EPO Form 2006)

1. **EPO Information Brochure "National law relating to the EPC"**
This brochure provides useful information regarding formal requirements and the steps to be taken before the patent authorities of the Contracting States in order to acquire rights in those states. Since the necessary steps are subject to change the latest edition of the brochure should always be used. Subsequent information is published in the Official Journal.
2. **Translation of the European patent application under Article 65(1) of the European Patent Convention**
Your attention is again drawn to the requirements regarding translation of the European patent specification laid down by a number of Contracting States under Article 65(1) EPC, to which reference is made in the communication under Rule 71(5) EPC. Failure to supply such translation(s) may result in the patent being deemed to be void "ab initio" in the State(s) in question. For further details you are recommended to consult the above-mentioned brochure.
3. **Payment of renewal fees for European patents**
Under Article 141 EPC "national" renewal fees in respect of a European patent may be imposed for the years which follow that in which the mention of the grant of the European patent is published in the "European Patent Bulletin". For further details you are recommended to consult the above-mentioned brochure.

REMARQUE RELATIVE A LA DECISION DE DELIVRANCE
D'UN BREVET EUROPEEN (OEB Form 2006)

1. **Brochure d'information de l'OEB "Droit national relatif à la CBE"**
Cette brochure fournit d'utiles renseignements sur les conditions de forme requises et sur les actes à accomplir auprès des offices de brevet des Etats contractants aux fins d'obtenir des droits dans les Etats contractants. Etant donné que les actes indispensables sont susceptibles de modifications, il serait bon de toujours consulter la dernière édition de la brochure. Toute information ultérieure est publiée au Journal Officiel.
2. **Traduction du fascicule du brevet européen en vertu de l'article 65(1) de la Convention sur le brevet européen**
Votre attention est de nouveau attirée sur l'obligation faite par certains Etats contractants, en vertu de l'article 65(1) CBE, de fournir une traduction du fascicule du brevet européen, à laquelle il est fait référence dans la notification établie conformément à la règle 71(5) CBE. Si la(les) traduction(s) n'est(ne sont) pas fournie(s), le brevet européen peut, dès l'origine, être réputé sans effet dans oet(ces) Etat(s). Pour plus de détails, nous vous renvoyons à la brochure susmentionnée.
3. **Paiement des taxes annuelles pour le brevet européen**
Conformément à l'article 141 CBE des taxes annuelles "nationales" dues au titre du brevet européen peuvent être perçues pour les années suivant celle au cours de laquelle la mention de la délivrance du brevet européen est publiée au "Bulletin européen des brevets". Pour plus de détails, nous vous renvoyons à la brochure susmentionnée.



Letter accompanying subsequently filed items

Representative:

PHILLIPS & LEIGH LLP
380
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
United Kingdom

Phone: +442078228888
Fax: +442078228899
E-mail: mail@pandl.com

80298 Munich
 Germany
 Tel. +49(0)89 2399-0 | Fax -4465

P.O. Box 5818
 2280 HV Rijswijk
 Netherlands
 Tel. +31(0)70 340-2040 | Fax -3016

10958 Berlin
 Germany
 Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number

07863260.1

Applicant's or representative's reference

FP-10-0597

	Description of document	Original file name	Assigned file name
1	Reply to the communication under rule 71(3) EPC	Letter to EPO Rule 71(3).pdf	IGRA-1.pdf
2	French translations of the claims	07863260.1 - French Translation.pdf	CLMSTRAN-FR-1.pdf
3	German translations of the claims	07863260.1 - German Translation.pdf	CLMSTRAN-DE-1.pdf

	Fees	Factor applied	Fee schedule	Amount to be paid
15-1	007 Fee for grant, including fee for publication of the European patent specification (R71(3))	1	960.00	960.00
	Total:		EUR	960.00

	Payment	
1	Method of payment	Debit from deposit account
	Currency:	EUR
	The European Patent Office is hereby authorised, to debit from the deposit account with the EPO any fees and costs indicated on the fees page.	
	Deposit account number:	28050057
	Account holder:	Phillips & Leigh
2	Refund/Reimbursement	
	Reimbursement (if any) to be made to EPO deposit account:	28050057
	Account holder:	Phillips & Leigh

Signatures

Place: London, GB
 Date: 12 May 2020

FP-10-0597

Signed by:	Arthur Boff 24434
Association:	PHILLIPS & LEIGH LLP
Representative name:	Arthur Boff
Capacity:	(Representative)

By EPOline

European Patent Office
80298 Munich
Germany

Our Reference: FP-10-0597

11th May 2020

Dear Sir/Madam,

Re: European Patent Application No. 07863260.1
“VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK”
In the Name of Immersion Corporation

We respond to the Communication under Rule 71(3) EPC.

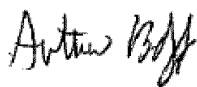
Approval of text

We hereby approve the text and drawings as mentioned at paragraph 1.1 of the Communication under Rule 71(3) EPC.

Claims translations and fee for grant

Please find enclosed the French and German translations of the claims. The fee for grant and printing is paid electronically. You are also authorised to debit any shortfall or credit any overpayment in those fees to that account.

Yours sincerely



Arthur Boff
Phillips & Leigh LLP
Association No. 380

Continuation / 2

Our ref: FP-10-1290

DEMANDE PRINCIPALE

Revendications :

1. Procédé comprenant :
 - 5 i) la réception (500) d'un signal d'entrée comprenant des informations associées à une manipulation (802) d'une surface d'un dispositif d'entrée non mécanique tactile (306), et
 - ii) la génération (504, 604, 706) d'un signal vibrotactile configuré pour amener un actionneur (108) à produire un effet vibrotactile (806) à la surface du dispositif
 - 10 d'entrée non mécanique tactile ;

comprenant en outre :

 - iii) le stockage d'une pluralité de profils de détente virtuelle stockés ;
 - iv) la détermination (704) de l'un de ladite pluralité de profils de détente virtuelle stockés pour générer un signal vibrotactile ;
 - 15 ladite détermination étant basée au moins en partie sur le signal d'entrée (102, 202, 306, 400) et l'effet vibrotactile étant configuré pour simuler une rétroaction mécanique.
2. Procédé selon la revendication 1, **comprenant en outre** :
 - 20 i) la génération d'un signal de système (708) associé à un système (110, 210) à manipuler ;
 - ii) le fait de baser le signal de système au moins en partie sur le signal d'entrée ; et
 - iii) la génération sensiblement simultanée (708) du signal de système et la génération (504, 604, 706) du signal vibrotactile.
 - 25
3. Procédé selon la revendication 2, **comprenant en outre** la détermination de générer ou non un signal de système (708) basé au moins en partie sur un état du système (110, 210) à manipuler.
- 30 4. Support lisible par ordinateur sur lequel est codé un code de programme pour effectuer le procédé selon l'une quelconque des revendications 1 à 3.
5. Système, comprenant :
 - i) un dispositif d'entrée non mécanique tactile (306) ;
 - 35 ii) au moins un actionneur (108, 208, 406) couplé au dispositif d'entrée non mécanique tactile ;

- iii) un processeur (106, 206) en communication avec le dispositif d'entrée tactile et ledit au moins un actionneur étant configuré pour :
- 5 a) recevoir (500) un signal d'entrée comprenant des informations associées à une manipulation (802) du dispositif d'entrée non mécanique tactile (102, 202, 400) ; et,
- b) générer (504, 604, 706) un signal vibrotactile configuré pour amener ledit actionneur (108) à produire un effet vibrotactile (806) sur une surface du dispositif d'entrée non mécanique tactile et l'effet vibrotactile étant configuré pour simuler une rétroaction mécanique ;
- 10 **dans lequel ;**
- iv) le processeur (106, 206) :
- a) comprend une mémoire (216) configurée pour stocker des profils de détente virtuelle, et
- b) est configuré pour effectuer le procédé selon l'une quelconque des
- 15 revendications 1 à 3.
6. Système selon la revendication 5, **dans lequel** le processeur (106, 206) est en outre configuré pour générer (706) un signal de système pour commander un système (110, 210) basé au moins en partie sur une manipulation du dispositif d'entrée non mécanique (102, 202, 306, 400).
- 20 7. Système selon la revendication 5 ou la revendication 6, **dans lequel** l'au moins un actionneur (406) est couplé à un boîtier (302, 402) du dispositif d'entrée non mécanique (306, 400).
- 25 8. Système selon l'une quelconque des revendications 5 à 7, **dans lequel** un capteur (104, 204, 408) est configuré pour détecter une manipulation du dispositif d'entrée non mécanique (102, 202, 400) et générer le signal d'entrée.

HAUPTANTRAG

Patentansprüche:

1. Verfahren, Folgendes umfassend:
 - 5 i) Empfangen (500) eines Eingangssignals, das Informationen umfasst, die einer Bedienung (802) einer Oberfläche einer berührungsempfindlichen nicht-mechanischen Eingabevorrichtung (306) zugeordnet sind, und
 - ii) Erzeugen (504, 604, 706) eines vibrotaktilen Signals, das konfiguriert ist, um einen Stellantrieb (108) zu veranlassen, einen vibrotaktilen Effekt (806) auf die Oberfläche
 - 10 der berührungsempfindlichen nicht-mechanischen Eingabevorrichtung zu erzeugen; **ferner Folgendes umfassend:**
 - iii) Speichern mehrerer gespeicherter virtueller Rastprofile;
 - iv) Bestimmen (704) eines aus den mehreren gespeicherten virtuellen Rastprofilen, um ein vibrotaktilen Signal zu erzeugen;
 - 15 wobei die Bestimmung mindestens teilweise auf dem Eingangssignal (102, 202, 306, 400) basiert und wobei der vibrotaktile Effekt konfiguriert ist, um eine mechanische Rückmeldung zu simulieren.
2. Verfahren nach Anspruch 1, **ferner Folgendes umfassend:-**
 - 20 i) Erzeugen eines Systemsignals (708), das einem zu bedienenden System (110, 210) zugeordnet ist;
 - ii) Basieren des Systemsignals mindestens teilweise auf dem Eingangssignal; und
 - iii) im Wesentlichen gleichzeitiges Erzeugen (708) des Systemsignals und Erzeugen (504, 604, 706) des vibrotaktilen Signals.
 - 25
3. Verfahren nach Anspruch 2, **ferner umfassend** das Bestimmen, ob ein Systemsignal (708) erzeugt werden soll, das mindestens teilweise auf einem Status des zu bedienenden Systems (110, 210) basiert.
- 30 4. Computerlesbares Medium, auf dem ein Programmcode codiert ist, um das Verfahren nach einem der Ansprüche 1 bis 3 durchzuführen.
5. System, Folgendes umfassend:
 - i) eine berührungsempfindliche nicht-mechanische Eingabevorrichtung (306);
 - 35 ii) mindestens einen Stellantrieb (108, 208, 406), der mit der berührungsempfindlichen nicht-mechanischen Eingabevorrichtung gekoppelt ist

- iii) einen Prozessor (106, 206), der mit der berührungsempfindlichen Eingabevorrichtung und dem mindestens einen Stellantrieb in Verbindung steht und für Folgendes konfiguriert ist:
- 5 a) Empfangen (500) eines Eingabesignals, das Informationen umfasst, die mit einer Bedienung (802) der berührungsempfindlichen nicht-mechanischen Eingabevorrichtung (102, 202, 400) verbunden sind; und,
- 10 b) Erzeugen (504, 604, 706) eines vibrotaktilen Signals, das konfiguriert ist, um den Stellantrieb (108) zu veranlassen, einen vibrotaktilen Effekt (806) auf eine Oberfläche der berührungsempfindlichen nicht-mechanischen Eingabevorrichtung zu erzeugen, und wobei der vibrotaktile Effekt konfiguriert ist, um eine mechanische Rückmeldung zu simulieren;
- wobei;**
- iv) der Prozessor (106, 206):
- 15 a) einen Speicher (216) umfasst, der konfiguriert ist, um virtuelle Rastprofile zu speichern, und
- b) konfiguriert ist, um das Verfahren nach einem der Ansprüche 1 bis 3 durchzuführen.
6. System nach Anspruch 5, **wobei** der Prozessor (106, 206) ferner konfiguriert ist, um ein Systemsignal zu erzeugen (706), um ein System (110, 210) zu steuern, das mindestens teilweise auf einer Bedienung der nicht-mechanischen Eingabevorrichtung (102, 202, 306, 400) basiert.
- 20 7. System nach Anspruch 5 oder 6, **wobei** der mindestens eine Stellantrieb (406) mit einem Gehäuse (302, 402) der nicht-mechanischen Eingabevorrichtung (306, 400) gekoppelt ist.
- 25 8. System nach einem der Ansprüche 5 bis 7, wobei ein Sensor (104, 204, 408) konfiguriert ist, um eine Bedienung der nicht-mechanischen Eingabevorrichtung (102, 202, 400) zu erfassen und das Eingabesignal zu erzeugen.
- 30



Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	8616792	
Application number	EP07863260.1	
Date of receipt	12 May 2020	
Receiving Office	European Patent Office, The Hague	
Your reference	FP-10-0597	
Applicant	All applicants as on file	
Documents submitted	package-data.xml epf1038.pdf (2 p.) CLMSTRAN-FR-1.pdf07863260.1 - French Translation.pdf (2 p.)	ep-sfd-request.xml IGRA-1.pdfLetter to EPO Rule 71(3).pdf (2 p.) CLMSTRAN-DE-1.pdf07863260.1 - German Translation.pdf (2 p.)
Submitted by	CN=Arthur Boff 24434	
Method of submission	Online	
Date and time receipt generated	12 May 2020, 14:17 (CEST)	
Message Digest	43:B7:8A:AE:C4:41:A9:63:04:16:E4:B2:9A:75:05:50:EC:F4:76:58	

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/

Application No.:

07 863 260.1

IV.2. Patent classification

The classification indicated on the published patent application remains unchanged. It is as follows:

INV. G06F3/01

IV.3. Title of the invention

The title indicated on the published patent application remains unchanged. It reads as follows:

VIRTUELLE ARRETIERUNGEN DURCH VIBROTAKTIL-RÜCKMELDUNG

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

DÉTENTES VIRTUELLES PAR UNE RÉTROACTION VIBROTACTILE

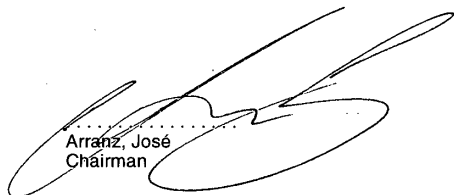
IV.4. Documentation

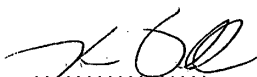
CDOC The following documents not mentioned in the Search Report were cited during the Examination Procedure:

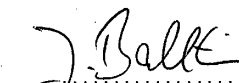
US 6 636 197 B1 (GOLDENBERG ALEX S [US] ET AL) 21 October 2003
(2003-10-21)

6-1-220

Date


Arranz, José
Chairman


Baldan, Marco
1st examiner


Ballerstein, Jens
2nd examiner

Enclosure(s):

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

CROSS-REFERENCES TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application No. 60/877,333 entitled "Virtual Detents through Vibrotactile Feedback," filed December 27, 2006.

FIELD OF THE INVENTION

The present invention generally relates to vibrotactile feedback. More particularly, the present invention relates to methods and systems for providing virtual detents through vibrotactile feedback.

10

BACKGROUND

Traditional mechanical device controls include switches, knobs, levels, sliders, faders, and the like. In the past, such controls have been essentially mechanical in nature, e.g., a knob turning a shaft coupled to a potentiometer to control an electrical input to a device such as a radio or audio amplifier, a knob turning a shaft coupled to a fan control or heating/air conditioning control in an automobile, or a lever controlling the opening and closing of a vent in an automobile.

15

With many traditionally mechanical functions being replaced by electronics, operation of electronic controls has been made less intuitive to users. For example, without click-stops or "detents," or otherwise a sense of mechanical resistance, it may be difficult to obtain a similar experience from an electronic substitute for a traditional mechanical control device or even effectively and efficiently operate such a device. A detent, such as a mechanical detent, can refer to the resistance of rotation of a wheel or shaft. A detent can be used to divide a rotation into discrete increments, or may be used to arrest rotation in a direction. For instance, a mechanical detent can be constructed from a notched wheel and a small gravity or spring-actuated lever.

20

25

Examples of input devices, known in the prior art, providing haptic feedback simulating detents are disclosed by US 6,636,197 B1 and US 2006/0038781 A1.

SUMMARY

Embodiments of the present invention disclosed herein provide methods and systems for providing virtual detents through vibrotactile feedback.

30

One embodiment of the invention is a method comprising the steps of receiving an input signal that comprises information associated with the manipulation of a surface of a touch-sensitive non mechanical input

device, and generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect comprising a virtual detent to the surface of the input device, with the vibrotactile effect configured to simulate mechanical feedback.

In another embodiment, a computer-readable medium (such as, for example, random access memory or a computer disk) comprises code for carrying out such a method.

Another embodiment of the invention is a system comprising a touch-sensitive non mechanical input

device and a processor that is in communication with the touch-sensitive non mechanical input device and that

- 5 is configured to receive an input signal comprising information associated with the manipulation of the touch-sensitive non mechanical input device. The processor may further be configured to generate a detent signal based at least in part on the manipulation of the input device. The system may further comprise an actuator coupled to the input device. The actuator may be in communication with the processor and configured to produce to the surface of the touch-sensitive non mechanical input
- 10 device a vibrotactile effect comprising a virtual detent based at least in part on the detent signal and configured to simulate mechanical feedback.

Further details of embodiments of the invention are set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

- These and other features, aspects, and advantages of the invention are better
- 15 understood when the following Detailed Description is read with reference to the accompanying drawings, wherein:

Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention;

- Figure 2 is a block diagram illustrating a second system for providing virtual detents
- 20 through vibrotactile feedback in one embodiment of the invention;

Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention;

Figure 4 is an illustration of a second device for providing virtual detents through vibrotactile feedback in a comparative example;

- Figure 5 is a flow diagram illustrating a first method for virtual detents through vibrotactile feedback;
- 25

Figure 6 is a flow diagram illustrating a second method for virtual detents through vibrotactile feedback;

- Figure 7 is a flow diagram illustrating a third method for virtual detents through vibrotactile feedback;
- 30

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through vibrotactile feedback; and

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention provide methods and systems for virtual detents through vibrotactile feedback. In one illustrative embodiment, a touch-sensitive surface is manipulated. A sensor detects the manipulation of the surface and sends an input signal to a processor. The input signal comprises information related to the manipulation of the surface. The processor determines whether to manipulate an audio system based at least in part on the input signal. The processor further determines whether to generate a signal configured to cause an actuator to vibrate the surface, the vibration based at least in part on the signal.

This example is given to introduce the reader to the general subject matter discussed. The invention is not limited to this example. The present invention is defined by the appended claims. Embodiments and examples not covered by the claims do not form part of the invention, they are provided to fully understand its principles. Below, examples of methods and systems for virtual detents through vibrotactile feedback are described.

Illustrative Devices for Enhanced Haptic Feedback

In one illustrative embodiment of a device configured to provide virtual detents through vibrotactile feedback, a portable music player may be configured to play music through a speaker and produce a virtual detent on a touch pad with an actuator. In one such embodiment, the portable music player may comprise a touch pad configured to generate an input signal to a processor based on a user contact. The processor may analyze the input signal and determine whether to manipulate the audio system and whether to generate a vibrotactile effect. If the processor determines a vibrotactile effect should be generated, the processor may generate a signal. The signal may be configured to cause the actuator to produce a vibrotactile effect to the touch pad in the form of a virtual detent.

Such an illustrative embodiment may be advantageously employed to simulate mechanical detents through vibrotactile feedback. Such simulated mechanical detents, or virtual detents, may provide useful feedback to a user. For example, a virtual detent may indicate the successful change in volume of a sound system. As another example, the absence of a virtual detent may indicate that a climate system is not turned on, or that it has reached the highest threshold of operation.

These further examples are given to introduce the reader to the general subject matter discussed herein. The invention is not limited to these examples. The following sections describe various embodiments of systems and methods for providing virtual detents through vibrotactile feedback.

Example of a First System for Virtual Detents through Vibrotactile Feedback

Referring now to the figures in which like numerals indicate like elements throughout the several figures, Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention. In the

5 embodiment shown, the system comprises an input device 102, a sensor 104, a processor 106, an actuator 108, and a system to be manipulated 110.

The Input Device and Sensor

Systems of the invention comprise an input device 102 and a sensor 104. The input device 102 shown in Figure 1 is configured to provide an input signal to the processor when
10 the input device 102 is manipulated. In other embodiments, sensor 104 can generate an input signal when the sensor 104 detects manipulation of the input device 102.

In a comparative example the input device 102 can be, for example, a mechanical input device. Examples of mechanical input devices include a rotary knob coupled to an encoder. Encoders of the input device 102 may comprise an optical encoder or a potentiometer.
15 In other embodiments according to the invention, the input device 102 may be a non-mechanical input device. For example, the input device 102 may be a touch-sensitive device, such as a touch pad or a touch screen.

The input device 102 is in communication with a sensor 104. The sensor detects movement of the input device 102. A sensor 104 can be configured to detect the movement
20 of a rotary knob, or other aspects of manipulation of the input device 102, such as position, velocity, acceleration, torque, rate of rotation, or the time of rotation.

Sensor 104 shown in Figure 1 comprises a contact-type sensor, such as a switch, a resistive sensor, a capacitive sensor, an infrared sensor, or an optical sensor. Alternatively, sensor 104 may comprise a non-contact sensor such as a field effect sensor or a proximity
25 sensor, and can be a surface or sub-surface sensor.

The Processor

The system illustrated in Figure 1 comprises a processor 106. The processor 106 may be configured to receive input signals from an input device 102 or a sensor 104 and to generate signals to an actuator 108. The signals may be configured to cause the actuator 108 to produce
30 a vibrotactile effect. Further, the processor can generate signals provided to a system to be manipulated 110.

In one embodiment, a dedicated processor 106 may receive input signals and generate signals. Although there is a single processor shown in Figure 1, the system may comprise a plurality of processors. The processor 106 may be configured to perform a variety of tasks.

For example, the processor 106 may comprise additional program code running on a native cellular phone processor.

5 The processor 106 may be configured to receive input signals. In some embodiments, the processor 106 may receive input signals from the input device 102. In other
embodiments, the processor 106 may receive input signals from the sensor 104. In the
embodiment shown in Figure 1, the input device 102, sensor 104 and the processor 106 are in
communication via a direct wired digital connection. For example, the input device 102, sensor
104, and the processor 106 may be in communication via a communication bus such as the
Universal Serial Bus (USB). In other embodiments, communication between an input device
10 102, sensor 104 and the processor 106 may be through analog signals and/or may be wireless.
For instance, the sensor 104 may be able to use Bluetooth, Wireless USB or Wi-Fi
to communicate with the processor 106.

 The processor 106 can also generate one or more signals. For example, a processor
may generate a signal when a valid input signal is received. In the embodiment shown in
15 Figure 1, as the input device 102 is manipulated, the processor 106 may generate a signal at
the same time or immediately after the manipulation. In one embodiment, the processor 106
may process software code running as an application on the processor and utilize the input
signal in the context of the software code to generate signals configured to cause virtual
detents.

20 The processor 106 may generate a signal, such as a detent signal, to the actuator 108.
The detent signal may be configured to cause an actuator 108 to produce a vibrotactile effect
in the form of a virtual detent on the input device 102.

 The processor 106 may generate a signal specific to an actuator 108. In one
embodiment, the signal may be generated with parameters specific to the actuator 108. For
25 example, the processor may analyze parameters associated with the actuator 108, such as the
actuator's resonant frequency, and generate a signal based at least in part on the parameters.
Other parameters of the actuator 108 may comprise, for example and without limitation, a
resonant frequency of the actuator, a maximum peak-to-peak amplitude or magnitude of the
actuator, or a minimum actuator response time.

30 The processor 106 may generate a signal by accessing a detent profile stored in a
memory (not shown in Figure 1). In one embodiment, the processor 106 may access a specific
detent profile based at least in part on the input signal. In certain embodiments, the processor
106 may determine which of a plurality of simulated mechanical detents to generate. For
example, the processor 106 may analyze the input signal and determine that a

hard stop is appropriate. Further, the processor 106 may then access the hard stop virtual detent profile in a memory, and generate a detent signal based on the hard stop virtual detent profile.

5 The processor 106 may be in communication with a system to be manipulated 110 or controlled. In some embodiments, the processor 106 may be configured to generate a system signal. The system signal may be provided to the system to be manipulated 110.

The system signal may be based at least in part on the manipulation of the input device. For example, an input device 102 in the form of a rotary knob may be rotated one entire revolution. The processor 106 may receive an input signal indicating the complete
10 rotation of the input device 102 and generate a system signal configured to manipulate a system 110 by maximizing or minimizing a level of the system.

While the device shown comprises one processor 106, other devices may comprise two or more processors. Processor 106, as well as other processors incorporated into one or more embodiments of the present invention, may comprise a computer-readable medium,
15 such as a random access memory (RAM) coupled to the processor (not shown in Figure 1). The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs for generating vibrotactile or other haptic effects. Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable gate arrays (FPGAs), and
20 state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

Such processors may comprise, or may be in communication with, media, for
25 example computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, an electronic, optical, magnetic, or other storage or transmission device capable of providing a processor with computer-readable instructions. Other examples of
30 media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other forms of computer-readable media may transmit or carry instructions to a computer, such as a router, private or public network, or other transmission device or

channel. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein. The instructions can comprise code from any suitable computer-programming language, including, for example, assembly code, C, C+, C++, Visual Basic, Java, Python, and JavaScript.

The Actuator

The system illustrated in Figure 1 further comprises one or more actuators 108. Each actuator 108 can be configured to receive a signal from the processor 106 and provide vibrotactile effects to the user in the form of virtual detents. The actuator 108 can vibrate the input device 102 to provide vibrotactile feedback.

The actuator 108 can provide vibrotactile feedback based on signals received from the processor 106. For example, the actuator 108 may be configured to generate a vibration after receiving a detent signal from the processor 106. The actuator 108 can vibrate the input device 102 at substantially the same time the input device is being manipulated.

The actuator 108 may be configured to simulate mechanical feedback through vibrotactile feedback. Specifically, in some embodiments the actuator 108 may be configured to provide the perception of a detent (i.e. a virtual detent) without the traditional means necessary for a mechanical detent. For example, the actuator 108 may be used in place of various mechanical components which traditionally provided tactile feedback, such as springs, brakes or cams. In some embodiments, the vibrotactile feedback may comprise a click effect replicating a mechanical click. In other embodiments, the vibrotactile feedback may not comprise a click effect, but some other effect, such as a spring effect or a barrier effect.

The actuator 108 may be configured to generate vibrotactile feedback with a variety of different characteristics. For example, the actuator may be configured to generate vibrotactile feedback with different frequencies, amplitudes, or waveforms. In one embodiment, the virtual detent may comprise a simulated click generated through a single pulse. In a second embodiment, the virtual detent may comprise a click-and-release effect generated by a double pulse. Figure 9 provides illustrations of various virtual detent profiles.

Because the actuator 108 may be configured to generate vibrotactile feedback, in contrast to mechanical feedback, the actuator 108 may provide vibrotactile feedback to non-mechanical input devices 102, such as a touch-sensitive pad, i.e., a touch pad or touch screen.

The actuator 108 may be configured to generate various types of vibrotactile feedback. For example, the actuator 108 may be configured to produce different virtual detents. The vibrotactile feedback may be generated in various directions. For example, the actuator 108 may vibrate the input device orthogonal to the motion of the input device.

5 The actuator 108 can be any of a variety of different types of force producing devices, including an eccentric rotating mass (ERM) actuator, a multifunctional (MFT) actuator, a linear mass actuator, an electro-magnetic actuator, a motor, a voice coil, a pneumatic or hydraulic actuator, an electro-active polymer, or any other suitable actuator. In one
10 embodiment, actuator 108 may comprise a plurality of actuators of the same or different design. For example, in one embodiment, two actuators may be employed. A first actuator may be configured to provide vibrotactile or other haptic effects having a high frequency of vibration (e.g. greater than 400Hz), while a second actuator may be configured to provide vibrotactile or other haptic effects having a low frequency of vibration (e.g. less than 400Hz).

15 Since some embodiments of the invention may use the actuator 108 to generate vibrotactile feedback, as opposed to mechanical feedback, a smaller actuator may be used than in other devices. For example, actuator 108 may comprise a circular actuator ten (10) millimeters in diameter and three and one half (3.5) millimeters thick.

20 Since the device may comprise a plurality of actuators, the number of actuators 108 may be based on the size and mass of the device. For example, an actuator 108 may be provided for every one hundred (100) grams of mass of the system. In such an example, a system measuring three hundred (300) grams may comprise three actuators. In another example, a cellular phone measuring three hundred (300) grams may only comprise a single but more powerful actuator.

25 In one embodiment, the number of actuators 108 may be based on what surface of the system is being vibrated. For example, if a PDA measures four hundred (400) grams, but only the display will be vibrated, the system may comprise only one actuator 108, especially if the display is isolated from the rest of the device such as by a suspension system. Alternatively, if vibrotactile feedback is provided to the entire PDA, the system may comprise two or more
30 actuators.

Each actuator 108 of a plurality of actuators may be configured to generate vibrotactile feedback to the input device 102. In one embodiment, the vibrotactile feedback generated by each of a plurality of actuators is synchronized.

35

The actuator 108 can be mounted to a touch-sensitive display, such as a touch screen (not shown in Figure 1). In one embodiment, the actuator 108 is mounted underneath the display, or alternatively, to the edge of the display, or laterally mounted to the display. In embodiments where the actuator 108 is mounted to a display, the display may be mounted in a suspension of compliant material, such as a foam gasket. Mounting a display to a foam gasket may ensure that the display is vibrated alone or with a different strength than the entire device.

In one embodiment, two actuators may be mounted to either side of a display. In one example, both actuators may face the same direction and be in the same phase. In one embodiment, two side-mounted actuators may vibrate a screen side-to-side. Side-mounted actuators may produce consistent forces across a screen, since the screen may be moving in the direction of its rigidity.

In one embodiment, two actuators are mounted behind a display. In one example, both actuators mounted behind the display may face the same direction and can vibrate the display in and out.

The System to Be Manipulated

The system illustrated in Figure 1 comprises a system to be manipulated 110. One or more systems to be manipulated 110 can each receive system signals from the processor 106. The system to be manipulated 110 may comprise a system capable of electrical or electromechanical control, such as and without limitation, a stereo system, a video system, a climate system (e.g. air conditioning and/or heating), a navigation system, automotive systems, wireless communication devices, security systems, a television, a video game system, a washing machine or a drying machine, or an oven.

In one embodiment, the system to be manipulated 110 may comprise a single system, such as a lighting system. In another embodiment, the system to be manipulated 110 may comprise a complex system comprising one or more elements. For example, the system to be manipulated 110 may be a heating and cooling system.

Example of a Second System for Virtual Detents through Vibrotactile Feedback

Figure 2 is a block diagram illustrating a second system for providing virtual detents through vibrotactile feedback in one embodiment of the invention. In the embodiment shown, the system comprises a rotary encoder 202, a sensor 204, a processor 206, and a linear resonant actuator 208. The system further comprises a visual system 210a, an audio system 210b, a climate system 210c, a display 212, a speaker 214, and a memory 216. An example of a visual system 210a is a video game system. An example of an audio system 210b is a

stereo system. An example of a climate system 210c is an air conditioning and heating system.

As shown in Figure 2, the input device can be the rotary encoder 202. The sensor 204 is in communication with the rotary encoder 202 and the processor 206. As the rotary encoder 202 is manipulated, the sensor 204 generates input signals associated with the manipulation, and transmits the input signals to the processor 206.

Once the processor 206 receives an input signal, the processor 206 can determine whether to generate a detent signal and/or a system signal. For example, if the input signal indicates a rotation of a knob in more than 5 degrees of motion, the processor 206 may generate a system signal and a detent signal.

The processor 206 is in communication with the linear resonant actuator 208. The processor 206 can receive input signals comprising information associated with a manipulation of the rotary encoder 202 and generate a signal configured to cause the linear resonant actuator 208 to produce a vibrotactile effect to the rotary encoder 202, the vibrotactile effect comprising a simulated mechanical detent.

As shown in Figure 2, the processor 206 is in communication with three systems: a video system 210a, a stereo system 210b, and a climate system 210c. The processor is also in communication with a display 212 and a speaker 214. The processor may synchronize changes in the display 212, sounds played via a speaker 214, and vibrotactile feedback in the rotary encoder 202.

In other embodiments, the input device may comprise a different device, such as a touch pad. The touch pad (not shown) may be in communication with a sensor 204. The sensor 204 may be configured to detect movement on the touch pad.

The sensor 204 can directly transmit input signals to the processor 206. In a specific example, the sensor 204 may send an input signal to the processor 206 once the rotary encoder is rotated 2 degrees or more.

The processor 206 can be in communication with one or a plurality of systems to be controlled. The processor 206 can cause the display 212 to show a graphical representation of a menu structure. The processor 206 can synchronize vibrotactile feedback with other events, such as changes in the display 212 or sounds played on the stereo system 210b. In one example, as the navigation of a menu system is shown on display 212, the input device may be vibrated while each item on the menu is traversed.

The processor 206 can be configured to determine a specific detent signal to generate. The detent signal may be based at least in part on the system which is actively being

controlled. For example, if the video system 210a is being controlled, the processor 206 may generate one type of detent signal, such as a click effect. Alternatively, if the stereo system 210b is being controlled, the processor 206 may generate a second type of detent signal, such as a hard stop virtual detent.

5 As shown in Figure 2, the processor 206 comprises memory 216. The memory 216 can be a high-speed cache memory, and configured to store vibrotactile feedback effects, such as virtual detent profiles. In one embodiment, the processor can access an effect profile stored in memory 216 after the processor 206 has determined what type of vibrotactile effect to generate.

10 A default library of vibrotactile effects, such as virtual detents, may be stored in the memory 216. For example, the processor 106 may store each virtual detent profile illustrated in Figure 9 in the memory 216. This profile may take the form of computer code. In one embodiment, the processor may be programmed with various types of vibrotactile effects not previously stored in memory 216. For example, each user of the system may author
15 individual vibrotactile effects to store in memory 216. In a second embodiment, the processor 106 may only store vibrotactile effects programmed by a manufacturer. In one embodiment, characteristics of the actuator may be stored in memory 216. For example, the frequency response of a system's actuator may be stored in memory 216.

Virtual Detents Through Vibrotactile Feedback

20 Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. Various embodiments of the invention may be used in devices without mechanical feedback. In other embodiments, the invention may be used to supplement mechanical feedback.

 The device in Figure 3 comprises a portable music player 300 having a body 302, a
25 graphical user interface display 304, and a circular touch pad 306. Although the touch pad 306 shown in Figure 3 is circular, in other embodiments the touch pad 306 may be linear, rectangular, or some other configuration. As shown in Figure 3, the input device 306 may be in communication with a display 304. As an example, the input device 306 may be configured to navigate a menu system which may be shown on the display 304. In other embodiments, the
30 input device 306 may not be in communication with a display 304.

 While the embodiment shown in Figure 3 comprises a portable music player, other embodiments may comprise other devices, such as a personal digital assistant (PDA), a portable video player, a portable game system, or a portable navigation device. Other

examples may include other electronic devices or appliances, such as a television, oven, or a lighting system.

A user may interact with the portable music player 300 by activating the circular touch pad 306. For example, a user may select an object on a menu displayed on the

5 graphical user interface display 304 by dragging a finger around the circular touch pad 306 in a clockwise or counter-clockwise direction.

An actuator (not shown in Figure 3) is coupled to the touch pad. As a user manipulates the circular touch pad 306, vibrotactile feedback in the form of virtual detents are provided to the user when the actuator vibrates the touch pad. The actuator generates

10 virtual detents through vibrotactile feedback, to simulate mechanical feedback.

Since the vibrotactile feedback may be programmable and variable, providing different types of vibrotactile feedback on the same input device will provide an enhanced interface. Vibrotactile feedback may aid in the selection of menus, control of levels (such as volume, bass, treble, balance, etc.), and navigation of lists.

15 Vibrotactile feedback may be based on the validity of an input. In one example, vibrotactile feedback is provided when a valid input is received, such as when a control is enabled and within an allowed range. If the controlled function is at or reaches a maximum or a minimum, vibrotactile feedback may be disabled, providing information that the attempted control is outside of the valid range of the system. Similarly, if the system is not active or

20 powered on, the absence of vibrotactile feedback may inform the user of that state.

The frequency and strength of the vibrotactile feedback may also be varied to provide an enhanced interface. In one embodiment, the type of vibrotactile feedback may be based at least in part on the content selected by a user.

In one embodiment the frequency and strength of the vibrotactile feedback notifies the

25 user of various levels of control. A stronger virtual detent can indicate a bigger decision in comparison to a weaker virtual detent indicative of a smaller decision. High and low strengths of vibrotactile feedback can indicate divisions in a list (i.e. separate words by letter, or numbers at every multiple of 10). A high or low strength of vibrotactile feedback can also indicate one or more points in a range, for example, the center position of a balance control. The

30 frequency of the vibrotactile feedback may represent the speed of navigation of the user's finger across the touch active surface or across the number of elements in a list.

In one embodiment, each system that is controlled by the input device may be associated with a type or profile of vibrotactile feedback. For example, the actuator vibrates the input device at a constant intensity when an audio system is being controlled by the input

device, and vibrates the input device at a periodic intensity when a temperature system is being controlled.

In one embodiment, a combination of vibrotactile effects is linked as a vibrotactile theme. A vibrotactile theme can correspond with an individual function or system. One theme can comprise a combination of single clicks and double clicks to represent simulated mechanical feedback for a system being changed or a threshold being reached. Another theme can comprise a combination of a constant, low intensity vibration with a hard stop virtual detent effect. While the first theme can be assigned to one system, such as a climate system the second theme can be assigned to a second system, such as a stereo system.

Figure 4 is an illustration of a device for providing virtual detents through vibrotactile feedback in a comparative example. The device in Figure 4 comprises a mechanical device, specifically a rotary knob 400. While the comparative example shown in Figure 4 comprises a rotary knob 400, other embodiments may comprise other input devices. In some other comparative examples, the input device may comprise a linear or rotary encoder, a potentiometer, or a fader. Alternatively, embodiments according to the present invention may comprise non-mechanical input devices, such as a touch-sensitive pad or a touch-sensitive screen.

The rotary knob 400 is configured to rotate in a rotary degree of freedom about an axis extending through the knob. In some comparative examples, the rotary knob may also be configured to move in a plane perpendicular to or along the rotary axis. The rotary knob 400 is coupled to a mounting surface 402. The mounting surface may be a surface on a control panel, dashboard, car console, mouse, joystick, industrial equipment, medical equipment, or any consumer electronics device.

A user interacts with the rotary knob 400 by rotating the knob in a clockwise or counter-clockwise direction. One or more actuators 406 can be coupled to the rotary knob 400 to generate vibrotactile feedback. As the knob is rotated, vibrotactile feedback may be generated in the form of virtual detents. For example, as the knob is rotated, an effect such as a hard stop may be generated by vibrating the knob.

The rotary knob 400 can be coupled to a sensor 408. Sensor 408 can detect movements in the rotary knob 400, and transmit data to a processor 106. A shaft 404 may connect the actuator 406 and sensor 408 with the rotary knob 400.

As shown in Figure 4, a rotary knob 400 is a generally cylindrical object. Other devices for providing virtual detents may have various designs, including but not limited to conical shapes, spherical shapes, oval shapes, cubical shapes, etc. The rotary knob 400 may have one or more textures on its surface, including but not limited to bumps, lines, grooves,

other types of grips, or projections or members extending from the device's surface. Such shapes and textures may allow a user to easily grip or contact the knob and rotate it.

The rotary knob 400 may be configured to control a system. For example, the rotary knob 400 may be located on a stereo receiver, and configured to control the volume of the stereo. In one comparative example, the rotary knob 400 may control a plurality of systems, such as a car's temperature system, navigation system, and/or communication system. For example, a user can pull a knob to a first elevation in order to control the temperature system of the car. To control a different system, a user may push the knob down to a different elevation. In another comparative example, a user selects a system to be controlled via a menu system navigated by the rotary knob 400 or other controls.

Examples of Methods for Virtual Detents through Vibrotactile Feedback

Figure 5 is a flow diagram illustrating a first method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 502, the sensor generates an input signal based at least in part on a manipulation of an input device. In step 502, the processor 106 receives an input signal comprising information associated with the manipulation of an input device 102. In step 504, the processor 106 generates a signal configured to cause an actuator to produce a vibrotactile effect to the input device 102, the vibrotactile effect comprising a simulated mechanical detent.

The processor 106 can receive and generate signals as digital signals or analog signals, via wireless or wired connections. The input signal can comprise information related to a manipulation of the input device 102. For instance, the information related to the manipulation of the input device may be positional data, for example, comprising information related to the change in position of the input device. In another example, the input signal may comprise information related to the speed of the change in position of the input device as well as the change in position of the input device. As a further example, the input signal comprises information related to the direction of a continuous user contact with a rotary touch pad along with the speed at which the rotary touch pad is contacted.

In step 504, a signal is generated by the processor. The signal can be configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, and based at least in part on the detent signal. The signal comprises information relating to a specific virtual detent to be generated by an actuator.

The signal may be based at least in part on the input signal, for instance, if the input signal indicates a fast manipulation of the input device, than the detent signal may comprise a high frequency vibrotactile effect. The signal may be based at least in part on a status of a system to be manipulated. In one embodiment, a signal is not generated if a system is off. In
5 another embodiment, if a system is off, than only a signal configured to produce a hard stop is generated.

In one embodiment, the signal is based on a system reaching a maximum or minimum threshold. For example, if a stereo system has reached the highest volume level, than the signal is configured to produce a hard stop virtual detent. Alternatively, if the system to be
10 controlled has reached a threshold no signal is generated. In another example, if the stereo system has not reached the highest or lowest volume level, a signal configured to produce a click effect virtual detent is generated.

The signal generated by the processor 106 may be synchronized with changes in the system 110. For example, a detent signal can be configured to cause a vibrotactile effect at
15 the same time as changes in a display, audio level or frequency, or control of an electromechanical system. The detent signal may also be synchronized with other types of feedback. For example, vibrotactile feedback produced by an actuator in response to the detent signal may be accompanied by an audible click or noise.

Figure 6 is a flow diagram illustrating a second method for providing virtual detents
20 through vibrotactile feedback in one embodiment of the present invention. In step 602, a sensor 104 detects a change in position of an input device 102. The sensor 104 can detect the rotation of a knob 400. The sensor 104 may detect, for example, relative changes, or changes from a reference point, in the position of an input device 102.

In step 604, the sensor 104 generates a detent signal. The detent signal can be
25 configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, the vibrotactile effect based at least in part on the detent signal.

The sensor 104 can be configured to only detect changes above a predetermined threshold. One sensor can be configured to detect movement of a rotary knob in one degree
30 increments. Another sensor can be configured with a higher detection threshold, and only detect rotations of five degrees or more. The detection threshold can correspond to a determination of whether a user intended to manipulate the device, or if the manipulation was accidental or unintended.

One or more sensors 104 can be configured to detect pressure or movement on a touch pad. As an example, three sensors configured to detect changes in force may be coupled to a touch pad. The force sensors may detect input on the touch pad, such as when a user drags a finger across the surface of the touch pad.

5 A processor 106 can generate the detent signal. The detent signal may be based at least in part on the manipulation or change in position of the input device. For example, a first detent signal may correspond to a small change in position of the input device, whereas a second detent signal may correspond to a larger change in position of the input device.

10 Figure 7 is a flow diagram illustrating a third method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 702, the sensor 104 detects a change in position of an input device. The sensor 104 can detect input from a rotary knob 400, or input via a touch pad or touch screen.

In step 704, the processor 106 determines whether to generate a detent signal. The processor 106 may determine whether to generate a detent signal based at least in part on a status of a system to be manipulated 110. For example, the processor 106 may generate a
15 detent signal if the system to be manipulated is turned on. As another example, the processor 106 may not generate a detent signal if the system to be manipulated is turned off.

In step 706, the processor 106 generates a detent signal. The processor 106 can generate the detent signal as a digital signal sent to the actuator 108.

20 In step 708, the processor 106 generates a system signal. The system signal can be configured to manipulate a system to be controlled, such as an audio system, a video system, a climate system, or a menu system. As examples, the system signal can change the volume of a stereo system, increase the output of a heater or air conditioner, or zoom in on a map.

In step 710, if the processor determines not to generate a detent signal, then the
25 processor may wait for a new change in position of the input device 710.

The processor 106 can generate detent signals and systems signals the system signal as digital signals or analog signals. The processor 106 can generate the detent signal 706 and the system signal 708 substantially simultaneously. In one embodiment, the system to be controlled is manipulated at substantially the same time as the vibrotactile feedback is
30 generated on the input device. In some embodiments, a user may experience a virtual detent as a system is being manipulated, giving the user the impression of mechanical detents.

The system signal can be based at least in part on an input signal. In one embodiment, an input signal may indicate that the input device is being manipulated with a quick motion. A corresponding system signal may manipulate the system to be controlled in

a like fashion. In one example, a rotary knob is quickly rotated. A processor may generate a system signal to a stereo system with a radio, the system signal moving through radio frequencies in large increments.

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through vibrotactile feedback. In step 802, an input device, such as a knob or a touch pad, is manipulated. A user can rotate a knob, or drag her finger across a touch pad. In response to the user input, a system is manipulated 804. Finally, a vibrotactile effect is produced on the input device 806.

The system may be manipulated based at least in part on the manipulation of the input device. For example, if a knob is rotated to the right one full revolution, the volume of a stereo system may be doubled. In another example, if a circular touch pad is contacted in a counter-clockwise motion, a menu structure shown on a display may navigate up.

The vibrotactile effect 806 can be synchronized with the manipulation of the system 804. As a user navigates a menu shown on a display, a vibrotactile effect may be produced on a circular touch pad input device.

Examples of Virtual Detents

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention. In Figures 9A-9H, the rotary knob 202 is shown on the right along with a representation of the virtual detent profile on the left corresponding with the rotary knob. The virtual detent profiles illustrated in Figures 9A-9H are exemplary embodiments of the invention. Other embodiments may be apparent to those skilled in the art. In some embodiments, various types of detents may be combined to produce a combination vibrotactile effect.

Figure 9A depicts a programmable virtual detent profile. Virtual detents are shown at A, B, C, D, and E. For example, as a rotary knob is rotated through each point A-E, the rotary knob may be vibrated to generate the feeling of a real detent. The magnitude and width of the vibrotactile feedback applied to the input device at each virtual detent may simulate the magnitude and width of a mechanical detent.

Figure 9B depicts a hard stop virtual detent profile. A hard stop, or barrier virtual detent, may simulate a mechanical hard stop or barrier. For example, a virtual hard stop may indicate that a system can no longer be manipulated. As an illustration, as a user turns a rotary knob, virtual detents may indicate each increasing fan level selected by a user. When

the fan level reaches its maximum, the processor 106 may send a detent signal to the actuator 108 comprising a barrier detent instruction.

Figure 9C depicts a hill virtual detent profile. A hill effect may simulate the approach to the end of a menu system, or a maximum or minimum threshold of a system. For example, as the user approaches the last item in a menu, the vibrotactile effect may gradually increase. As another example, when the user is approaching the end of a wrap-around menu structure, the intensity of the vibrotactile feedback may increase until the user reaches the beginning item, which may be accompanied by vibrotactile feedback with lower intensity.

Figure 9D depicts a compound virtual detent profile. In some embodiments, the magnitude and/or width of the vibrotactile feedback may be varied at each point. In such embodiments, a compound effect may include two or more effects such as barriers or detents. A compound effect may be related to the operational characteristics of a system. For example, a compound effect used in conjunction with a menu system may generate light intensity vibrotactile feedback while a menu is traversed within a subcategory, but generate heavier intensity vibrotactile feedback when larger categories of the menu are traversed. In one embodiment, a hill effect may be used as a user traverses contact names beginning with the same letter. When a new letter is reached, a hard stop effect may be used to indicate the new letter.

Figure 9E depicts a spring virtual detent profile. A spring virtual detent may indicate a preferred position of an input device. For example, as a user manipulates a rotary knob away from a home position, a spring effect virtual detent may increase in intensity as the knobs distance from the home position increases.

Figure 9F depicts a damper virtual detent profile. In a damper virtual detent, the vibrotactile force may increase or decrease based on the speed of the manipulation of an input device. For example, a light vibrotactile effect may accompany slow rotation of a rotary knob, while a heavier vibrotactile effect may accompany faster rotation of the rotary knob.

Figure 9G depicts a constant virtual detent profile. A constant force effect may be a continuous force independent of the position or manipulation of the input device. For example, as a rotary knob is rotated, the force of the vibrotactile effect may remain constant. A constant virtual detent profile may be used in combination with a null force profile, such that vibrotactile effects are generated at a constant intensity during part of a manipulation of an input device, and not generated at all at a later time. For example, a constant vibrotactile force may be produced on a rotary knob until a threshold is reached, upon which no vibrotactile force is generated in response to manipulation of the rotary knob. In another

example, a constant vibrotactile force may be output while a user has selected one item in a menu system, but not generated when a user selects a different item in a menu system.

Figure 9H depicts a periodic virtual detent profile. The periodic force effect profile may comprise a sine wave, square wave, or triangular wave profile. In one example of a
5 triangular virtual detent, the intensity of a virtual detent may increase and decrease linearly over time. A periodic virtual detent may last for a set period of time.

General

The foregoing description of embodiments of the invention has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit
10 the invention to the precise forms disclosed. Numerous modifications and adaptations thereof will be apparent to those skilled in the art. The scope of the present invention is defined solely by the appended claims.

MAIN REQUEST

Claims:

1. A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of a surface of a touch-sensitive non mechanical input device
 - 5 (306), and
 - ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the surface of the touch-sensitive non mechanical input device;
 - further comprising:**
 - 10 iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles to generate a vibrotactile signal;

wherein said determination is based at least in part on the

input signal (102, 202, 306, 400) and the vibrotactile effect is

 - 15 configured to simulate mechanical feedback.
2. The method of claim 1, **further comprising :-**
 - i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - 20 ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and generating (504, 604, 706) the vibrotactile signal.
3. The method of claim 2, **further comprising** determining whether to generate a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.
- 25 4. A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 3.
- 30 5. A system comprising:
 - i) a touch-sensitive non mechanical input device (306);
 - ii) at least one actuator (108, 208, 406) coupled to the touch-sensitive non mechanical input device

MAIN REQUEST

- iii) a processor (106, 206) in communication with the touch-sensitive input device and said at least one actuator and configured to:
- a) receive (500) an input signal comprising information associated with a manipulation (802) of the touch-sensitive : non mechanical input device (102, 202, 400); and,
 - b) generate (504, 604, 706) a vibrotactile signal configured to cause said actuator (108) to produce a vibrotactile effect (806) to a surface of the touch-sensitive : non mechanical input device and the vibrotactile effect is configured to simulate mechanical feedback;
- 10 **wherein;**
- iv) the processor (106, 206):
 - a) comprises memory (216) configured to store virtual detent profiles, and
 - b) is configured to effect the method of any of claims 1 to 3.
- 15 6. The system of claim 5, **wherein** the processor (106, 206) is further configured to generate (706) a system signal to control a system (110, 210) based at least in part on a manipulation of the : non mechanical input device (102, 202, 306, 400).
- 20 7. The system of claim 5 or claim 6, **wherein** the at least one actuator (406) is coupled to a housing (302, 402) of the : non mechanical input device (306, 400).
- 25 8. The system of any of claims 5 to 7, **wherein** a sensor (104, 204, 408) is configured to detect manipulation of the : non mechanical input device (102, 202, 400) and generate the input signal.

WO 2008/085487

PCT/US2007/026355

1/10

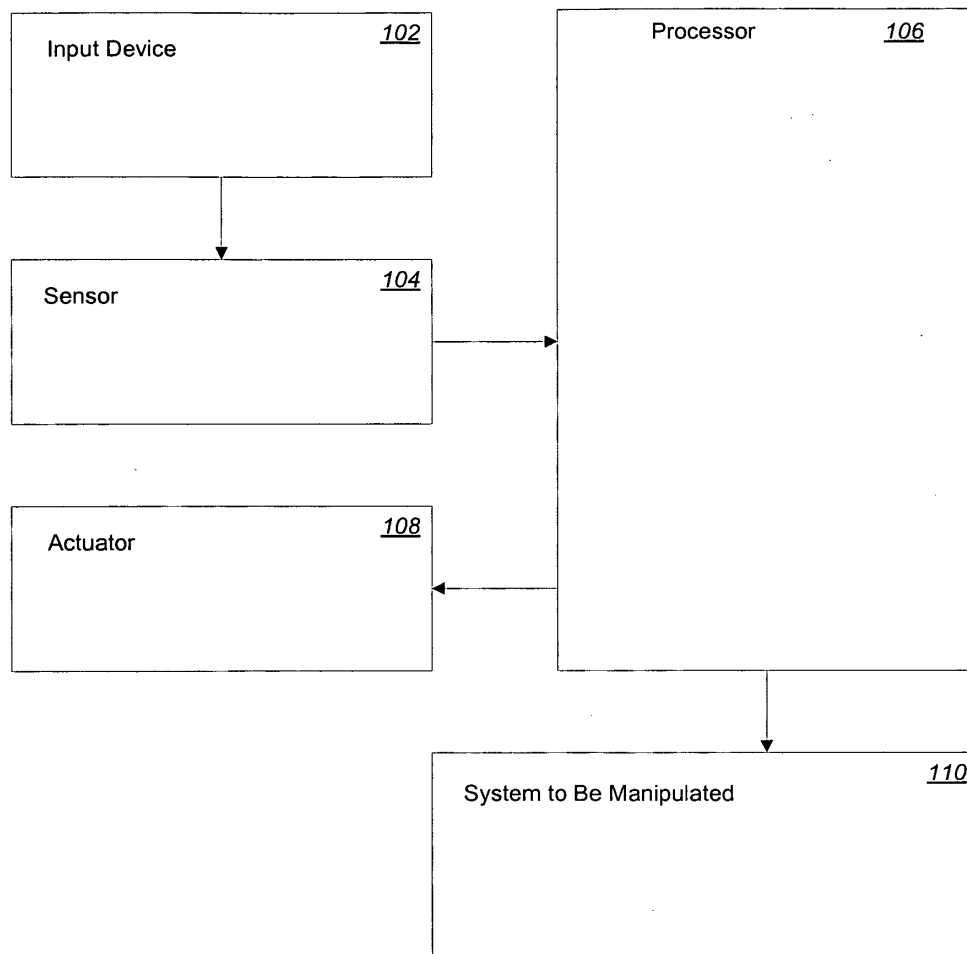


Figure 1

WO 2008/085487

PCT/US2007/026355

2/10

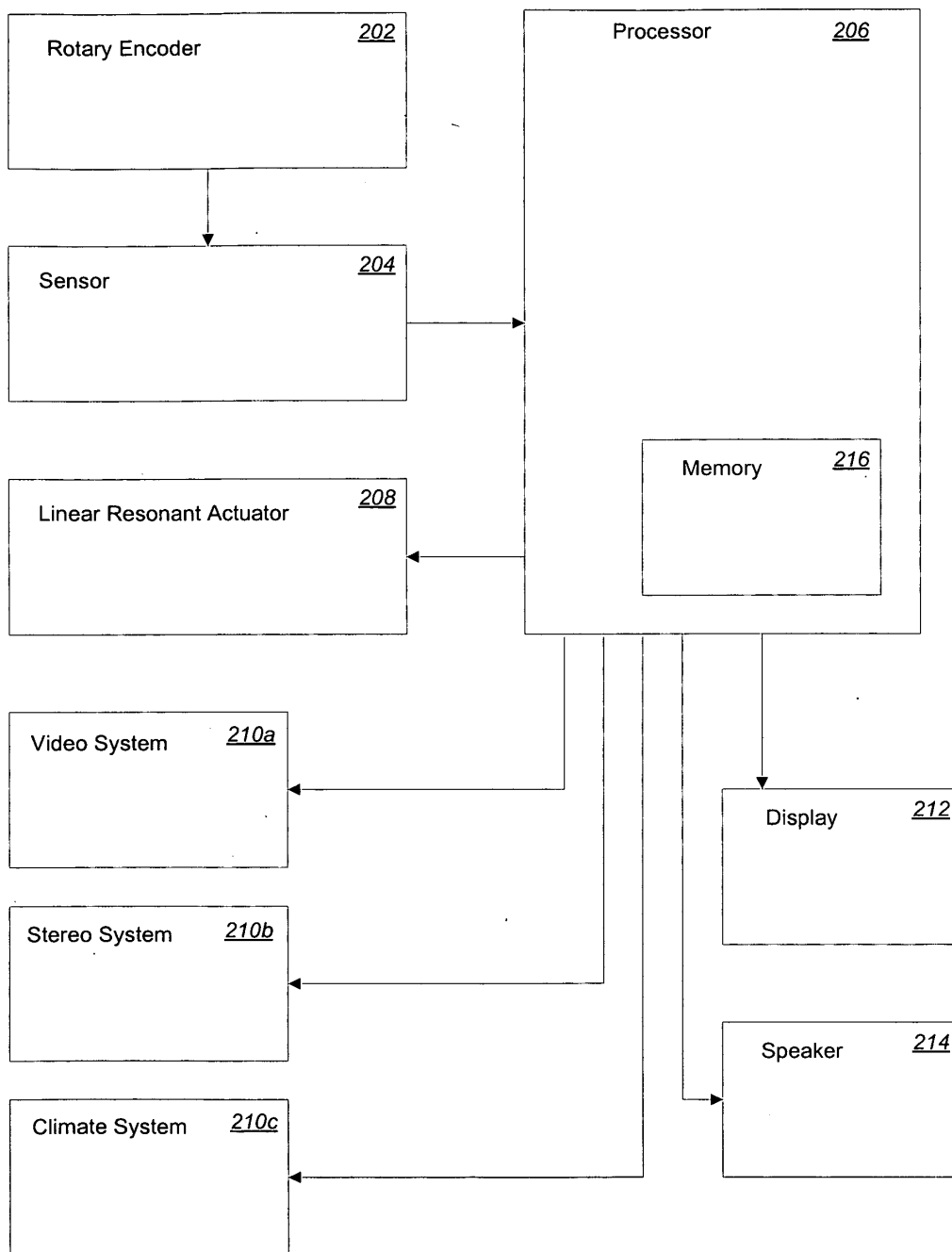


Figure 2

WO 2008/085487

PCT/US2007/026355

3/10

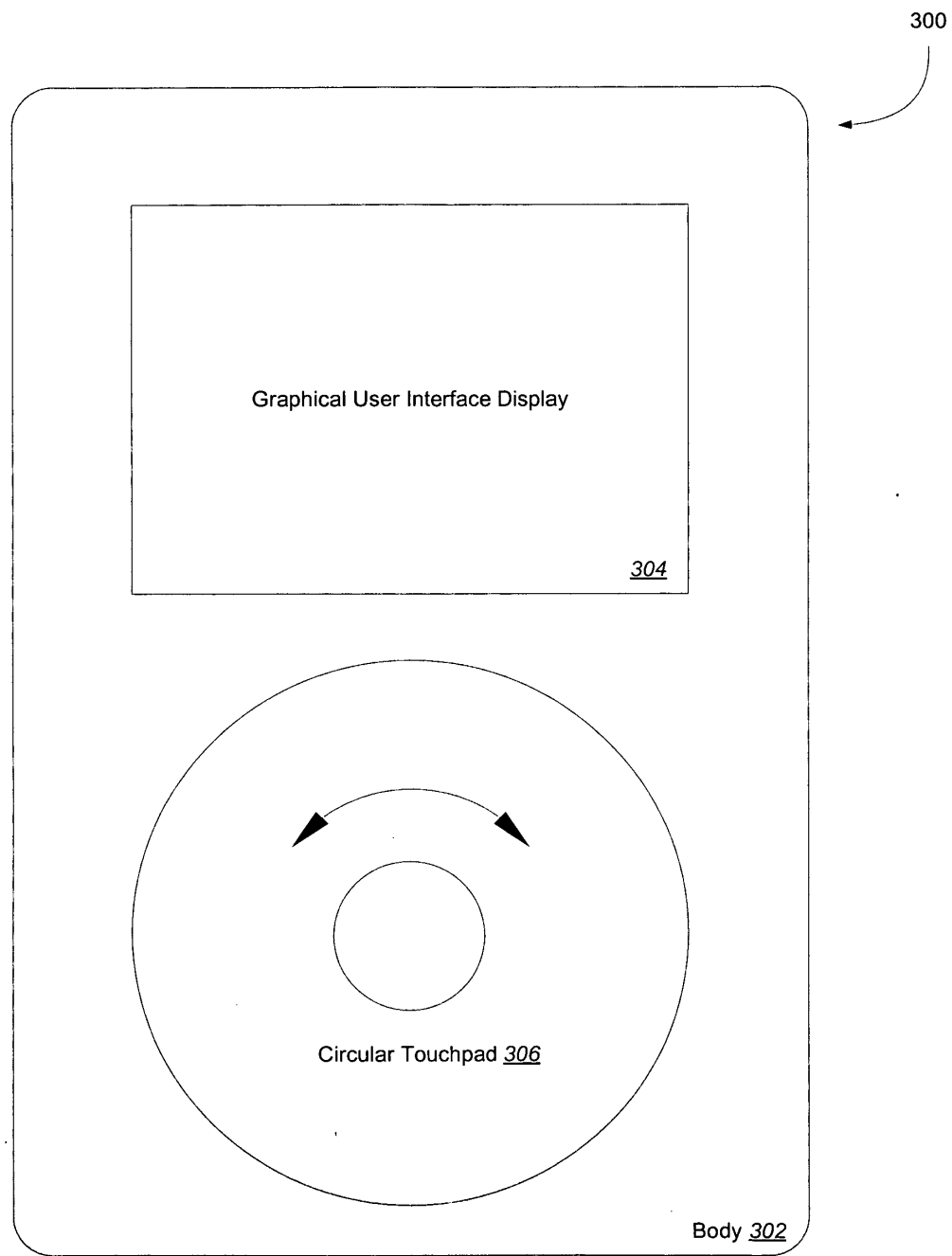


Figure 3

WO 2008/085487

PCT/US2007/026355

4/10

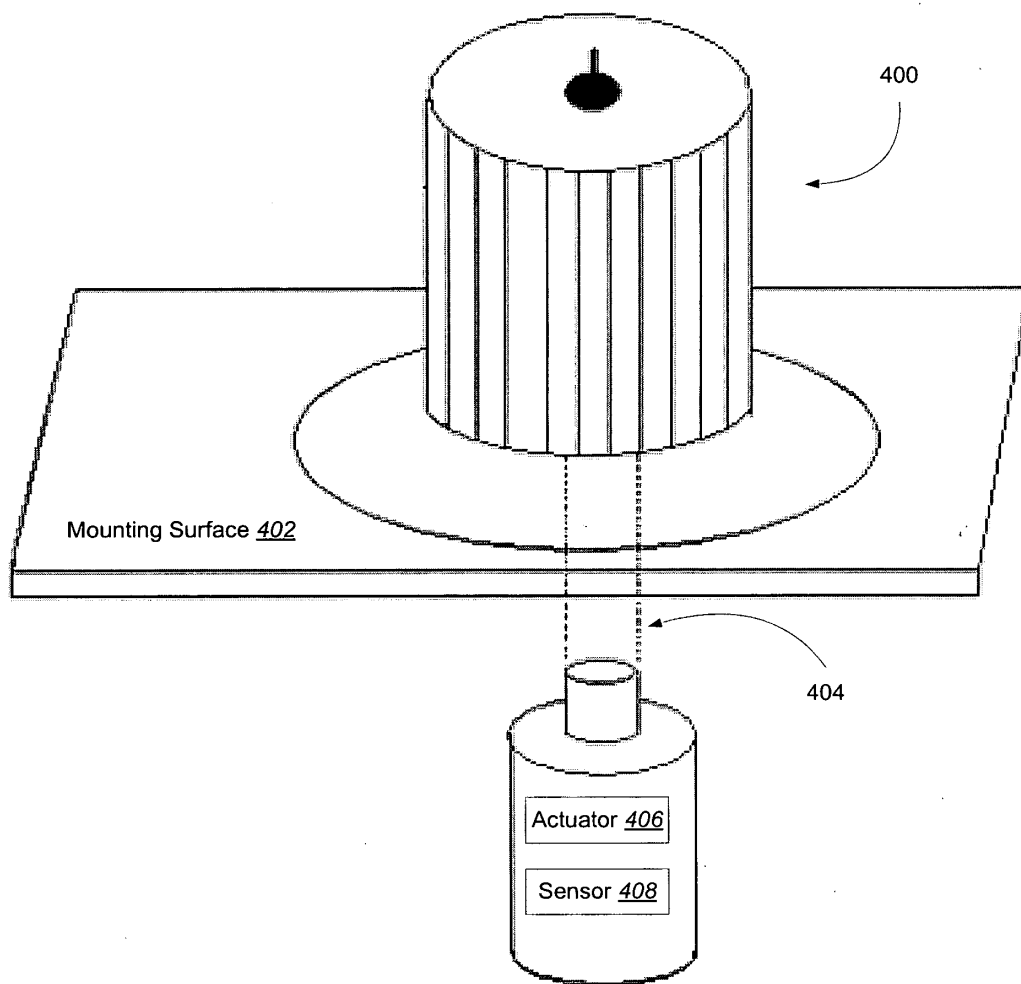


Figure 4

WO 2008/085487

PCT/US2007/026355

5/10

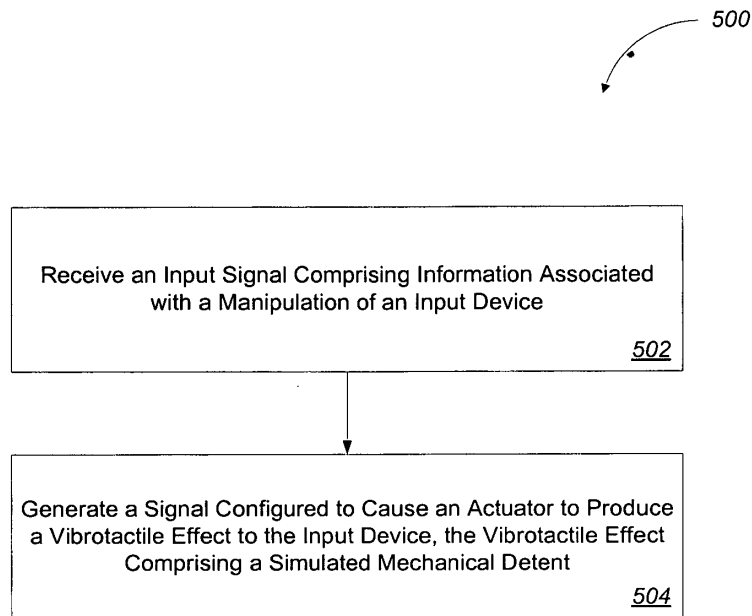


Figure 5

WO 2008/085487

PCT/US2007/026355

6/10

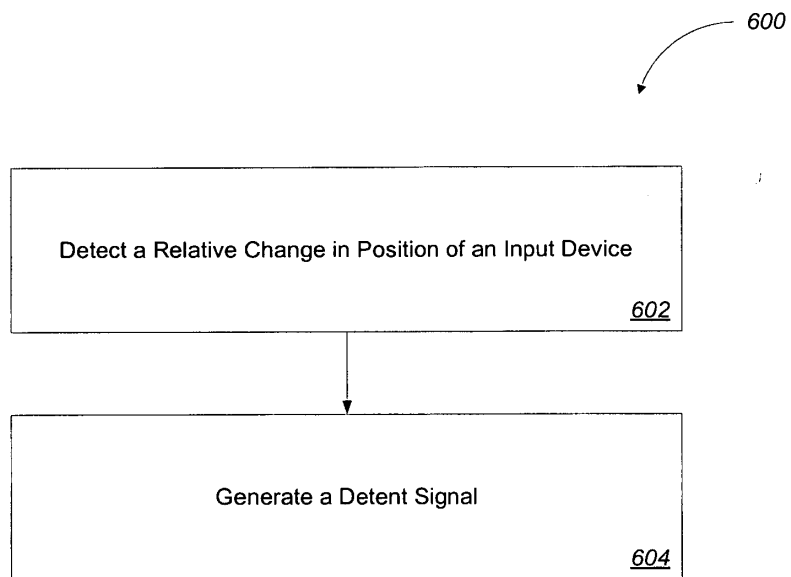


Figure 6

WO 2008/085487

PCT/US2007/026355

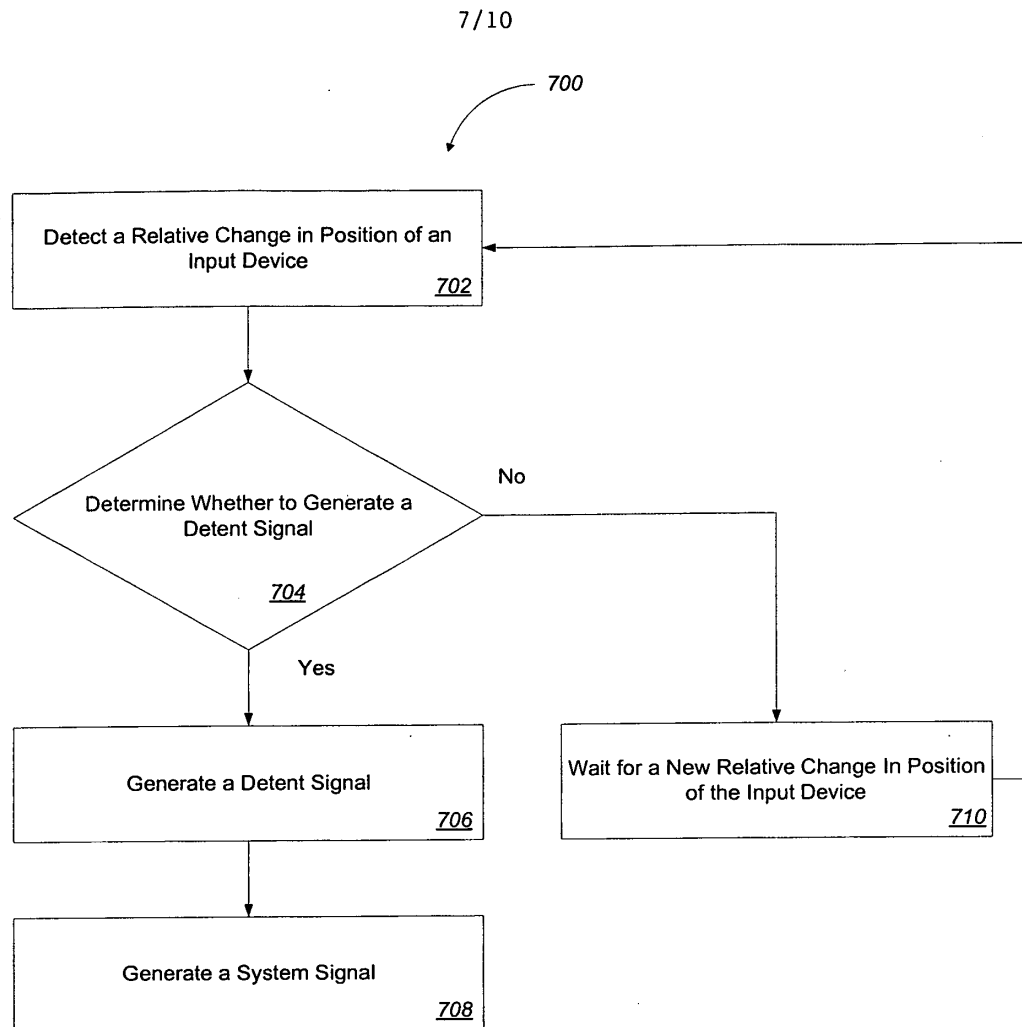


Figure 7

WO 2008/085487

PCT/US2007/026355

8/T0

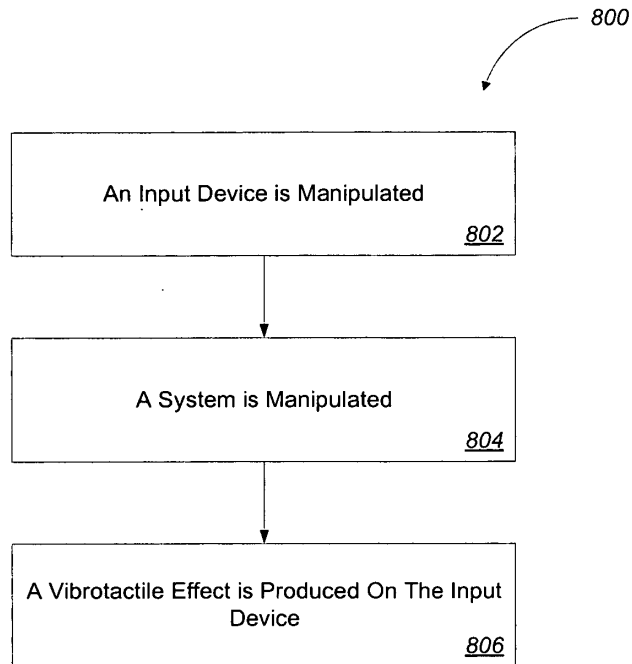


Figure 8

WO 2008/085487

PCT/US2007/026355

9/10

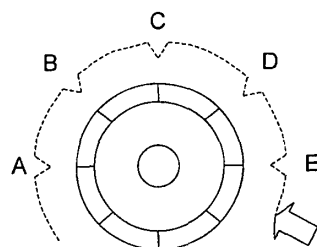
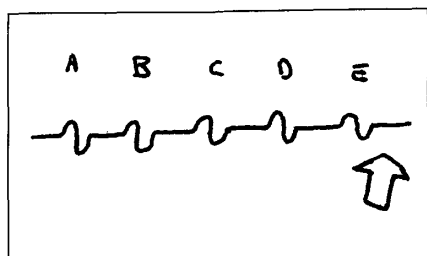


Figure 9A

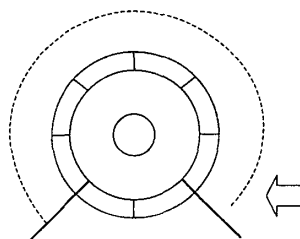
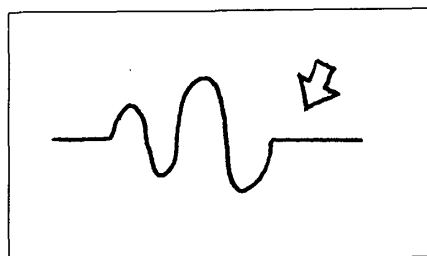


Figure 9B

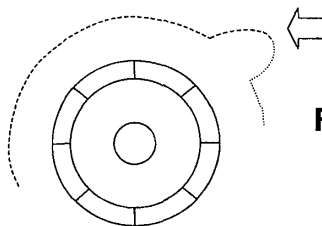
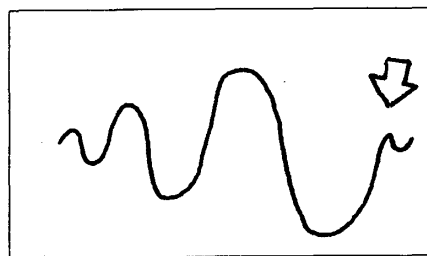


Figure 9C

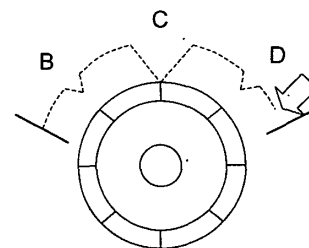
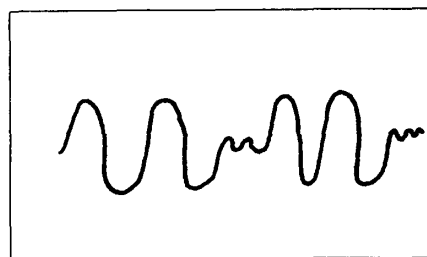


Figure 9D

WO 2008/085487

PCT/US2007/026355

10/10

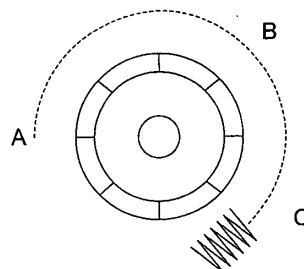
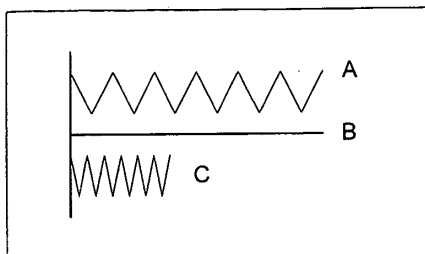


Figure 9E

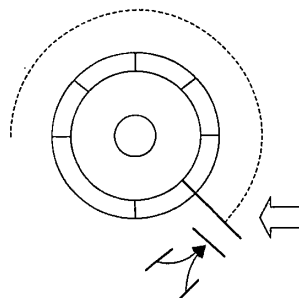
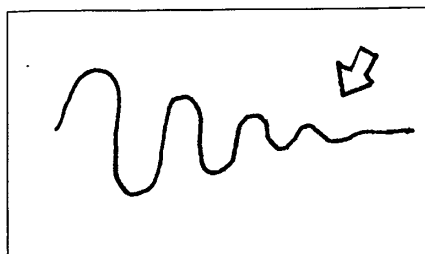


Figure 9F

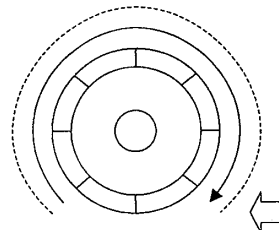
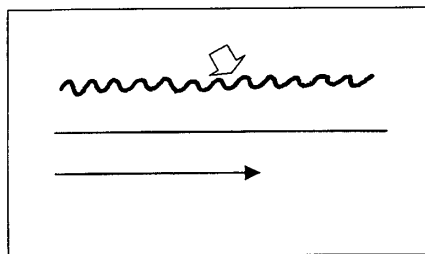


Figure 9G

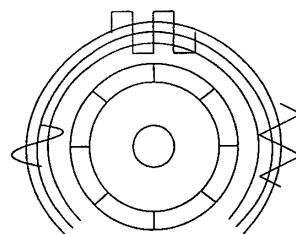
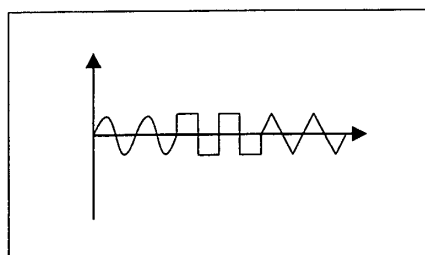


Figure 9H



European Patent Office
Postbus 5818
2280 HV Rijswijk
NETHERLANDS
Tel: +31 70 340 2040
Fax: +31 70 340 3016



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME-UNI

Formalities Officer
Name: Abily, Yolande
Tel: +31 70 340 - 4386
or call
+31 (0)70 340 45 00

Application No. 07 863 260.1 - 1203	Ref. FP-10-0597	Date 16.01.2020
Applicant Immersion Corporation		

Communication under Rule 71(3) EPC

1. Intention to grant

You are informed that the examining division intends to grant a European patent on the basis of the above application, with the text and drawings and the related bibliographic data as indicated below.

A copy of the relevant documents is enclosed.

1.1 In the text for the Contracting States:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR

Description, Pages

1-19 filed in electronic form on 29-10-2019

Claims, Numbers

1-8 filed in electronic form on 29-10-2019

Drawings, Sheets

1/10-10/10 as published

With the following amendments to the above-mentioned documents according to your request dated 26-11-2019:

Claims, Numbers 1, 5-8

With the following amendments to the above-mentioned documents proposed by the division

Description, Pages 1-3, 19

Claims, Numbers 1

Comments**DESCRIPTION**

Page 1: Incorporated by reference clause removed.

Page 1: Mention of relevant prior art in the description (Rule 42(1) EPC)

Pages 1-3: Description adapted to amended claims (Art. 84 EPC)

Page 19: Inconsistency between claim and description removed (Art. 84 EPC)

CLAIMS

Pages 20, 21, CLAIMS 1, 5-8: Inconsistency between claim and description removed (Art. 84 EPC)

Page 20, Claim 1: Inappropriate two-part form

1.2 Bibliographic data

The title of the invention in the three official languages of the European Patent Office, the international patent classification, the designated contracting states, the registered name(s) of the applicant(s) and the other bibliographic data are shown on **EPO Form 2056** (enclosed).

2. Invitation

You are invited, **within a non-extendable period of four months** of notification of this communication,

2.1 to EITHER approve the text communicated above and verify the bibliographic data (Rule 71(5) EPC)

(1) by filing a translation of the claim(s) in the other two official languages of the EPO

Fee code	EUR
----------	-----

(2a) by paying the fee for grant including the fee for publication:
minus any amount already paid (Rule 71a(5) EPC):

007	925.00
	0.00

Total amount:	925.00
---------------	--------

(3) by paying additional claims fees under Rule 71(4) EPC;
number of claims fees payable: 0
minus any amount already paid (Rule 71a(5) EPC):

016	0.00
	0.00

Total amount:	0.00
---------------	------

Important: If the translations of the claims and fees have already been filed and paid respectively in reply to a previous communication under Rule 71(3) EPC, e.g. in the case of resumption of examination after approval (see Guidelines C-V, 6), **agreement as to the text to be granted** (Rule 71a(1) EPC) must be expressed within the same time limit (e.g. by approving the text and verifying the bibliographic data, by confirming that grant proceedings can go ahead with the documents on file and/or by stating which translations of the claims already on file are to be used).

Note 1: See "Notes concerning fee payments" below.

Note 2: Any overpaid "minus" amounts will be refunded when the decision to grant (EPO Form 2006A) has been issued.

Note 3: For the calculation of the grant fee under Article 2(2), No. 7, RFees (old fee structure), the number of pages is determined on the basis of a clean copy of the application documents, in which text deleted as a result of any amendments by the examining division is not shown. Such clean copy is made available via on-line file inspection only.

2.2 OR, in the case of disapproval, to request reasoned amendments or corrections to the text communicated above or keep to the latest text submitted by you (Rule 71(6) EPC).

In this case the translations of the claims and fee payments mentioned under point 2.1 above are NOT due.

The terms "amendment(s)" and "correction(s)" refer only to amendments or corrections of the application documents and not of other documents (e.g. bibliographic data, the designation of the inventor, etc.).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the examining division requesting that you correct this deficiency (Rule 137(4) EPC).

2.3 Bibliographic data

Where you request a change or correction of bibliographic data in response to the Rule 71(3) communication, this will **not** cause the sending of a further communication under Rule 71(3) EPC. You will still have to pay the fees and file translations in reply to the Rule 71(3) communication in the case of 2.1 above, unless you also file a reasoned request for amendments or corrections in response to the Rule 71(3) communication (see case 2.2 above).

3. Loss of rights

If neither of the two possible actions above (see points 2.1 or 2.2) is performed in due time, the European patent application will be deemed to be withdrawn (Rule 71(7) EPC).

4. Further procedure

4.1 In the case of point 2.1 above

- 4.1.1** The decision to grant the European patent will be issued, and the **mention of the grant** of the patent will be published in the European Patent Bulletin, if the requirements concerning the translation of the claims and the payment of all fees are fulfilled and there is agreement as to the text to be granted (Rule 71a(1) EPC).

Note on payment of the renewal fee:

If a renewal fee becomes due before the next possible date for publication of the mention of the grant of the European patent, publication will be effected only after the renewal fee and any additional fee have been paid (Rule 71a(4) EPC).

Under Article 86(2) EPC, the obligation to pay renewal fees to the European Patent Office terminates with the payment of the renewal fee due in respect of the year in which the mention of the grant of the European patent is published.

Note on payment of the designation fee(s):

If the designation fee(s) become(s) due after the communication under Rule 71(3) EPC, the mention of the grant of the European patent will not be published until these fees have been paid (Rule 71a(3) EPC).

- 4.1.2** After publication, the **European patent specification** can be downloaded free of charge from the EPO publication server <https://data.epo.org/publication-server>.

4.1.3 Filing of translations in the contracting states

As regards translation requirements prescribed by the contracting states under Article 65(1) EPC, please consult the website of the European Patent Office

www.epo.org → Law & practice → Legal texts, National law relating to the EPC

www.epo.org → Law & practice → All Legal texts → London Agreement

In the case of a valid extension or validation

As regards translation requirements prescribed by the extension or validation states, please consult the website of the European Patent Office

www.epo.org → Law & practice → Legal texts, National law relating to the EPC

Failure to supply a prescribed translation in a contracting state, or in an extension or validation state may result in the patent being deemed to be void *ab initio* in the state concerned (Art. 65(3) EPC).

4.2 In the case of 2.2 above

If the present communication under Rule 71(3) EPC is based on an auxiliary request and, within the time limit, you maintain the main request or a higher ranking request which is not allowable, the application will be refused (Art. 97(2) EPC).

If the examining division gives its consent to the requested amendments or corrections, it will issue a new communication under Rule 71(3) EPC; otherwise, it shall resume the examination proceedings (Rule 71(6) EPC).

5. Filing of a divisional application

Any divisional application relating to this European patent application must be filed directly with the European Patent Office in Munich, The Hague or Berlin and will be in the language of the proceedings for the present application, or if the latter was not in an official language of the EPO, the divisional application may be filed in the language of the present application as filed (see Article 76(1) and Rule 36(2) EPC). Any such divisional application must be filed while the present application is still pending (Rule 36(1) EPC; Guidelines A-IV, 1.1.1).

6. Notes concerning fee payments

6.1 Making payments

For payments made via deposit account, please note that as from 1 December 2017 debit orders will only be carried out if filed in an electronically processable format (xml), using an accepted means of filing as laid down in the Arrangements for deposit accounts (ADA), published in the Supplementary publication in the Official Journal.

All relevant information related to the modes of payment of fees to the EPO can be retrieved from the EPO website at "**Making Payments**".

6.2 Information concerning fee amounts

Procedural fees are usually adjusted every two years, on even years, with effect from 1 April. Therefore, before making a payment, parties should verify the amounts actually due on the date of payment using the applicable version of the Schedule of fees and expenses, published as a Supplement to the Official Journal of the EPO, available on the EPO website (www.epo.org) at www.epo.org/schedule-of-fees. The "Schedule of fees" table allows the viewing, downloading and searching of individual fee amounts, both current and previous.

6.3 Note to users of the automatic debiting procedure

The fee for grant, including the fee for publication, and any additional claims fees due under Rule 71(4) EPC will be debited automatically on the date of filing of the translations of the claims, or on the last day of the period of this communication. However, if the designation fee(s) become(s) due as set out in Rule 71a(3) EPC and/or a renewal fee becomes due as set out in Rule 71a(4) EPC, these should be paid separately by another permitted way of payment in order not to delay the publication of the mention of the grant. The same applies in these circumstances to the payment of extension and validation fees. The same applies in these circumstances to the payment of extension and validation fees.

Note: If a waiver is expressed in response to a Rule 71(3) communication (see OJ EPO 2015, A52), the fee for grant, including the fee for publication/printing, and any additional claims fees will not be debited automatically. These fees must be paid separately by another means of payment allowed under the Rules relating to Fees.

Examining Division:

Chairman:	Arranz, José
2nd Examiner:	Ballerstein, Jens
1st Examiner:	Baldan, Marco



Abily, Yolande
For the Examining Division
Tel. No.: +31 70 340 - 4386

Branch at The Hague

Enclosures: Text intended for grant

EPO Form 2056

Annex to EPO Form 2004, Communication pursuant to Rule 71(3) EPC

Bibliographical data of European patent application No. 07 863 260.1

For the intended grant of the European patent, the bibliographical data are set out below, for information:

Title of invention:

- VIRTUELLE ARRETIERUNGEN DURCH VIBROTAKTIL-RÜCKMELDUNG
- VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK
- DÉTENTES VIRTUELLES PAR UNE RÉTROACTION VIBROTACTILE

Classification: INV. G06F3/01

Date of filing: 27.12.2007

Priority claimed: US / 27.12.2006 / USP877333

Contracting States*
for which fees have been paid:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC
MT NL PL PT RO SE SI SK TR

Extension States*
for which fees have been paid:

AL BA HR MK RS

Validation States*
for which fees have been paid:

Applicant(s):**

Immersion Corporation
50 Rio Robles
San Jose CA 95134
US

Inventor(s):

LEVIN, Michael, D.
1230 Gronwall Court
Los Altos, California 94024
US

*) If the time limit for the payment of designation fees according to Rule 39(1) EPC has not yet expired and the applicant has not withdrawn any designation, **all Contracting States/Extension States/Validation States** are currently still deemed to be designated. See also Rule 71a(3) EPC and, if applicable, the above Note to users of the automatic debiting procedure.

**) If two or more applicants have designated different Contracting States, this is indicated here.

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

CROSS-REFERENCES TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application No. 60/877,333 entitled "Virtual Detents through Vibrotactile Feedback," filed December 27, 2006. ¶

¶ 2006, the entirety

5 of which is hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention generally relates to vibrotactile feedback. More particularly, the present invention relates to methods and systems for providing virtual detents through vibrotactile feedback.

10

BACKGROUND

Traditional mechanical device controls include switches, knobs, levels, sliders, faders, and the like. In the past, such controls have been essentially mechanical in nature, e.g., a knob turning a shaft coupled to a potentiometer to control an electrical input to a device such as a radio or audio amplifier, a knob turning a shaft coupled to a fan control or heating/air conditioning control in an automobile, or a lever controlling the opening and closing of a vent in an automobile.

15

With many traditionally mechanical functions being replaced by electronics, operation of electronic controls has been made less intuitive to users. For example, without click-stops or "detents," or otherwise a sense of mechanical resistance, it may be difficult to obtain a similar experience from an electronic substitute for a traditional mechanical control device or even effectively and efficiently operate such a device. A detent, such as a mechanical detent, can refer to the resistance of rotation of a wheel or shaft. A detent can be used to divide a rotation into discrete increments, or may be used to arrest rotation in a direction. For instance, a mechanical detent can be constructed from a notched wheel and a small gravity or

20

spring-actuated 2 lever. ¶

25

Examples of input devices, known in the prior art, providing haptic feedback simulating detents are disclosed by US 6,636,197 B1 and US 2006/0038781 A1. ¶

¶ lever.

SUMMARY

Embodiments of the present invention disclosed herein provide methods and systems for providing virtual detents through vibrotactile feedback.

30

One embodiment of the invention is a method comprising the steps of receiving an input signal that comprises information associated with the manipulation of a surface of a touch-sensitive 2 non mechanical input 2

input device, and generating a vibrotactile signal configured to cause an

actuator to produce a vibrotactile effect comprising a virtual detent to the surface of the input device, with the vibrotactile effect configured to simulate mechanical feedback.

In another embodiment, a computer-readable medium (such as, for example, random access memory or a computer disk) comprises code for carrying out such a method.

Another embodiment of the invention is a system comprising a touch-sensitive ~~non mechanical input~~ ~~input~~ device and a processor that is in communication with the touch-sensitive ~~non mechanical input~~ ~~input~~ device and that

- 5 is configured to receive an input signal comprising information associated with the manipulation of the touch-sensitive ~~non mechanical input~~ ~~input~~ device. The processor may further be configured to generate a detent signal based at least in part on the manipulation of the input device. The system may further comprise an actuator coupled to the input device. The actuator may be in communication with the processor and configured to produce to the surface of the touch-
- 10 sensitive ~~non mechanical input~~ ~~input~~ device a vibrotactile effect comprising a virtual detent based at least in part on the detent signal and configured to simulate mechanical feedback.

Further details of embodiments of the invention are set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

- These and other features, aspects, and advantages of the invention are better
- 15 understood when the following Detailed Description is read with reference to the accompanying drawings, wherein:
- Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention;
- Figure 2 is a block diagram illustrating a second system for providing virtual detents
- 20 through vibrotactile feedback in one embodiment of the invention;
- Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention;
- Figure 4 is an illustration of a second device for providing virtual detents through vibrotactile feedback in a comparative example;
- 25 Figure 5 is a flow diagram illustrating a first method for virtual detents through vibrotactile feedback;
- Figure 6 is a flow diagram illustrating a second method for virtual detents through vibrotactile feedback;
- Figure 7 is a flow diagram illustrating a third method for virtual detents through
- 30 vibrotactile feedback;
- Figure 8 is a flow diagram illustrating a fourth method for virtual detents through vibrotactile feedback; and
- Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention provide methods and systems for virtual detents through vibrotactile feedback. In one illustrative embodiment, a touch-sensitive surface is manipulated. A sensor detects the manipulation of the surface and sends an input signal to a processor. The input signal comprises information related to the manipulation of the surface. The processor determines whether to manipulate an audio system based at least in part on the input signal. The processor further determines whether to generate a signal configured to cause an actuator to vibrate the surface, the vibration based at least in part on the signal.

This example is given to introduce the reader to the general subject matter discussed. The invention is not limited to this example. The present invention is defined by the appended claims. Embodiments and examples not covered by the claims do not form part of the invention, they are provided to fully understand its principles.

Below, examples of methods and systems for virtual detents through vibrotactile feedback are described.

Illustrative Devices for Enhanced Haptic Feedback

In one illustrative embodiment of a device configured to provide virtual detents through vibrotactile feedback, a portable music player may be configured to play music through a speaker and produce a virtual detent on a touch pad with an actuator. In one such embodiment, the portable music player may comprise a touch pad configured to generate an input signal to a processor based on a user contact. The processor may analyze the input signal and determine whether to manipulate the audio system and whether to generate a vibrotactile effect. If the processor determines a vibrotactile effect should be generated, the processor may generate a signal. The signal may be configured to cause the actuator to produce a vibrotactile effect to the touch pad in the form of a virtual detent.

Such an illustrative embodiment may be advantageously employed to simulate mechanical detents through vibrotactile feedback. Such simulated mechanical detents, or virtual detents, may provide useful feedback to a user. For example, a virtual detent may indicate the successful change in volume of a sound system. As another example, the absence of a virtual detent may indicate that a climate system is not turned on, or that it has reached the highest threshold of operation.

These further examples are given to introduce the reader to the general subject matter discussed herein. The invention is not limited to these examples. The following sections describe various embodiments of systems and methods for providing virtual detents through vibrotactile feedback.

Example of a First System for Virtual Detents through Vibrotactile Feedback

Referring now to the figures in which like numerals indicate like elements throughout the several figures, Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention. In the

5 embodiment shown, the system comprises an input device 102, a sensor 104, a processor 106, an actuator 108, and a system to be manipulated 110.

The Input Device and Sensor

Systems of the invention comprise an input device 102 and a sensor 104. The input device 102 shown in Figure 1 is configured to provide an input signal to the processor when the input device 102 is manipulated. In other embodiments, sensor 104 can generate an input
10 signal when the sensor 104 detects manipulation of the input device 102.

In a comparative example the input device 102 can be, for example, a mechanical input device. Examples of mechanical input devices include a rotary knob coupled to an encoder. Encoders of the input device 102 may comprise an optical encoder or a potentiometer.
15 In other embodiments according to the invention, the input device 102 may be a non-mechanical input device. For example, the input device 102 may be a touch-sensitive device, such as a touch pad or a touch screen.

The input device 102 is in communication with a sensor 104. The sensor detects movement of the input device 102. A sensor 104 can be configured to detect the movement
20 of a rotary knob, or other aspects of manipulation of the input device 102, such as position, velocity, acceleration, torque, rate of rotation, or the time of rotation.

Sensor 104 shown in Figure 1 comprises a contact-type sensor, such as a switch, a resistive sensor, a capacitive sensor, an infrared sensor, or an optical sensor. Alternatively, sensor 104 may comprise a non-contact sensor such as a field effect sensor or a proximity
25 sensor, and can be a surface or sub-surface sensor.

The Processor

The system illustrated in Figure 1 comprises a processor 106. The processor 106 may be configured to receive input signals from an input device 102 or a sensor 104 and to generate signals to an actuator 108. The signals may be configured to cause the actuator 108 to produce
30 a vibrotactile effect. Further, the processor can generate signals provided to a system to be manipulated 110.

In one embodiment, a dedicated processor 106 may receive input signals and generate signals. Although there is a single processor shown in Figure 1, the system may comprise a plurality of processors. The processor 106 may be configured to perform a variety of tasks.

For example, the processor 106 may comprise additional program code running on a native cellular phone processor.

5 The processor 106 may be configured to receive input signals. In some embodiments, the processor 106 may receive input signals from the input device 102. In other embodiments, the processor 106 may receive input signals from the sensor 104. In the embodiment shown in Figure 1, the input device 102, sensor 104 and the processor 106 are in communication via a direct wired digital connection. For example, the input device 102, sensor 104, and the processor 106 may be in communication via a communication bus such as the Universal Serial Bus (USB). In other embodiments, communication between an input device 10 102, sensor 104 and the processor 106 may be through analog signals and/or may be wireless. For instance, the sensor 104 may be able to use Bluetooth, Wireless USB or Wi-Fi to communicate with the processor 106.

The processor 106 can also generate one or more signals. For example, a processor may generate a signal when a valid input signal is received. In the embodiment shown in 15 Figure 1, as the input device 102 is manipulated, the processor 106 may generate a signal at the same time or immediately after the manipulation. In one embodiment, the processor 106 may process software code running as an application on the processor and utilize the input signal in the context of the software code to generate signals configured to cause virtual detents.

20 The processor 106 may generate a signal, such as a detent signal, to the actuator 108. The detent signal may be configured to cause an actuator 108 to produce a vibrotactile effect in the form of a virtual detent on the input device 102.

The processor 106 may generate a signal specific to an actuator 108. In one embodiment, the signal may be generated with parameters specific to the actuator 108. For 25 example, the processor may analyze parameters associated with the actuator 108, such as the actuator's resonant frequency, and generate a signal based at least in part on the parameters. Other parameters of the actuator 108 may comprise, for example and without limitation, a resonant frequency of the actuator, a maximum peak-to-peak amplitude or magnitude of the actuator, or a minimum actuator response time.

30 The processor 106 may generate a signal by accessing a detent profile stored in a memory (not shown in Figure 1). In one embodiment, the processor 106 may access a specific detent profile based at least in part on the input signal. In certain embodiments, the processor 106 may determine which of a plurality of simulated mechanical detents to generate. For example, the processor 106 may analyze the input signal and determine that a

hard stop is appropriate. Further, the processor 106 may then access the hard stop virtual detent profile in a memory, and generate a detent signal based on the hard stop virtual detent profile.

5 The processor 106 may be in communication with a system to be manipulated 110 or controlled. In some embodiments, the processor 106 may be configured to generate a system signal. The system signal may be provided to the system to be manipulated 110.

The system signal may be based at least in part on the manipulation of the input device. For example, an input device 102 in the form of a rotary knob may be rotated one entire revolution. The processor 106 may receive an input signal indicating the complete
10 rotation of the input device 102 and generate a system signal configured to manipulate a system 110 by maximizing or minimizing a level of the system.

While the device shown comprises one processor 106, other devices may comprise two or more processors. Processor 106, as well as other processors incorporated into one or more embodiments of the present invention, may comprise a computer-readable medium,
15 such as a random access memory (RAM) coupled to the processor (not shown in Figure 1). The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs for generating vibrotactile or other haptic effects. Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable gate arrays (FPGAs), and
20 state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

Such processors may comprise, or may be in communication with, media, for
25 example computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, an electronic, optical, magnetic, or other storage or transmission device capable of providing a processor with computer-readable instructions. Other examples of
30 media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other forms of computer-readable media may transmit or carry instructions to a computer, such as a router, private or public network, or other transmission device or

channel. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein. The instructions can comprise code from any suitable computer-programming language, including, for example, assembly code, C, C+, C++, Visual Basic, Java, Python, and JavaScript.

The Actuator

The system illustrated in Figure 1 further comprises one or more actuators 108. Each actuator 108 can be configured to receive a signal from the processor 106 and provide vibrotactile effects to the user in the form of virtual detents. The actuator 108 can vibrate the input device 102 to provide vibrotactile feedback.

The actuator 108 can provide vibrotactile feedback based on signals received from the processor 106. For example, the actuator 108 may be configured to generate a vibration after receiving a detent signal from the processor 106. The actuator 108 can vibrate the input device 102 at substantially the same time the input device is being manipulated.

The actuator 108 may be configured to simulate mechanical feedback through vibrotactile feedback. Specifically, in some embodiments the actuator 108 may be configured to provide the perception of a detent (i.e. a virtual detent) without the traditional means necessary for a mechanical detent. For example, the actuator 108 may be used in place of various mechanical components which traditionally provided tactile feedback, such as springs, brakes or cams. In some embodiments, the vibrotactile feedback may comprise a click effect replicating a mechanical click. In other embodiments, the vibrotactile feedback may not comprise a click effect, but some other effect, such as a spring effect or a barrier effect.

The actuator 108 may be configured to generate vibrotactile feedback with a variety of different characteristics. For example, the actuator may be configured to generate vibrotactile feedback with different frequencies, amplitudes, or waveforms. In one embodiment, the virtual detent may comprise a simulated click generated through a single pulse. In a second embodiment, the virtual detent may comprise a click-and-release effect generated by a double pulse. Figure 9 provides illustrations of various virtual detent profiles.

Because the actuator 108 may be configured to generate vibrotactile feedback, in contrast to mechanical feedback, the actuator 108 may provide vibrotactile feedback to non-mechanical input devices 102, such as a touch-sensitive pad, i.e., a touch pad or touch screen.

The actuator 108 may be configured to generate various types of vibrotactile feedback. For example, the actuator 108 may be configured to produce different virtual detents. The vibrotactile feedback may be generated in various directions. For example, the actuator 108 may vibrate the input device orthogonal to the motion of the input device.

5 The actuator 108 can be any of a variety of different types of force producing devices, including an eccentric rotating mass (ERM) actuator, a multifunctional (MFT) actuator, a linear mass actuator, an electro-magnetic actuator, a motor, a voice coil, a pneumatic or hydraulic actuator, an electro-active polymer, or any other suitable actuator. In one
10 embodiment, actuator 108 may comprise a plurality of actuators of the same or different design. For example, in one embodiment, two actuators may be employed. A first actuator may be configured to provide vibrotactile or other haptic effects having a high frequency of vibration (e.g. greater than 400Hz), while a second actuator may be configured to provide vibrotactile or other haptic effects having a low frequency of vibration (e.g. less than 400Hz).

15 Since some embodiments of the invention may use the actuator 108 to generate vibrotactile feedback, as opposed to mechanical feedback, a smaller actuator may be used than in other devices. For example, actuator 108 may comprise a circular actuator ten (10) millimeters in diameter and three and one half (3.5) millimeters thick.

20 Since the device may comprise a plurality of actuators, the number of actuators 108 may be based on the size and mass of the device. For example, an actuator 108 may be provided for every one hundred (100) grams of mass of the system. In such an example, a system measuring three hundred (300) grams may comprise three actuators. In another example, a cellular phone measuring three hundred (300) grams may only comprise a single but more powerful actuator.

25 In one embodiment, the number of actuators 108 may be based on what surface of the system is being vibrated. For example, if a PDA measures four hundred (400) grams, but only the display will be vibrated, the system may comprise only one actuator 108, especially if the display is isolated from the rest of the device such as by a suspension system. Alternatively, if vibrotactile feedback is provided to the entire PDA, the system may comprise two or more
30 actuators.

Each actuator 108 of a plurality of actuators may be configured to generate vibrotactile feedback to the input device 102. In one embodiment, the vibrotactile feedback generated by each of a plurality of actuators is synchronized.

35

The actuator 108 can be mounted to a touch-sensitive display, such as a touch screen (not shown in Figure 1). In one embodiment, the actuator 108 is mounted underneath the display, or alternatively, to the edge of the display, or laterally mounted to the display. In embodiments where the actuator 108 is mounted to a display, the display may be mounted in a suspension of compliant material, such as a foam gasket. Mounting a display to a foam gasket may ensure that the display is vibrated alone or with a different strength than the entire device.

In one embodiment, two actuators may be mounted to either side of a display. In one example, both actuators may face the same direction and be in the same phase. In one embodiment, two side-mounted actuators may vibrate a screen side-to-side. Side-mounted actuators may produce consistent forces across a screen, since the screen may be moving in the direction of its rigidity.

In one embodiment, two actuators are mounted behind a display. In one example, both actuators mounted behind the display may face the same direction and can vibrate the display in and out.

The System to Be Manipulated

The system illustrated in Figure 1 comprises a system to be manipulated 110. One or more systems to be manipulated 110 can each receive system signals from the processor 106. The system to be manipulated 110 may comprise a system capable of electrical or electromechanical control, such as and without limitation, a stereo system, a video system, a climate system (e.g. air conditioning and/or heating), a navigation system, automotive systems, wireless communication devices, security systems, a television, a video game system, a washing machine or a drying machine, or an oven.

In one embodiment, the system to be manipulated 110 may comprise a single system, such as a lighting system. In another embodiment, the system to be manipulated 110 may comprise a complex system comprising one or more elements. For example, the system to be manipulated 110 may be a heating and cooling system.

Example of a Second System for Virtual Detents through Vibrotactile Feedback

Figure 2 is a block diagram illustrating a second system for providing virtual detents through vibrotactile feedback in one embodiment of the invention. In the embodiment shown, the system comprises a rotary encoder 202, a sensor 204, a processor 206, and a linear resonant actuator 208. The system further comprises a visual system 210a, an audio system 210b, a climate system 210c, a display 212, a speaker 214, and a memory 216. An example of a visual system 210a is a video game system. An example of an audio system 210b is a

stereo system. An example of a climate system 210c is an air conditioning and heating system.

As shown in Figure 2, the input device can be the rotary encoder 202. The sensor 204 is in communication with the rotary encoder 202 and the processor 206. As the rotary encoder 202 is manipulated, the sensor 204 generates input signals associated with the manipulation, and transmits the input signals to the processor 206.

Once the processor 206 receives an input signal, the processor 206 can determine whether to generate a detent signal and/or a system signal. For example, if the input signal indicates a rotation of a knob in more than 5 degrees of motion, the processor 206 may generate a system signal and a detent signal.

The processor 206 is in communication with the linear resonant actuator 208. The processor 206 can receive input signals comprising information associated with a manipulation of the rotary encoder 202 and generate a signal configured to cause the linear resonant actuator 208 to produce a vibrotactile effect to the rotary encoder 202, the vibrotactile effect comprising a simulated mechanical detent.

As shown in Figure 2, the processor 206 is in communication with three systems: a video system 210a, a stereo system 210b, and a climate system 210c. The processor is also in communication with a display 212 and a speaker 214. The processor may synchronize changes in the display 212, sounds played via a speaker 214, and vibrotactile feedback in the rotary encoder 202.

In other embodiments, the input device may comprise a different device, such as a touch pad. The touch pad (not shown) may be in communication with a sensor 204. The sensor 204 may be configured to detect movement on the touch pad.

The sensor 204 can directly transmit input signals to the processor 206. In a specific example, the sensor 204 may send an input signal to the processor 206 once the rotary encoder is rotated 2 degrees or more.

The processor 206 can be in communication with one or a plurality of systems to be controlled. The processor 206 can cause the display 212 to show a graphical representation of a menu structure. The processor 206 can synchronize vibrotactile feedback with other events, such as changes in the display 212 or sounds played on the stereo system 210b. In one example, as the navigation of a menu system is shown on display 212, the input device may be vibrated while each item on the menu is traversed.

The processor 206 can be configured to determine a specific detent signal to generate. The detent signal may be based at least in part on the system which is actively being

controlled. For example, if the video system 210a is being controlled, the processor 206 may generate one type of detent signal, such as a click effect. Alternatively, if the stereo system 210b is being controlled, the processor 206 may generate a second type of detent signal, such as a hard stop virtual detent.

5 As shown in Figure 2, the processor 206 comprises memory 216. The memory 216 can be a high-speed cache memory, and configured to store vibrotactile feedback effects, such as virtual detent profiles. In one embodiment, the processor can access an effect profile stored in memory 216 after the processor 206 has determined what type of vibrotactile effect to generate.

10 A default library of vibrotactile effects, such as virtual detents, may be stored in the memory 216. For example, the processor 106 may store each virtual detent profile illustrated in Figure 9 in the memory 216. This profile may take the form of computer code. In one embodiment, the processor may be programmed with various types of vibrotactile effects not previously stored in memory 216. For example, each user of the system may author
15 individual vibrotactile effects to store in memory 216. In a second embodiment, the processor 106 may only store vibrotactile effects programmed by a manufacturer. In one embodiment, characteristics of the actuator may be stored in memory 216. For example, the frequency response of a system's actuator may be stored in memory 216.

Virtual Detents Through Vibrotactile Feedback

20 Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. Various embodiments of the invention may be used in devices without mechanical feedback. In other embodiments, the invention may be used to supplement mechanical feedback.

 The device in Figure 3 comprises a portable music player 300 having a body 302, a
25 graphical user interface display 304, and a circular touch pad 306. Although the touch pad 306 shown in Figure 3 is circular, in other embodiments the touch pad 306 may be linear, rectangular, or some other configuration. As shown in Figure 3, the input device 306 may be in communication with a display 304. As an example, the input device 306 may be configured to navigate a menu system which may be shown on the display 304. In other embodiments, the
30 input device 306 may not be in communication with a display 304.

 While the embodiment shown in Figure 3 comprises a portable music player, other embodiments may comprise other devices, such as a personal digital assistant (PDA), a portable video player, a portable game system, or a portable navigation device. Other

examples may include other electronic devices or appliances, such as a television, oven, or a lighting system.

A user may interact with the portable music player 300 by activating the circular touch pad 306. For example, a user may select an object on a menu displayed on the

- 5 graphical user interface display 304 by dragging a finger around the circular touch pad 306 in a clockwise or counter-clockwise direction.

An actuator (not shown in Figure 3) is coupled to the touch pad. As a user manipulates the circular touch pad 306, vibrotactile feedback in the form of virtual detents are provided to the user when the actuator vibrates the touch pad. The actuator generates

10 virtual detents through vibrotactile feedback, to simulate mechanical feedback.

Since the vibrotactile feedback may be programmable and variable, providing different types of vibrotactile feedback on the same input device will provide an enhanced interface. Vibrotactile feedback may aid in the selection of menus, control of levels (such as volume, bass, treble, balance, etc.), and navigation of lists.

- 15 Vibrotactile feedback may be based on the validity of an input. In one example, vibrotactile feedback is provided when a valid input is received, such as when a control is enabled and within an allowed range. If the controlled function is at or reaches a maximum or a minimum, vibrotactile feedback may be disabled, providing information that the attempted control is outside of the valid range of the system. Similarly, if the system is not active or
- 20 powered on, the absence of vibrotactile feedback may inform the user of that state.

The frequency and strength of the vibrotactile feedback may also be varied to provide an enhanced interface. In one embodiment, the type of vibrotactile feedback may be based at least in part on the content selected by a user.

- In one embodiment the frequency and strength of the vibrotactile feedback notifies the
- 25 user of various levels of control. A stronger virtual detent can indicate a bigger decision in comparison to a weaker virtual detent indicative of a smaller decision. High and low strengths of vibrotactile feedback can indicate divisions in a list (i.e. separate words by letter, or numbers at every multiple of 10). A high or low strength of vibrotactile feedback can also indicate one or more points in a range, for example, the center position of a balance control. The
- 30 frequency of the vibrotactile feedback may represent the speed of navigation of the user's finger across the touch active surface or across the number of elements in a list.

In one embodiment, each system that is controlled by the input device may be associated with a type or profile of vibrotactile feedback. For example, the actuator vibrates the input device at a constant intensity when an audio system is being controlled by the input

device, and vibrates the input device at a periodic intensity when a temperature system is being controlled.

In one embodiment, a combination of vibrotactile effects is linked as a vibrotactile theme. A vibrotactile theme can correspond with an individual function or system. One theme can comprise a combination of single clicks and double clicks to represent simulated mechanical feedback for a system being changed or a threshold being reached. Another theme can comprise a combination of a constant, low intensity vibration with a hard stop virtual detent effect. While the first theme can be assigned to one system, such as a climate system the second theme can be assigned to a second system, such as a stereo system.

Figure 4 is an illustration of a device for providing virtual detents through vibrotactile feedback in a comparative example. The device in Figure 4 comprises a mechanical device, specifically a rotary knob 400. While the comparative example shown in Figure 4 comprises a rotary knob 400, other embodiments may comprise other input devices. In some other comparative examples, the input device may comprise a linear or rotary encoder, a potentiometer, or a fader. Alternatively, embodiments according to the present invention may comprise non-mechanical input devices, such as a touch-sensitive pad or a touch-sensitive screen.

The rotary knob 400 is configured to rotate in a rotary degree of freedom about an axis extending through the knob. In some comparative examples, the rotary knob may also be configured to move in a plane perpendicular to or along the rotary axis. The rotary knob 400 is coupled to a mounting surface 402. The mounting surface may be a surface on a control panel, dashboard, car console, mouse, joystick, industrial equipment, medical equipment, or any consumer electronics device.

A user interacts with the rotary knob 400 by rotating the knob in a clockwise or counter-clockwise direction. One or more actuators 406 can be coupled to the rotary knob 400 to generate vibrotactile feedback. As the knob is rotated, vibrotactile feedback may be generated in the form of virtual detents. For example, as the knob is rotated, an effect such as a hard stop may be generated by vibrating the knob.

The rotary knob 400 can be coupled to a sensor 408. Sensor 408 can detect movements in the rotary knob 400, and transmit data to a processor 106. A shaft 404 may connect the actuator 406 and sensor 408 with the rotary knob 400.

As shown in Figure 4, a rotary knob 400 is a generally cylindrical object. Other devices for providing virtual detents may have various designs, including but not limited to conical shapes, spherical shapes, oval shapes, cubical shapes, etc. The rotary knob 400 may have one or more textures on its surface, including but not limited to bumps, lines, grooves,

other types of grips, or projections or members extending from the device's surface. Such shapes and textures may allow a user to easily grip or contact the knob and rotate it.

The rotary knob 400 may be configured to control a system. For example, the rotary knob 400 may be located on a stereo receiver, and configured to control the volume of the stereo. In one comparative example, the rotary knob 400 may control a plurality of systems, such as a car's temperature system, navigation system, and/or communication system. For example, a user can pull a knob to a first elevation in order to control the temperature system of the car. To control a different system, a user may push the knob down to a different elevation. In another comparative example, a user selects a system to be controlled via a menu system navigated by the rotary knob 400 or other controls.

Examples of Methods for Virtual Detents through Vibrotactile Feedback

Figure 5 is a flow diagram illustrating a first method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 502, the sensor generates an input signal based at least in part on a manipulation of an input device. In step 502, the processor 106 receives an input signal comprising information associated with the manipulation of an input device 102. In step 504, the processor 106 generates a signal configured to cause an actuator to produce a vibrotactile effect to the input device 102, the vibrotactile effect comprising a simulated mechanical detent.

The processor 106 can receive and generate signals as digital signals or analog signals, via wireless or wired connections. The input signal can comprise information related to a manipulation of the input device 102. For instance, the information related to the manipulation of the input device may be positional data, for example, comprising information related to the change in position of the input device. In another example, the input signal may comprise information related to the speed of the change in position of the input device as well as the change in position of the input device. As a further example, the input signal comprises information related to the direction of a continuous user contact with a rotary touch pad along with the speed at which the rotary touch pad is contacted.

In step 504, a signal is generated by the processor. The signal can be configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, and based at least in part on the detent signal. The signal comprises information relating to a specific virtual detent to be generated by an actuator.

The signal may be based at least in part on the input signal, for instance, if the input signal indicates a fast manipulation of the input device, than the detent signal may comprise a high frequency vibrotactile effect. The signal may be based at least in part on a status of a system to be manipulated. In one embodiment, a signal is not generated if a system is off. In
5 another embodiment, if a system is off, than only a signal configured to produce a hard stop is generated.

In one embodiment, the signal is based on a system reaching a maximum or minimum threshold. For example, if a stereo system has reached the highest volume level, than the signal is configured to produce a hard stop virtual detent. Alternatively, if the system to be
10 controlled has reached a threshold no signal is generated. In another example, if the stereo system has not reached the highest or lowest volume level, a signal configured to produce a click effect virtual detent is generated.

The signal generated by the processor 106 may be synchronized with changes in the system 110. For example, a detent signal can be configured to cause a vibrotactile effect at
15 the same time as changes in a display, audio level or frequency, or control of an electromechanical system. The detent signal may also be synchronized with other types of feedback. For example, vibrotactile feedback produced by an actuator in response to the detent signal may be accompanied by an audible click or noise.

Figure 6 is a flow diagram illustrating a second method for providing virtual detents
20 through vibrotactile feedback in one embodiment of the present invention. In step 602, a sensor 104 detects a change in position of an input device 102. The sensor 104 can detect the rotation of a knob 400. The sensor 104 may detect, for example, relative changes, or changes from a reference point, in the position of an input device 102.

In step 604, the sensor 104 generates a detent signal. The detent signal can be
25 configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, the vibrotactile effect based at least in part on the detent signal.

The sensor 104 can be configured to only detect changes above a predetermined threshold. One sensor can be configured to detect movement of a rotary knob in one degree
30 increments. Another sensor can be configured with a higher detection threshold, and only detect rotations of five degrees or more. The detection threshold can correspond to a determination of whether a user intended to manipulate the device, or if the manipulation was accidental or unintended.

One or more sensors 104 can be configured to detect pressure or movement on a touch pad. As an example, three sensors configured to detect changes in force may be coupled to a touch pad. The force sensors may detect input on the touch pad, such as when a user drags a finger across the surface of the touch pad.

5 A processor 106 can generate the detent signal. The detent signal may be based at least in part on the manipulation or change in position of the input device. For example, a first detent signal may correspond to a small change in position of the input device, whereas a second detent signal may correspond to a larger change in position of the input device.

10 Figure 7 is a flow diagram illustrating a third method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 702, the sensor 104 detects a change in position of an input device. The sensor 104 can detect input from a rotary knob 400, or input via a touch pad or touch screen.

In step 704, the processor 106 determines whether to generate a detent signal. The processor 106 may determine whether to generate a detent signal based at least in part on a status of a system to be manipulated 110. For example, the processor 106 may generate a
15 detent signal if the system to be manipulated is turned on. As another example, the processor 106 may not generate a detent signal if the system to be manipulated is turned off.

In step 706, the processor 106 generates a detent signal. The processor 106 can generate the detent signal as a digital signal sent to the actuator 108.

20 In step 708, the processor 106 generates a system signal. The system signal can be configured to manipulate a system to be controlled, such as an audio system, a video system, a climate system, or a menu system. As examples, the system signal can change the volume of a stereo system, increase the output of a heater or air conditioner, or zoom in on a map.

In step 710, if the processor determines not to generate a detent signal, then the
25 processor may wait for a new change in position of the input device 710.

The processor 106 can generate detent signals and systems signals the system signal as digital signals or analog signals. The processor 106 can generate the detent signal 706 and the system signal 708 substantially simultaneously. In one embodiment, the system to be controlled is manipulated at substantially the same time as the vibrotactile feedback is
30 generated on the input device. In some embodiments, a user may experience a virtual detent as a system is being manipulated, giving the user the impression of mechanical detents.

The system signal can be based at least in part on an input signal. In one embodiment, an input signal may indicate that the input device is being manipulated with a quick motion. A corresponding system signal may manipulate the system to be controlled in

a like fashion. In one example, a rotary knob is quickly rotated. A processor may generate a system signal to a stereo system with a radio, the system signal moving through radio frequencies in large increments.

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through vibrotactile feedback. In step 802, an input device, such as a knob or a touch pad, is manipulated. A user can rotate a knob, or drag her finger across a touch pad. In response to the user input, a system is manipulated 804. Finally, a vibrotactile effect is produced on the input device 806.

The system may be manipulated based at least in part on the manipulation of the input device. For example, if a knob is rotated to the right one full revolution, the volume of a stereo system may be doubled. In another example, if a circular touch pad is contacted in a counter-clockwise motion, a menu structure shown on a display may navigate up.

The vibrotactile effect 806 can be synchronized with the manipulation of the system 804. As a user navigates a menu shown on a display, a vibrotactile effect may be produced on a circular touch pad input device.

Examples of Virtual Detents

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention. In Figures 9A-9H, the rotary knob 202 is shown on the right along with a representation of the virtual detent profile on the left corresponding with the rotary knob. The virtual detent profiles illustrated in Figures 9A-9H are exemplary embodiments of the invention. Other embodiments may be apparent to those skilled in the art. In some embodiments, various types of detents may be combined to produce a combination vibrotactile effect.

Figure 9A depicts a programmable virtual detent profile. Virtual detents are shown at A, B, C, D, and E. For example, as a rotary knob is rotated through each point A-E, the rotary knob may be vibrated to generate the feeling of a real detent. The magnitude and width of the vibrotactile feedback applied to the input device at each virtual detent may simulate the magnitude and width of a mechanical detent.

Figure 9B depicts a hard stop virtual detent profile. A hard stop, or barrier virtual detent, may simulate a mechanical hard stop or barrier. For example, a virtual hard stop may indicate that a system can no longer be manipulated. As an illustration, as a user turns a rotary knob, virtual detents may indicate each increasing fan level selected by a user. When

the fan level reaches its maximum, the processor 106 may send a detent signal to the actuator 108 comprising a barrier detent instruction.

Figure 9C depicts a hill virtual detent profile. A hill effect may simulate the approach to the end of a menu system, or a maximum or minimum threshold of a system. For example, as the user approaches the last item in a menu, the vibrotactile effect may gradually increase. As another example, when the user is approaching the end of a wrap-around menu structure, the intensity of the vibrotactile feedback may increase until the user reaches the beginning item, which may be accompanied by vibrotactile feedback with lower intensity.

Figure 9D depicts a compound virtual detent profile. In some embodiments, the magnitude and/or width of the vibrotactile feedback may be varied at each point. In such embodiments, a compound effect may include two or more effects such as barriers or detents. A compound effect may be related to the operational characteristics of a system. For example, a compound effect used in conjunction with a menu system may generate light intensity vibrotactile feedback while a menu is traversed within a subcategory, but generate heavier intensity vibrotactile feedback when larger categories of the menu are traversed. In one embodiment, a hill effect may be used as a user traverses contact names beginning with the same letter. When a new letter is reached, a hard stop effect may be used to indicate the new letter.

Figure 9E depicts a spring virtual detent profile. A spring virtual detent may indicate a preferred position of an input device. For example, as a user manipulates a rotary knob away from a home position, a spring effect virtual detent may increase in intensity as the knobs distance from the home position increases.

Figure 9F depicts a damper virtual detent profile. In a damper virtual detent, the vibrotactile force may increase or decrease based on the speed of the manipulation of an input device. For example, a light vibrotactile effect may accompany slow rotation of a rotary knob, while a heavier vibrotactile effect may accompany faster rotation of the rotary knob.

Figure 9G depicts a constant virtual detent profile. A constant force effect may be a continuous force independent of the position or manipulation of the input device. For example, as a rotary knob is rotated, the force of the vibrotactile effect may remain constant. A constant virtual detent profile may be used in combination with a null force profile, such that vibrotactile effects are generated at a constant intensity during part of a manipulation of an input device, and not generated at all at a later time. For example, a constant vibrotactile force may be produced on a rotary knob until a threshold is reached, upon which no vibrotactile force is generated in response to manipulation of the rotary knob. In another

example, a constant vibrotactile force may be output while a user has selected one item in a menu system, but not generated when a user selects a different item in a menu system.

Figure 9H depicts a periodic virtual detent profile. The periodic force effect profile may comprise a sine wave, square wave, or triangular wave profile. In one example of a
5 triangular virtual detent, the intensity of a virtual detent may increase and decrease linearly over time. A periodic virtual detent may last for a set period of time.

General

The foregoing description of embodiments of the invention has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit
10 the invention to the precise forms disclosed. Numerous modifications and adaptations thereof will be apparent to those skilled in the art. The scope of the present invention is defined solely by the appended claims. ~~art without departing from the spirit and scope of the present invention.~~

MAIN REQUEST

Claims:

1. A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of a surface of a touch-sensitive ~~input~~ non mechanical input ~~input~~ device
 - 5 (306), and
 - ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the surface of the touch-sensitive ~~input~~ non mechanical input ~~input~~ device;

further comprising:

 - 10 iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles to generate a vibrotactile signal;
 - ~~characterised in that~~ wherein ~~input~~ ~~input~~
 - 15 ~~characterised in that~~ said determination is based at least in part on the input signal (102, 202, 306, 400) and the vibrotactile effect is configured to simulate mechanical feedback.
2. The method of claim 1, **further comprising :-**
 - i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - 20 ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and generating (504, 604, 706) the vibrotactile signal.
 3. The method of claim 2, **further comprising** determining whether to generate a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.
 - 25 4. A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 3.
 - 30 5. A system comprising:
 - i) a touch-sensitive ~~input~~ non mechanical input ~~input~~ device (306);
 - ii) at least one actuator (108, 208, 406) coupled to the touch-sensitive ~~input~~ non mechanical input ~~input~~ device

MAIN REQUEST

- iii) a processor (106, 206) in communication with the touch-sensitive input device and said at least one actuator and configured to:
- a) receive (500) an input signal comprising information associated with a manipulation (802) of the touch-sensitive ~~input~~ non mechanical input ~~input~~ device (102, 202, 400); and,
 - b) generate (504, 604, 706) a vibrotactile signal configured to cause said actuator (108) to produce a vibrotactile effect (806) to a surface of the touch-sensitive ~~input~~ non mechanical input ~~input~~ device and the vibrotactile effect is configured to simulate mechanical feedback;
- 10 **wherein;**
- iv) the processor (106, 206):
 - a) comprises memory (216) configured to store virtual detent profiles, and
 - 15 b) is configured to effect the method of any of claims 1 to 3.
6. The system of claim 5, **wherein** the processor (106, 206) is further configured to generate (706) a system signal to control a system (110, 210) based at least in part on a manipulation of the ~~input~~ non mechanical input ~~input~~ device (102, 202, 306, 400).
- 20 7. The system of claim 5 or claim 6, **wherein** the at least one actuator (406) is coupled to a housing (302, 402) of the ~~input~~ non mechanical input ~~input~~ device (306, 400).
- 25 8. The system of any of claims 5 to 7, **wherein** a sensor (104, 204, 408) is configured to detect manipulation of the ~~input~~ non mechanical input ~~input~~ device (102, 202, 400) and generate the input signal.

WO 2008/085487

PCT/US2007/026355

1/10

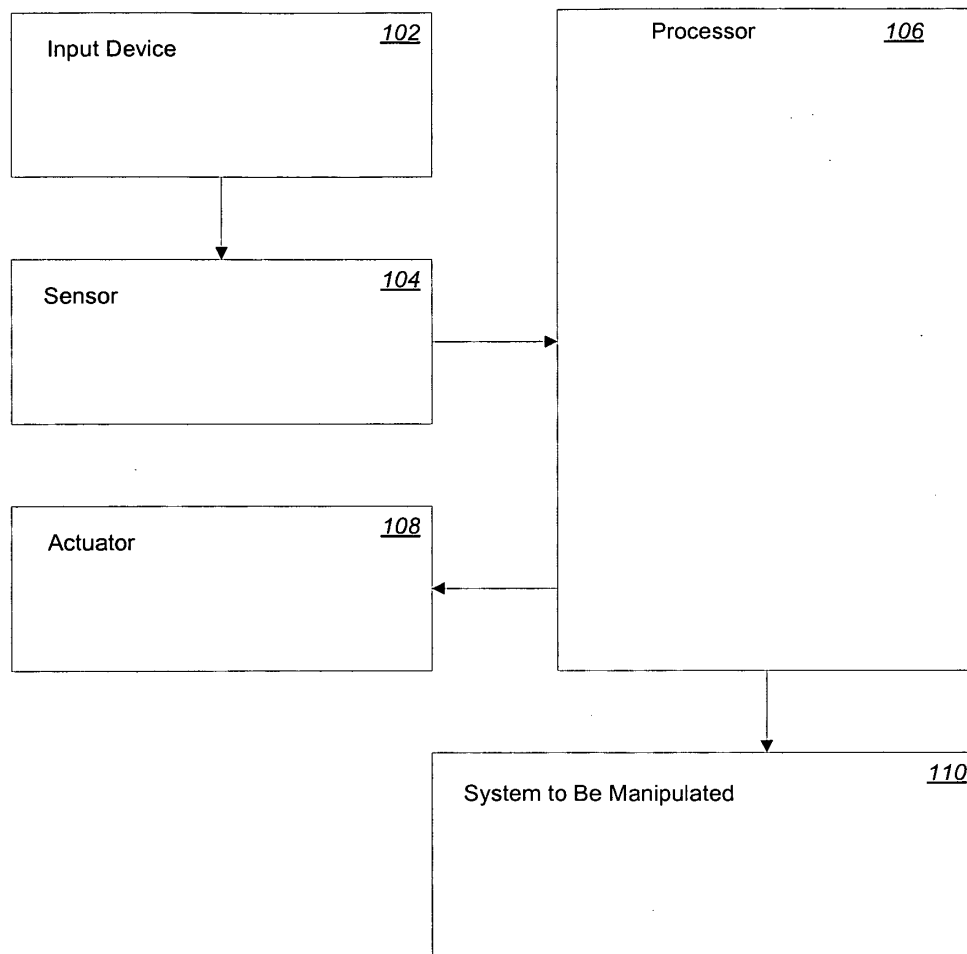


Figure 1

WO 2008/085487

PCT/US2007/026355

2/10

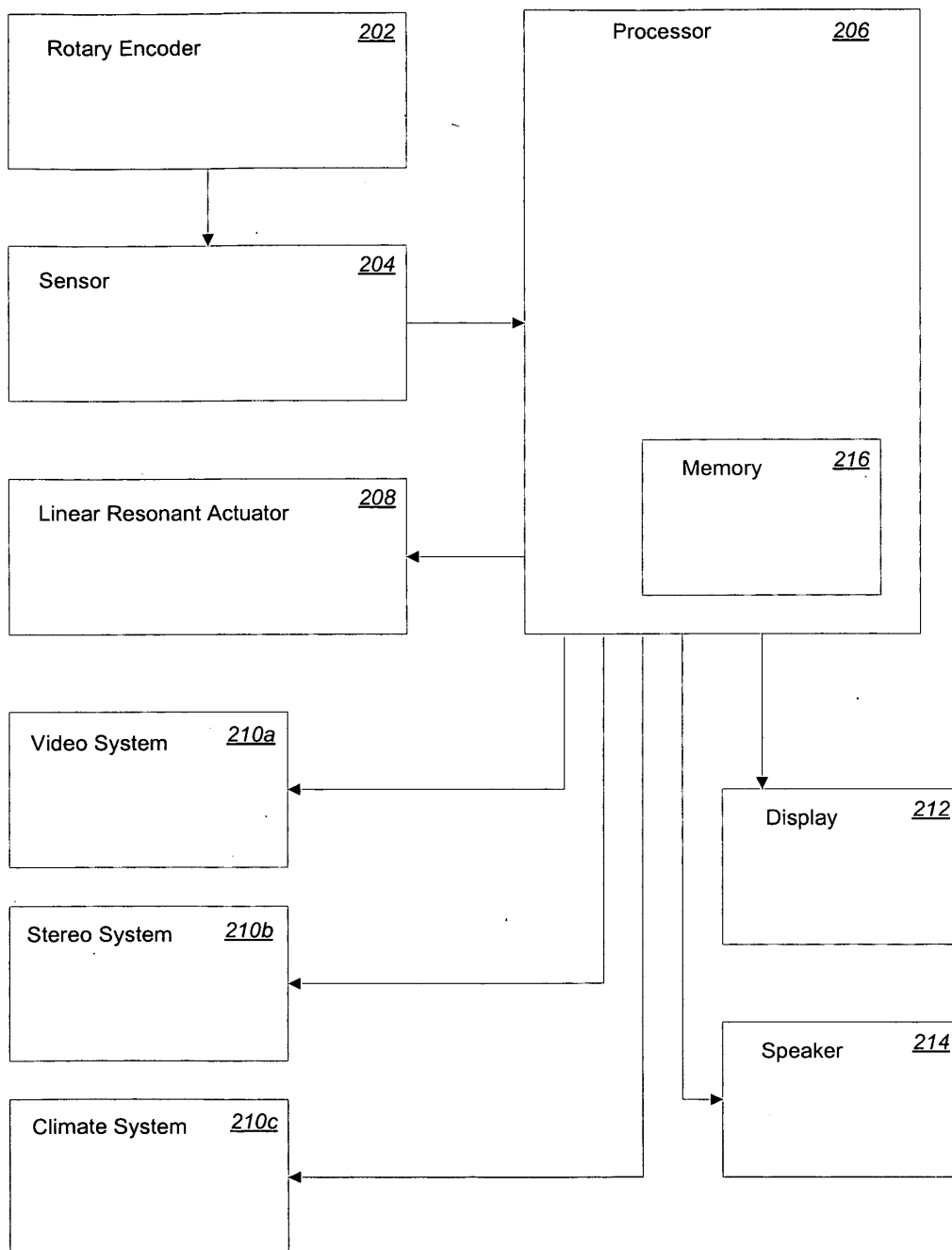


Figure 2

WO 2008/085487

PCT/US2007/026355

3/10

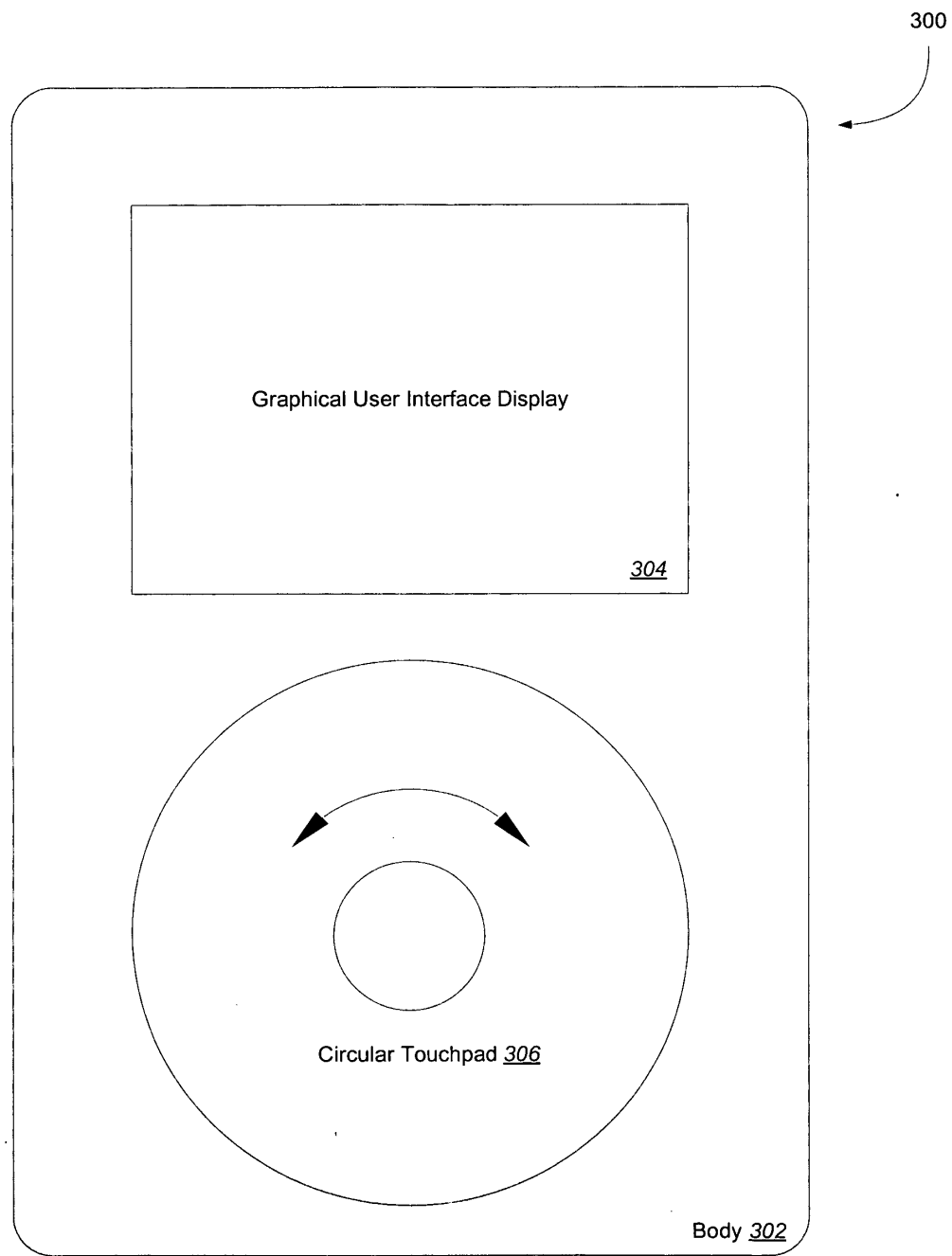


Figure 3

WO 2008/085487

PCT/US2007/026355

4/10

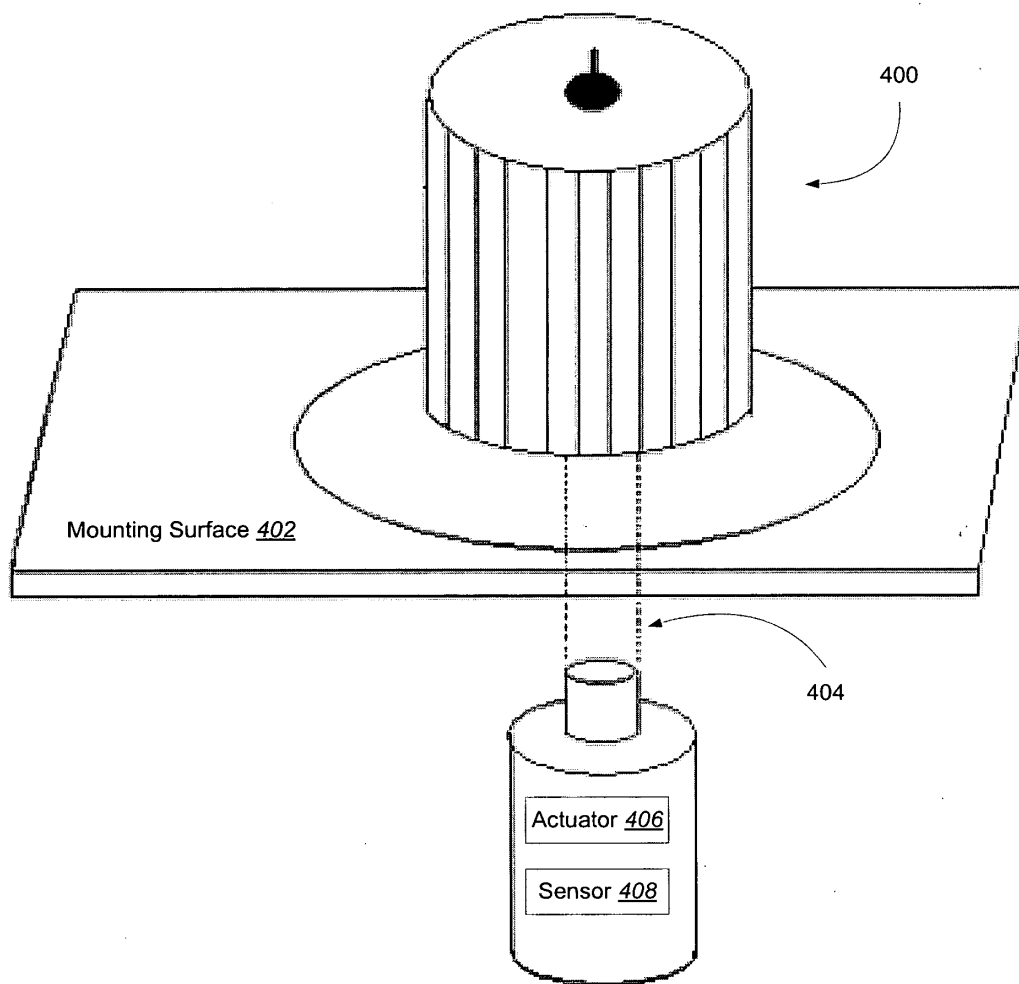


Figure 4

WO 2008/085487

PCT/US2007/026355

5/10

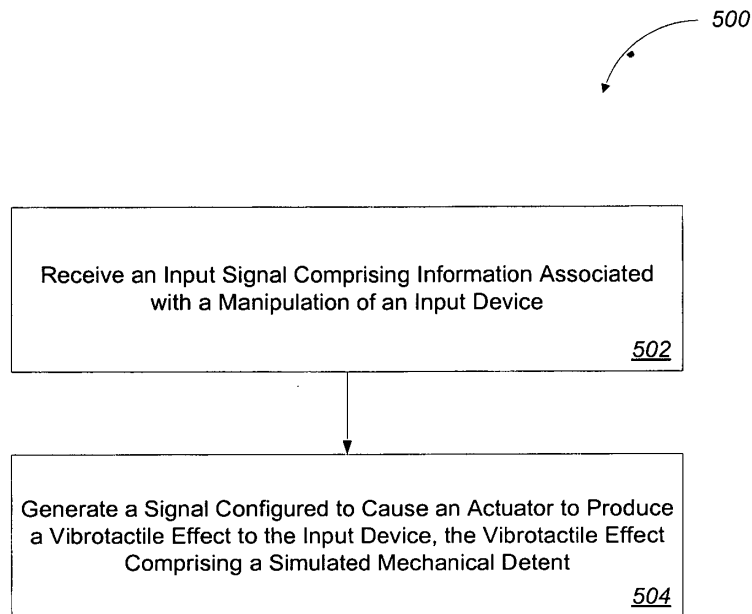


Figure 5

WO 2008/085487

PCT/US2007/026355

6/10

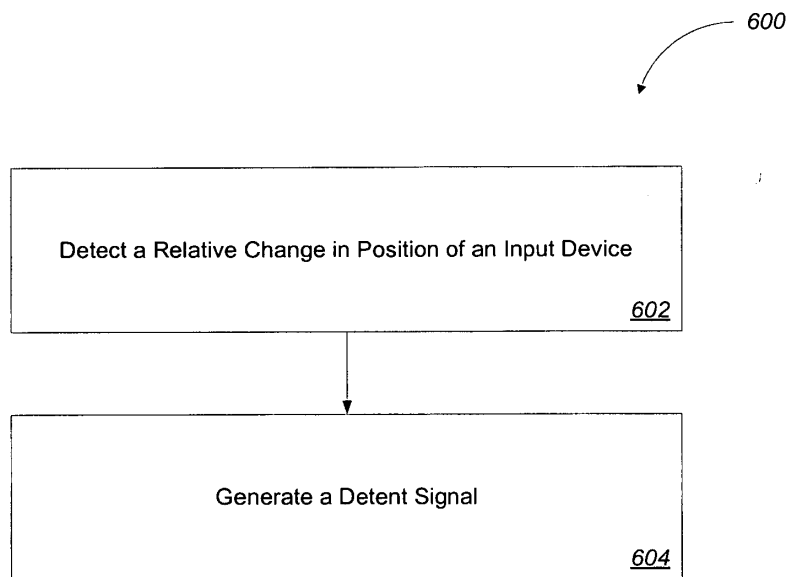


Figure 6

WO 2008/085487

PCT/US2007/026355

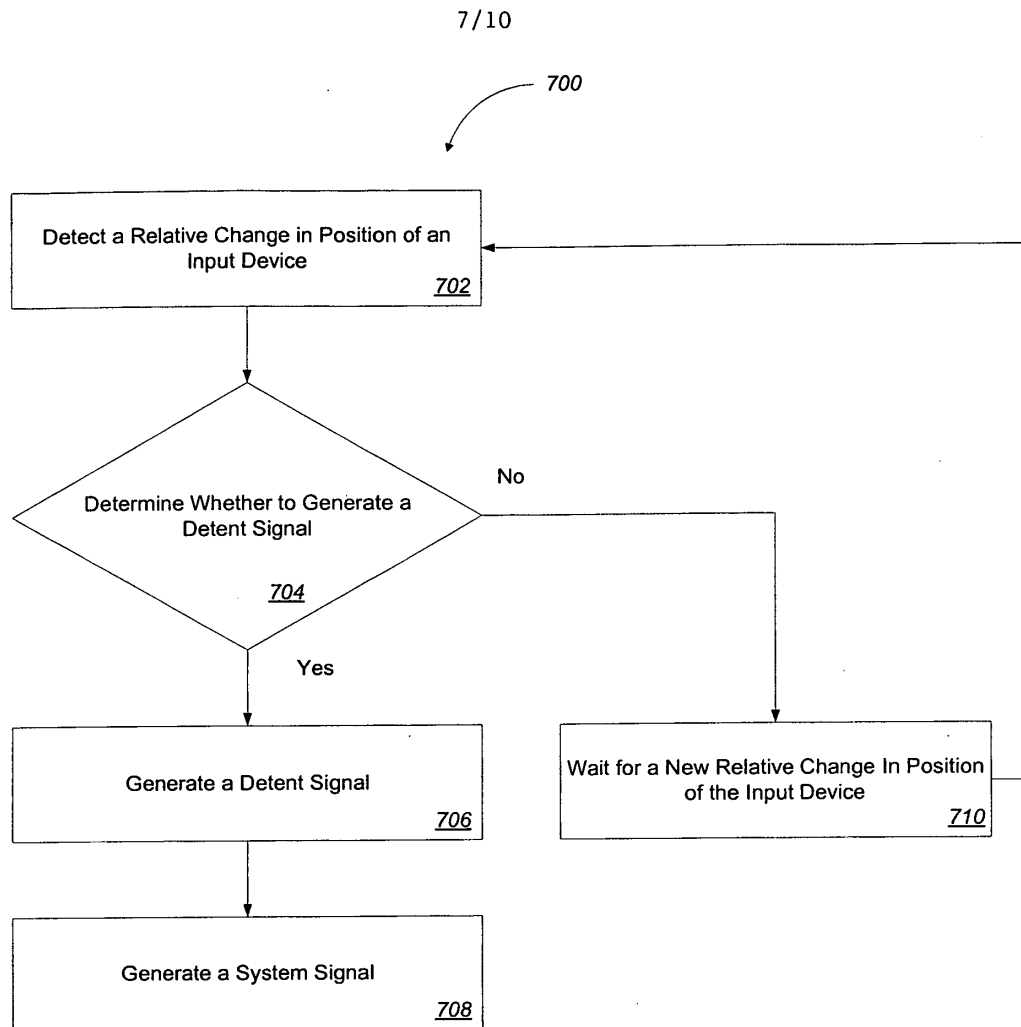


Figure 7

WO 2008/085487

PCT/US2007/026355

8/T0

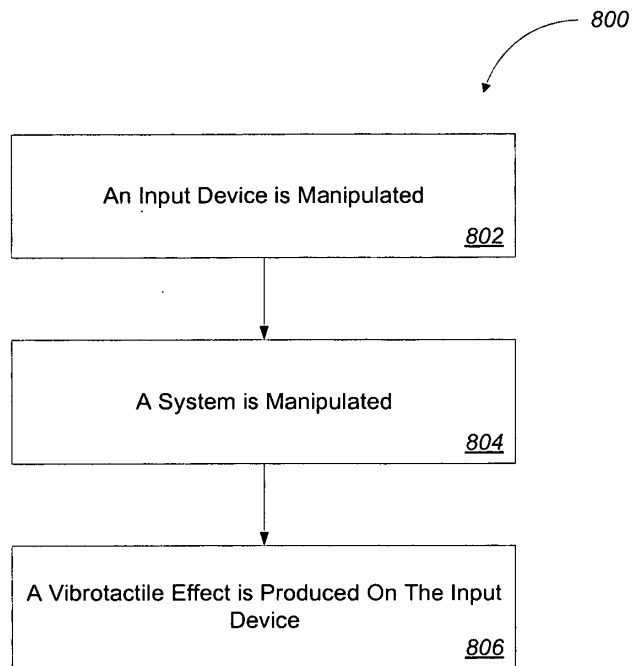


Figure 8

WO 2008/085487

PCT/US2007/026355

9/10

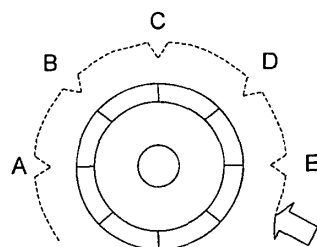
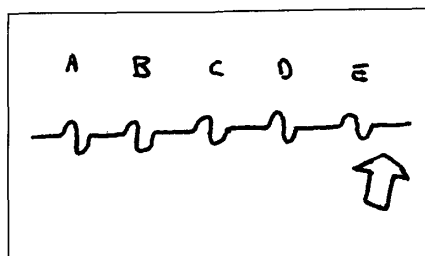


Figure 9A

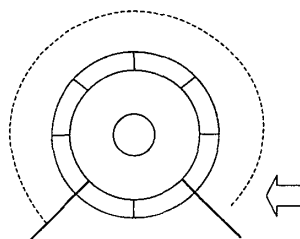
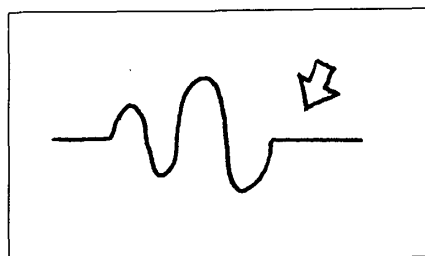


Figure 9B

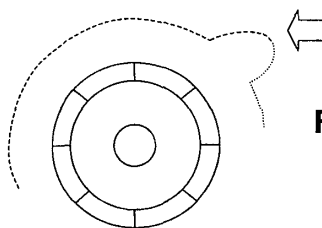
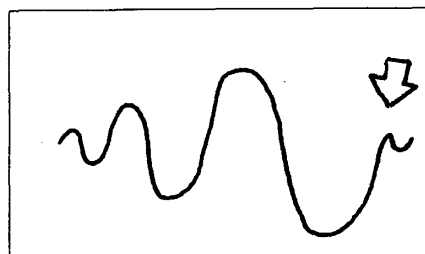


Figure 9C

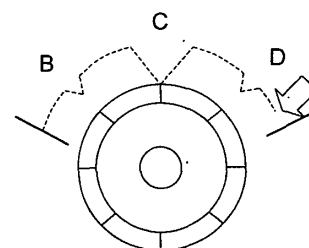
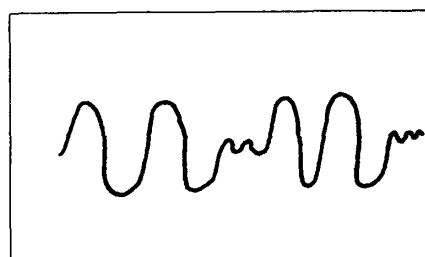


Figure 9D

WO 2008/085487

PCT/US2007/026355

10/10

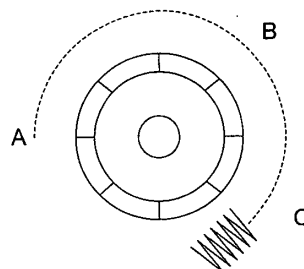
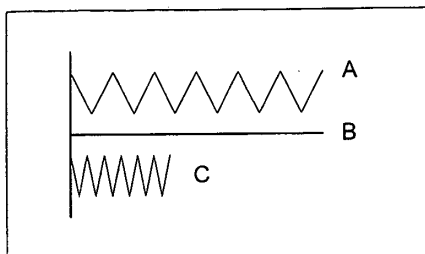


Figure 9E

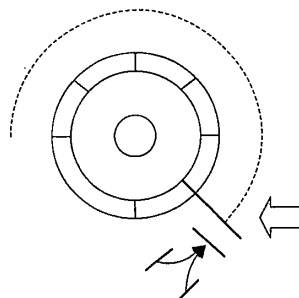
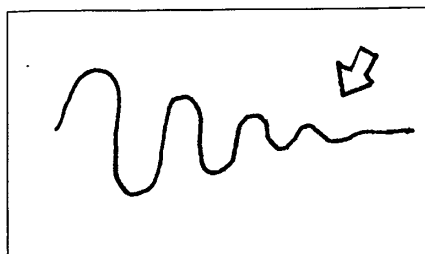


Figure 9F

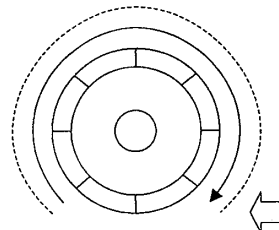
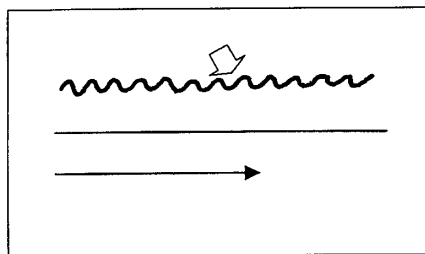


Figure 9G

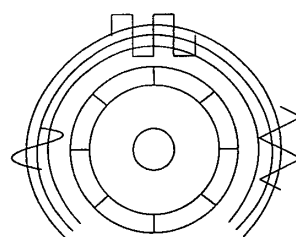
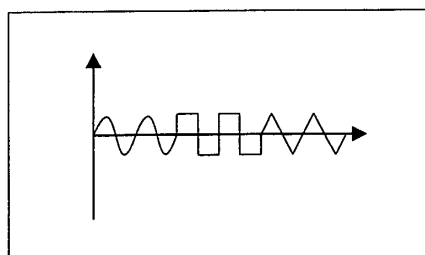


Figure 9H



European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact
Brouwers, Marja



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME UNI

ONLY BY FAX

Date
26.11.2019

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1221 / 2126667
Applicant/Proprietor Immersion Corporation	

BRIEF COMMUNICATION

Oral Proceedings on 29.11.19 at 09:30 hours

Subject: ☒ Your letter of 29.10.2019.....
☐ Maintenance / Cancellation / postponement at the instigation of the division
☐ Consultation by telephone on.....(EPO Form 2036)

- Communication:
1. ☐ The date / time fixed for oral proceedings is maintained.
☐ The reasons are indicated on enclosed EPO Form 2906.
 2. ☐ The above-mentioned oral proceedings will start at hours.
 3. ☒ The summons to attend oral proceedings on the date indicated above is cancelled.
 - 3.1 ☐ The reasons are indicated on enclosed EPO Form 2906.
☒ The procedure will be continued in writing.
☐ A new date will be set later.
☐ New summons will follow.
 - 3.2 ☐ For administrative reasons the oral proceedings are postponed to a later date. New summons will follow.
 - 3.3 ☐ The application is deemed to be withdrawn. The right to oral proceedings only persists as long as proceedings are pending.
 4. ☐ The request for the oral proceedings to be held by videoconference:
 - 4.1 ☐ is allowed.
 - 4.2 ☐ is rejected.
☐ No videoconference studio is available on the date indicated above.
☐ See enclosed EPO Form 2906.

5. ☒ Please confirm receipt of this communication by return fax with date stamp and signature to the EPO central fax server in Munich: (+49) (0) 89 23 99 44 65.

Please take note.

For the Examining Division



Enclosure(s): ☐ EPO Form 2906
☐ EPO Form 2036

VERZEND CONTROLE RAPPORT

TIJD : 26/11/2019 17:01
 NAAM : 11
 FAX : 3386
 TEL : 0703403386
 SER NR: E71281A8J539705

DATUM, TIJD	26/11 17:00
FAX NR./NAAM	000442078228899
TIJDSDUUR	00:00:28
PAGINA'S	02
RESULT	OK
MODE	STANDAARD
	FCM



European Patent Office
 80298 MUNICH
 GERMANY

Questions about this communication ?
 Contact Customer Services at www.epo.org/contact
 Brouwers, Marja



Phillips & Leigh LLP
 Temple Chambers
 3-7 Temple Avenue
 London EC4Y 0DA
 ROYAUME UNI

ONLY BY FAX

Date
26.11.2019

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1221 / 2126667
Applicant/Propriétaire Immersion Corporation	

BRIEF COMMUNICATION

Oral Proceedings on 29.11.19 at 09:30 hours

Subject: ☒ Your letter of 29.10.2019
☐ Maintenance / Cancellation / postponement at the instigation of the division
☐ Consultation by telephone on(EPO Form 2036)

- Communication:
1. ☐ The date / time fixed for oral proceedings is maintained.
☐ The reasons are indicated on enclosed EPO Form 2906.
 2. ☐ The above-mentioned oral proceedings will start at hours.
 3. ☒ The summons to attend oral proceedings on the date indicated above is cancelled.
 - 3.1 ☐ The reasons are indicated on enclosed EPO Form 2906.
☒ The procedure will be continued in writing.
☐ A new date will be set later.



Letter accompanying subsequently filed items

Representative:

PHILLIPS & LEIGH LLP
380
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
United Kingdom

Phone: +442078228888
Fax: +442078228899
E-mail: mail@pandl.com

80298 Munich
Germany
Tel. +49(0)89 2399-0 | Fax -4465

P.O. Box 5818
2280 HV Rijswijk
Netherlands
Tel. +31(0)70 340-2040 | Fax -3016

10958 Berlin
Germany
Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number

07863260.1

Applicant's or representative's reference

FP-10-0597

	Description of document	Original file name	Assigned file name
1	Letter dealing with Oral proceedings	Written Submissions.pdf	ORAL-1.pdf
2	Amended description (clean copy)	Clean Description.pdf	DESC-1.pdf
3	Amended description with annotations	Tracked Description.pdf	DESC-HWA-1.pdf
4	Amended claims (clean copy)	Main Request - Clean.pdf	CLMS-1.pdf
5	Amended claims with annotations	Main Request - Tracked.pdf	CLMS-HWA-1.pdf

	Payment	
1	Method of payment	Not specified

Signatures

Place: London, GB
Date: 29 October 2019
Signed by: Arthur Boff 24434
Association: PHILLIPS & LEIGH LLP
Representative name: Arthur Boff
Capacity: (Representative)

FP-10-0597

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

CROSS-REFERENCES TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application No. 60/877,333 entitled "Virtual Detents through Vibrotactile Feedback," filed December 27, 2006, the entirety of which is hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention generally relates to vibrotactile feedback. More particularly, the present invention relates to methods and systems for providing virtual detents through vibrotactile feedback.

BACKGROUND

Traditional mechanical device controls include switches, knobs, levels, sliders, faders, and the like. In the past, such controls have been essentially mechanical in nature, e.g., a knob turning a shaft coupled to a potentiometer to control an electrical input to a device such as a radio or audio amplifier, a knob turning a shaft coupled to a fan control or heating/air conditioning control in an automobile, or a lever controlling the opening and closing of a vent in an automobile.

With many traditionally mechanical functions being replaced by electronics, operation of electronic controls has been made less intuitive to users. For example, without click-stops or "detents," or otherwise a sense of mechanical resistance, it may be difficult to obtain a similar experience from an electronic substitute for a traditional mechanical control device or even effectively and efficiently operate such a device. A detent, such as a mechanical detent, can refer to the resistance of rotation of a wheel or shaft. A detent can be used to divide a rotation into discrete increments, or may be used to arrest rotation in a direction. For instance, a mechanical detent can be constructed from a notched wheel and a small gravity or spring-actuated lever.

SUMMARY

Embodiments of the present invention disclosed herein provide methods and systems for providing virtual detents through vibrotactile feedback.

One embodiment of the invention is a method comprising the steps of receiving an input signal that comprises information associated with the manipulation of a surface of a touch-sensitive input device, and generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect comprising a virtual detent to the surface of the input device, with the vibrotactile effect configured to simulate mechanical feedback.

In another embodiment, a computer-readable medium (such as, for example, random access memory or a computer disk) comprises code for carrying out such a method.

Another embodiment of the invention is a system comprising a touch-sensitive input device and a processor that is in communication with the touch-sensitive input device and that
5 is configured to receive an input signal comprising information associated with the manipulation of the touch-sensitive input device. The processor may further be configured to generate a detent signal based at least in part on the manipulation of the input device. The system may further comprise an actuator coupled to the input device. The actuator may be in
10 communication with the processor and configured to produce to the surface of the touch-sensitive input device a vibrotactile effect comprising a virtual detent based at least in part on the detent signal and configured to simulate mechanical feedback.

Further details of embodiments of the invention are set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the invention are better
15 understood when the following Detailed Description is read with reference to the accompanying drawings, wherein:

Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention;

Figure 2 is a block diagram illustrating a second system for providing virtual detents
20 through vibrotactile feedback in one embodiment of the invention;

Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention;

Figure 4 is an illustration of a second device for providing virtual detents through vibrotactile feedback in a comparative example;

25 Figure 5 is a flow diagram illustrating a first method for virtual detents through vibrotactile feedback;

Figure 6 is a flow diagram illustrating a second method for virtual detents through vibrotactile feedback;

Figure 7 is a flow diagram illustrating a third method for virtual detents through
30 vibrotactile feedback;

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through vibrotactile feedback; and

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention provide methods and systems for virtual detents through vibrotactile feedback. In one illustrative embodiment, a touch-sensitive surface is manipulated. A sensor detects the manipulation of the surface and sends an input signal to a processor. The input signal comprises information related to the manipulation of the surface. The processor determines whether to manipulate an audio system based at least in part on the input signal. The processor further determines whether to generate a signal configured to cause an actuator to vibrate the surface, the vibration based at least in part on the signal.

This example is given to introduce the reader to the general subject matter discussed. The invention is not limited to this example. Below, examples of methods and systems for virtual detents through vibrotactile feedback are described.

Illustrative Devices for Enhanced Haptic Feedback

In one illustrative embodiment of a device configured to provide virtual detents through vibrotactile feedback, a portable music player may be configured to play music through a speaker and produce a virtual detent on a touch pad with an actuator. In one such embodiment, the portable music player may comprise a touch pad configured to generate an input signal to a processor based on a user contact. The processor may analyze the input signal and determine whether to manipulate the audio system and whether to generate a vibrotactile effect. If the processor determines a vibrotactile effect should be generated, the processor may generate a signal. The signal may be configured to cause the actuator to produce a vibrotactile effect to the touch pad in the form of a virtual detent.

Such an illustrative embodiment may be advantageously employed to simulate mechanical detents through vibrotactile feedback. Such simulated mechanical detents, or virtual detents, may provide useful feedback to a user. For example, a virtual detent may indicate the successful change in volume of a sound system. As another example, the absence of a virtual detent may indicate that a climate system is not turned on, or that it has reached the highest threshold of operation.

These further examples are given to introduce the reader to the general subject matter discussed herein. The invention is not limited to these examples. The following sections describe various embodiments of systems and methods for providing virtual detents through vibrotactile feedback.

Example of a First System for Virtual Detents through Vibrotactile Feedback

Referring now to the figures in which like numerals indicate like elements throughout the several figures, Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention. In the
5 embodiment shown, the system comprises an input device 102, a sensor 104, a processor 106, an actuator 108, and a system to be manipulated 110.

The Input Device and Sensor

Systems of the invention comprise an input device 102 and a sensor 104. The input device 102 shown in Figure 1 is configured to provide an input signal to the processor when
10 the input device 102 is manipulated. In other embodiments, sensor 104 can generate an input signal when the sensor 104 detects manipulation of the input device 102.

In a comparative example the input device 102 can be, for example, a mechanical input device. Examples of mechanical input devices include a rotary knob coupled to an encoder. Encoders of the input device 102 may comprise an optical encoder or a potentiometer.
15 In other embodiments according to the invention, the input device 102 may be a non-mechanical input device. For example, the input device 102 may be a touch-sensitive device, such as a touch pad or a touch screen.

The input device 102 is in communication with a sensor 104. The sensor detects movement of the input device 102. A sensor 104 can be configured to detect the movement
20 of a rotary knob, or other aspects of manipulation of the input device 102, such as position, velocity, acceleration, torque, rate of rotation, or the time of rotation.

Sensor 104 shown in Figure 1 comprises a contact-type sensor, such as a switch, a resistive sensor, a capacitive sensor, an infrared sensor, or an optical sensor. Alternatively, sensor 104 may comprise a non-contact sensor such as a field effect sensor or a proximity
25 sensor, and can be a surface or sub-surface sensor.

The Processor

The system illustrated in Figure 1 comprises a processor 106. The processor 106 may be configured to receive input signals from an input device 102 or a sensor 104 and to generate signals to an actuator 108. The signals may be configured to cause the actuator 108 to produce
30 a vibrotactile effect. Further, the processor can generate signals provided to a system to be manipulated 110.

In one embodiment, a dedicated processor 106 may receive input signals and generate signals. Although there is a single processor shown in Figure 1, the system may comprise a plurality of processors. The processor 106 may be configured to perform a variety of tasks.

For example, the processor 106 may comprise additional program code running on a native cellular phone processor.

The processor 106 may be configured to receive input signals. In some embodiments, the processor 106 may receive input signals from the input device 102. In other
5 embodiments, the processor 106 may receive input signals from the sensor 104. In the
embodiment shown in Figure 1, the input device 102, sensor 104 and the processor 106 are in
communication via a direct wired digital connection. For example, the input device 102, sensor
104, and the processor 106 may be in communication via a communication bus such as the
Universal Serial Bus (USB). In other embodiments, communication between an input device
10 102, sensor 104 and the processor 106 may be through analog signals and/or may be wireless.
For instance, the sensor 104 may be able to use Bluetooth, Wireless USB or Wi-Fi
to communicate with the processor 106.

The processor 106 can also generate one or more signals. For example, a processor
may generate a signal when a valid input signal is received. In the embodiment shown in
15 Figure 1, as the input device 102 is manipulated, the processor 106 may generate a signal at
the same time or immediately after the manipulation. In one embodiment, the processor 106
may process software code running as an application on the processor and utilize the input
signal in the context of the software code to generate signals configured to cause virtual
detents.

20 The processor 106 may generate a signal, such as a detent signal, to the actuator 108.
The detent signal may be configured to cause an actuator 108 to produce a vibrotactile effect
in the form of a virtual detent on the input device 102.

The processor 106 may generate a signal specific to an actuator 108. In one
embodiment, the signal may be generated with parameters specific to the actuator 108. For
25 example, the processor may analyze parameters associated with the actuator 108, such as the
actuator's resonant frequency, and generate a signal based at least in part on the parameters.
Other parameters of the actuator 108 may comprise, for example and without limitation, a
resonant frequency of the actuator, a maximum peak-to-peak amplitude or magnitude of the
actuator, or a minimum actuator response time.

30 The processor 106 may generate a signal by accessing a detent profile stored in a
memory (not shown in Figure 1). In one embodiment, the processor 106 may access a specific
detent profile based at least in part on the input signal. In certain embodiments, the processor
106 may determine which of a plurality of simulated mechanical detents to generate. For
example, the processor 106 may analyze the input signal and determine that a

hard stop is appropriate. Further, the processor 106 may then access the hard stop virtual detent profile in a memory, and generate a detent signal based on the hard stop virtual detent profile.

5 The processor 106 may be in communication with a system to be manipulated 110 or controlled. In some embodiments, the processor 106 may be configured to generate a system signal. The system signal may be provided to the system to be manipulated 110.

10 The system signal may be based at least in part on the manipulation of the input device. For example, an input device 102 in the form of a rotary knob may be rotated one entire revolution. The processor 106 may receive an input signal indicating the complete rotation of the input device 102 and generate a system signal configured to manipulate a system 110 by maximizing or minimizing a level of the system.

15 While the device shown comprises one processor 106, other devices may comprise two or more processors. Processor 106, as well as other processors incorporated into one or more embodiments of the present invention, may comprise a computer-readable medium, such as a random access memory (RAM) coupled to the processor (not shown in Figure 1). The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs for generating vibrotactile or other haptic effects. Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable gate arrays (FPGAs), and state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

20 Such processors may comprise, or may be in communication with, media, for example computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, an electronic, optical, magnetic, or other storage or transmission device capable of providing a processor with computer-readable instructions. Other examples of media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other forms of computer-readable media may transmit or carry instructions to a computer, such as a router, private or public network, or other transmission device or

channel. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein. The instructions can comprise code from any suitable computer-programming language, including, for example, assembly code, C, C+, C++, Visual Basic, Java, Python, and JavaScript.

The Actuator

The system illustrated in Figure 1 further comprises one or more actuators 108. Each actuator 108 can be configured to receive a signal from the processor 106 and provide vibrotactile effects to the user in the form of virtual detents. The actuator 108 can vibrate the input device 102 to provide vibrotactile feedback.

The actuator 108 can provide vibrotactile feedback based on signals received from the processor 106. For example, the actuator 108 may be configured to generate a vibration after receiving a detent signal from the processor 106. The actuator 108 can vibrate the input device 102 at substantially the same time the input device is being manipulated.

The actuator 108 may be configured to simulate mechanical feedback through vibrotactile feedback. Specifically, in some embodiments the actuator 108 may be configured to provide the perception of a detent (i.e. a virtual detent) without the traditional means necessary for a mechanical detent. For example, the actuator 108 may be used in place of various mechanical components which traditionally provided tactile feedback, such as springs, brakes or cams. In some embodiments, the vibrotactile feedback may comprise a click effect replicating a mechanical click. In other embodiments, the vibrotactile feedback may not comprise a click effect, but some other effect, such as a spring effect or a barrier effect.

The actuator 108 may be configured to generate vibrotactile feedback with a variety of different characteristics. For example, the actuator may be configured to generate vibrotactile feedback with different frequencies, amplitudes, or waveforms. In one embodiment, the virtual detent may comprise a simulated click generated through a single pulse. In a second embodiment, the virtual detent may comprise a click-and-release effect generated by a double pulse. Figure 9 provides illustrations of various virtual detent profiles.

Because the actuator 108 may be configured to generate vibrotactile feedback, in contrast to mechanical feedback, the actuator 108 may provide vibrotactile feedback to non-mechanical input devices 102, such as a touch-sensitive pad, i.e., a touch pad or touch screen.

The actuator 108 may be configured to generate various types of vibrotactile feedback. For example, the actuator 108 may be configured to produce different virtual detents. The vibrotactile feedback may be generated in various directions. For example, the actuator 108 may vibrate the input device orthogonal to the motion of the input device.

5 The actuator 108 can be any of a variety of different types of force producing devices, including an eccentric rotating mass (ERM) actuator, a multifunctional (MFT) actuator, a linear mass actuator, an electro-magnetic actuator, a motor, a voice coil, a pneumatic or hydraulic actuator, an electro-active polymer, or any other suitable actuator. In one
10 embodiment, actuator 108 may comprise a plurality of actuators of the same or different design. For example, in one embodiment, two actuators may be employed. A first actuator may be configured to provide vibrotactile or other haptic effects having a high frequency of vibration (e.g. greater than 400Hz), while a second actuator may be configured to provide vibrotactile or other haptic effects having a low frequency of vibration (e.g. less than 400Hz).

15 Since some embodiments of the invention may use the actuator 108 to generate vibrotactile feedback, as opposed to mechanical feedback, a smaller actuator may be used than in other devices. For example, actuator 108 may comprise a circular actuator ten (10) millimeters in diameter and three and one half (3.5) millimeters thick.

 Since the device may comprise a plurality of actuators, the number of actuators 108
20 may be based on the size and mass of the device. For example, an actuator 108 may be provided for every one hundred (100) grams of mass of the system. In such an example, a system measuring three hundred (300) grams may comprise three actuators. In another example, a cellular phone measuring three hundred (300) grams may only comprise a single but more powerful actuator.

25 In one embodiment, the number of actuators 108 may be based on what surface of the system is being vibrated. For example, if a PDA measures four hundred (400) grams, but only the display will be vibrated, the system may comprise only one actuator 108, especially if the display is isolated from the rest of the device such as by a suspension system. Alternatively, if vibrotactile feedback is provided to the entire PDA, the system may comprise two or more
30 actuators.

 Each actuator 108 of a plurality of actuators may be configured to generate vibrotactile feedback to the input device 102. In one embodiment, the vibrotactile feedback generated by each of a plurality of actuators is synchronized.

35

The actuator 108 can be mounted to a touch-sensitive display, such as a touch screen (not shown in Figure 1). In one embodiment, the actuator 108 is mounted underneath the display, or alternatively, to the edge of the display, or laterally mounted to the display. In embodiments where the actuator 108 is mounted to a display, the display may be mounted in
5 a suspension of compliant material, such as a foam gasket. Mounting a display to a foam gasket may ensure that the display is vibrated alone or with a different strength than the entire device.

In one embodiment, two actuators may be mounted to either side of a display. In one example, both actuators may face the same direction and be in the same phase. In one
10 embodiment, two side-mounted actuators may vibrate a screen side-to-side. Side-mounted actuators may produce consistent forces across a screen, since the screen may be moving in the direction of its rigidity.

In one embodiment, two actuators are mounted behind a display. In one example, both actuators mounted behind the display may face the same direction and can vibrate the
15 display in and out.

The System to Be Manipulated

The system illustrated in Figure 1 comprises a system to be manipulated 110. One or more systems to be manipulated 110 can each receive system signals from the processor 106. The system to be manipulated 110 may comprise a system capable of electrical or
20 electromechanical control, such as and without limitation, a stereo system, a video system, a climate system (e.g. air conditioning and/or heating), a navigation system, automotive systems, wireless communication devices, security systems, a television, a video game system, a washing machine or a drying machine, or an oven.

In one embodiment, the system to be manipulated 110 may comprise a single system, such as a lighting system. In another embodiment, the system to be manipulated 110 may
25 comprise a complex system comprising one or more elements. For example, the system to be manipulated 110 may be a heating and cooling system.

Example of a Second System for Virtual Detents through Vibrotactile Feedback

Figure 2 is a block diagram illustrating a second system for providing virtual detents
30 through vibrotactile feedback in one embodiment of the invention. In the embodiment shown, the system comprises a rotary encoder 202, a sensor 204, a processor 206, and a linear resonant actuator 208. The system further comprises a visual system 210a, an audio system 210b, a climate system 210c, a display 212, a speaker 214, and a memory 216. An example of a visual system 210a is a video game system. An example of an audio system 210b is a

stereo system. An example of a climate system 210c is an air conditioning and heating system.

As shown in Figure 2, the input device can be the rotary encoder 202. The sensor 204 is in communication with the rotary encoder 202 and the processor 206. As the rotary encoder 202 is manipulated, the sensor 204 generates input signals associated with the manipulation, and transmits the input signals to the processor 206.

Once the processor 206 receives an input signal, the processor 206 can determine whether to generate a detent signal and/or a system signal. For example, if the input signal indicates a rotation of a knob in more than 5 degrees of motion, the processor 206 may generate a system signal and a detent signal.

The processor 206 is in communication with the linear resonant actuator 208. The processor 206 can receive input signals comprising information associated with a manipulation of the rotary encoder 206 and generate a signal configured to cause the linear resonant actuator 208 to produce a vibrotactile effect to the rotary encoder 202, the vibrotactile effect comprising a simulated mechanical detent.

As shown in Figure 2, the processor 206 is in communication with three systems: a video system 210a, a stereo system 210b, and a climate system 210c. The processor is also in communication with a display 212 and a speaker 214. The processor may synchronize changes in the display 212, sounds played via a speaker 214, and vibrotactile feedback in the rotary encoder 202.

In other embodiments, the input device may comprise a different device, such as a touch pad. The touch pad (not shown) may be in communication with a sensor 204. The sensor 204 may be configured to detect movement on the touch pad.

The sensor 204 can directly transmit input signals to the processor 206. In a specific example, the sensor 204 may send an input signal to the processor 206 once the rotary encoder is rotated 2 degrees or more.

The processor 206 can be in communication with one or a plurality of systems to be controlled. The processor 206 can cause the display 212 to show a graphical representation of a menu structure. The processor 206 can synchronize vibrotactile feedback with other events, such as changes in the display 212 or sounds played on the stereo system 210b. In one example, as the navigation of a menu system is shown on display 212, the input device may be vibrated while each item on the menu is traversed.

The processor 206 can be configured to determine a specific detent signal to generate. The detent signal may be based at least in part on the system which is actively being

controlled. For example, if the video system 210a is being controlled, the processor 206 may generate one type of detent signal, such as a click effect. Alternatively, if the stereo system 210b is being controlled, the processor 206 may generate a second type of detent signal, such as a hard stop virtual detent.

5 As shown in Figure 2, the processor 206 comprises memory 216. The memory 216 can be a high-speed cache memory, and configured to store vibrotactile feedback effects, such as virtual detent profiles. In one embodiment, the processor can access an effect profile stored in memory 216 after the processor 206 has determined what type of vibrotactile effect to generate.

10 A default library of vibrotactile effects, such as virtual detents, may be stored in the memory 216. For example, the processor 106 may store each virtual detent profile illustrated in Figure 9 in the memory 216. This profile may take the form of computer code. In one embodiment, the processor may be programmed with various types of vibrotactile effects not previously stored in memory 216. For example, each user of the system may author
15 individual vibrotactile effects to store in memory 216. In a second embodiment, the processor 106 may only store vibrotactile effects programmed by a manufacturer. In one embodiment, characteristics of the actuator may be stored in memory 216. For example, the frequency response of a system's actuator may be stored in memory 216.

Virtual Detents Through Vibrotactile Feedback

20 Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. Various embodiments of the invention may be used in devices without mechanical feedback. In other embodiments, the invention may be used to supplement mechanical feedback.

 The device in Figure 3 comprises a portable music player 300 having a body 302, a
25 graphical user interface display 304, and a circular touch pad 306. Although the touch pad 306 shown in Figure 3 is circular, in other embodiments the touch pad 306 may be linear, rectangular, or some other configuration. As shown in Figure 3, the input device 306 may be in communication with a display 304. As an example, the input device 306 may be configured to navigate a menu system which may be shown on the display 304. In other embodiments, the
30 input device 306 may not be in communication with a display 304.

 While the embodiment shown in Figure 3 comprises a portable music player, other embodiments may comprise other devices, such as a personal digital assistant (PDA), a portable video player, a portable game system, or a portable navigation device. Other

examples may include other electronic devices or appliances, such as a television, oven, or a lighting system.

A user may interact with the portable music player 300 by activating the circular touch pad 306. For example, a user may select an object on a menu displayed on the graphical user interface display 304 by dragging a finger around the circular touch pad 306 in a clockwise or counter-clockwise direction.

An actuator (not shown in Figure 3) is coupled to the touch pad. As a user manipulates the circular touch pad 306, vibrotactile feedback in the form of virtual detents are provided to the user when the actuator vibrates the touch pad. The actuator generates virtual detents through vibrotactile feedback, to simulate mechanical feedback.

Since the vibrotactile feedback may be programmable and variable, providing different types of vibrotactile feedback on the same input device will provide an enhanced interface. Vibrotactile feedback may aid in the selection of menus, control of levels (such as volume, bass, treble, balance, etc.), and navigation of lists.

Vibrotactile feedback may be based on the validity of an input. In one example, vibrotactile feedback is provided when a valid input is received, such as when a control is enabled and within an allowed range. If the controlled function is at or reaches a maximum or a minimum, vibrotactile feedback may be disabled, providing information that the attempted control is outside of the valid range of the system. Similarly, if the system is not active or powered on, the absence of vibrotactile feedback may inform the user of that state.

The frequency and strength of the vibrotactile feedback may also be varied to provide an enhanced interface. In one embodiment, the type of vibrotactile feedback may be based at least in part on the content selected by a user.

In one embodiment the frequency and strength of the vibrotactile feedback notifies the user of various levels of control. A stronger virtual detent can indicate a bigger decision in comparison to a weaker virtual detent indicative of a smaller decision. High and low strengths of vibrotactile feedback can indicate divisions in a list (i.e. separate words by letter, or numbers at every multiple of 10). A high or low strength of vibrotactile feedback can also indicate one or more points in a range, for example, the center position of a balance control. The frequency of the vibrotactile feedback may represent the speed of navigation of the user's finger across the touch active surface or across the number of elements in a list.

In one embodiment, each system that is controlled by the input device may be associated with a type or profile of vibrotactile feedback. For example, the actuator vibrates the input device at a constant intensity when an audio system is being controlled by the input

device, and vibrates the input device at a periodic intensity when a temperature system is being controlled.

In one embodiment, a combination of vibrotactile effects is linked as a vibrotactile theme. A vibrotactile theme can correspond with an individual function or system. One theme can comprise a combination of single clicks and double clicks to represent simulated mechanical feedback for a system being changed or a threshold being reached. Another theme can comprise a combination of a constant, low intensity vibration with a hard stop virtual detent effect. While the first theme can be assigned to one system, such as a climate system the second theme can be assigned to a second system, such as a stereo system.

Figure 4 is an illustration of a device for providing virtual detents through vibrotactile feedback in a comparative example. The device in Figure 4 comprises a mechanical device, specifically a rotary knob 400. While the comparative example shown in Figure 4 comprises a rotary knob 400, other embodiments may comprise other input devices. In some other comparative examples, the input device may comprise a linear or rotary encoder, a potentiometer, or a fader. Alternatively, embodiments according to the present invention may comprise non-mechanical input devices, such as a touch-sensitive pad or a touch-sensitive screen.

The rotary knob 400 is configured to rotate in a rotary degree of freedom about an axis extending through the knob. In some comparative examples, the rotary knob may also be configured to move in a plane perpendicular to or along the rotary axis. The rotary knob 400 is coupled to a mounting surface 402. The mounting surface may be a surface on a control panel, dashboard, car console, mouse, joystick, industrial equipment, medical equipment, or any consumer electronics device.

A user interacts with the rotary knob 400 by rotating the knob in a clockwise or counter-clockwise direction. One or more actuators 406 can be coupled to the rotary knob 400 to generate vibrotactile feedback. As the knob is rotated, vibrotactile feedback may be generated in the form of virtual detents. For example, as the knob is rotated, an effect such as a hard stop may be generated by vibrating the knob.

The rotary knob 400 can be coupled to a sensor 408. Sensor 408 can detect movements in the rotary knob 400, and transmit data to a processor 106. A shaft 404 may connect the actuator 406 and sensor 408 with the rotary knob 400.

As shown in Figure 4, a rotary knob 400 is a generally cylindrical object. Other devices for providing virtual detents may have various designs, including but not limited to conical shapes, spherical shapes, oval shapes, cubical shapes, etc. The rotary knob 400 may have one or more textures on its surface, including but not limited to bumps, lines, grooves,

other types of grips, or projections or members extending from the device's surface. Such shapes and textures may allow a user to easily grip or contact the knob and rotate it.

The rotary knob 400 may be configured to control a system. For example, the rotary knob 400 may be located on a stereo receiver, and configured to control the volume of the stereo. In one comparative example, the rotary knob 400 may control a plurality of systems, such as a car's temperature system, navigation system, and/or communication system. For example, a user can pull a knob to a first elevation in order to control the temperature system of the car. To control a different system, a user may push the knob down to a different elevation. In another comparative example, a user selects a system to be controlled via a menu system navigated by the rotary knob 400 or other controls.

Examples of Methods for Virtual Detents through Vibrotactile Feedback

Figure 5 is a flow diagram illustrating a first method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 502, the sensor generates an input signal based at least in part on a manipulation of an input device. In step 502, the processor 106 receives an input signal comprising information associated with the manipulation of an input device 102. In step 504, the processor 106 generates a signal configured to cause an actuator to produce a vibrotactile effect to the input device 102, the vibrotactile effect comprising a simulated mechanical detent.

The processor 106 can receive and generate signals as digital signals or analog signals, via wireless or wired connections. The input signal can comprise information related to a manipulation of the input device 102. For instance, the information related to the manipulation of the input device may be positional data, for example, comprising information related to the change in position of the input device. In another example, the input signal may comprise information related to the speed of the change in position of the input device as well as the change in position of the input device. As a further example, the input signal comprises information related to the direction of a continuous user contact with a rotary touch pad along with the speed at which the rotary touch pad is contacted.

In step 504, a signal is generated by the processor. The signal can be configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, and based at least in part on the detent signal. The signal comprises information relating to a specific virtual detent to be generated by an actuator.

The signal may be based at least in part on the input signal, for instance, if the input signal indicates a fast manipulation of the input device, than the detent signal may comprise a high frequency vibrotactile effect. The signal may be based at least in part on a status of a system to be manipulated. In one embodiment, a signal is not generated if a system is off. In
5 another embodiment, if a system is off, than only a signal configured to produce a hard stop is generated.

In one embodiment, the signal is based on a system reaching a maximum or minimum threshold. For example, if a stereo system has reached the highest volume level, than the signal is configured to produce a hard stop virtual detent. Alternatively, if the system to be
10 controlled has reached a threshold no signal is generated. In another example, if the stereo system has not reached the highest or lowest volume level, a signal configured to produce a click effect virtual detent is generated.

The signal generated by the processor 106 may be synchronized with changes in the system 110. For example, a detent signal can be configured to cause a vibrotactile effect at
15 the same time as changes in a display, audio level or frequency, or control of an electromechanical system. The detent signal may also be synchronized with other types of feedback. For example, vibrotactile feedback produced by an actuator in response to the detent signal may be accompanied by an audible click or noise.

Figure 6 is a flow diagram illustrating a second method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 602, a
20 sensor 104 detects a change in position of an input device 102. The sensor 104 can detect the rotation of a knob 400. The sensor 104 may detect, for example, relative changes, or changes from a reference point, in the position of an input device 102.

In step 604, the sensor 104 generates a detent signal. The detent signal can be
25 configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, the vibrotactile effect based at least in part on the detent signal.

The sensor 104 can be configured to only detect changes above a predetermined threshold. One sensor can be configured to detect movement of a rotary knob in one degree
30 increments. Another sensor can be configured with a higher detection threshold, and only detect rotations of five degrees or more. The detection threshold can correspond to a determination of whether a user intended to manipulate the device, or if the manipulation was accidental or unintended.

One or more sensors 104 can be configured to detect pressure or movement on a touch pad. As an example, three sensors configured to detect changes in force may be coupled to a touch pad. The force sensors may detect input on the touch pad, such as when a user drags a finger across the surface of the touch pad.

5 A processor 106 can generate the detent signal. The detent signal may be based at least in part on the manipulation or change in position of the input device. For example, a first detent signal may correspond to a small change in position of the input device, whereas a second detent signal may correspond to a larger change in position of the input device.

10 Figure 7 is a flow diagram illustrating a third method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 702, the sensor 104 detects a change in position of an input device. The sensor 104 can detect input from a rotary knob 400, or input via a touch pad or touch screen.

15 In step 704, the processor 106 determines whether to generate a detent signal. The processor 106 may determine whether to generate a detent signal based at least in part on a status of a system to be manipulated 110. For example, the processor 106 may generate a detent signal if the system to be manipulated is turned on. As another example, the processor 106 may not generate a detent signal if the system to be manipulated is turned off.

 In step 706, the processor 106 generates a detent signal. The processor 106 can generate the detent signal as a digital signal sent to the actuator 108.

20 In step 708, the processor 106 generates a system signal. The system signal can be configured to manipulate a system to be controlled, such as an audio system, a video system, a climate system, or a menu system. As examples, the system signal can change the volume of a stereo system, increase the output of a heater or air conditioner, or zoom in on a map.

25 In step 710, if the processor determines not to generate a detent signal, then the processor may wait for a new change in position of the input device 710.

 The processor 106 can generate detent signals and system signals. The system signal as digital signals or analog signals. The processor 106 can generate the detent signal 706 and the system signal 708 substantially simultaneously. In one embodiment, the system to be controlled is manipulated at substantially the same time as the vibrotactile feedback is generated on the input device. In some embodiments, a user may experience a virtual detent as a system is being manipulated, giving the user the impression of mechanical detents.

 The system signal can be based at least in part on an input signal. In one embodiment, an input signal may indicate that the input device is being manipulated with a quick motion. A corresponding system signal may manipulate the system to be controlled in

a like fashion. In one example, a rotary knob is quickly rotated. A processor may generate a system signal to a stereo system with a radio, the system signal moving through radio frequencies in large increments.

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through
5 vibrotactile feedback. In step 802, an input device, such as a knob or a touch pad, is manipulated. A user can rotate a knob, or drag her finger across a touch pad. In response to the user input, a system is manipulated 804. Finally, a vibrotactile effect is produced on the input device 806.

10 The system may be manipulated based at least in part on the manipulation of the input device. For example, if a knob is rotated to the right one full revolution, the volume of a stereo system may be doubled. In another example, if a circular touch pad is contacted in a counter-clockwise motion, a menu structure shown on a display may navigate up.

The vibrotactile effect 806 can be synchronized with the manipulation of the system 804. As a user navigates a menu shown on a display, a vibrotactile effect may be produced
15 on a circular touch pad input device.

Examples of Virtual Detents

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention. In Figures 9A-9H, the rotary knob 202 is shown on the right along with a representation of the virtual detent profile on the left
20 corresponding with the rotary knob. The virtual detent profiles illustrated in Figures 9A-9H are exemplary embodiments of the invention. Other embodiments may be apparent to those skilled in the art. In some embodiments, various types of detents may be combined to produce a combination vibrotactile effect.

Figure 9A depicts a programmable virtual detent profile. Virtual detents are shown at
25 A, B, C, D, and E. For example, as a rotary knob is rotated through each point A-E, the rotary knob may be vibrated to generate the feeling of a real detent. The magnitude and width of the vibrotactile feedback applied to the input device at each virtual detent may simulate the magnitude and width of a mechanical detent.

Figure 9B depicts a hard stop virtual detent profile. A hard stop, or barrier virtual
30 detent, may simulate a mechanical hard stop or barrier. For example, a virtual hard stop may indicate that a system can no longer be manipulated. As an illustration, as a user turns a rotary knob, virtual detents may indicate each increasing fan level selected by a user. When

the fan level reaches its maximum, the processor 106 may send a detent signal to the actuator 108 comprising a barrier detent instruction.

Figure 9C depicts a hill virtual detent profile. A hill effect may simulate the approach to the end of a menu system, or a maximum or minimum threshold of a system. For example, as the user approaches the last item in a menu, the vibrotactile effect may gradually increase. As another example, when the user is approaching the end of a wrap-around menu structure, the intensity of the vibrotactile feedback may increase until the user reaches the beginning item, which may be accompanied by vibrotactile feedback with lower intensity.

Figure 9D depicts a compound virtual detent profile. In some embodiments, the magnitude and/or width of the vibrotactile feedback may be varied at each point. In such embodiments, a compound effect may include two or more effects such as barriers or detents. A compound effect may be related to the operational characteristics of a system. For example, a compound effect used in conjunction with a menu system may generate light intensity vibrotactile feedback while a menu is traversed within a subcategory, but generate heavier intensity vibrotactile feedback when larger categories of the menu are traversed. In one embodiment, a hill effect may be used as a user traverses contact names beginning with the same letter. When a new letter is reached, a hard stop effect may be used to indicate the new letter.

Figure 9E depicts a spring virtual detent profile. A spring virtual detent may indicate a preferred position of an input device. For example, as a user manipulates a rotary knob away from a home position, a spring effect virtual detent may increase in intensity as the knobs distance from the home position increases.

Figure 9F depicts a damper virtual detent profile. In a damper virtual detent, the vibrotactile force may increase or decrease based on the speed of the manipulation of an input device. For example, a light vibrotactile effect may accompany slow rotation of a rotary knob, while a heavier vibrotactile effect may accompany faster rotation of the rotary knob.

Figure 9G depicts a constant virtual detent profile. A constant force effect may be a continuous force independent of the position or manipulation of the input device. For example, as a rotary knob is rotated, the force of the vibrotactile effect may remain constant. A constant virtual detent profile may be used in combination with a null force profile, such that vibrotactile effects are generated at a constant intensity during part of a manipulation of an input device, and not generated at all at a later time. For example, a constant vibrotactile force may be produced on a rotary knob until a threshold is reached, upon which no vibrotactile force is generated in response to manipulation of the rotary knob. In another

example, a constant vibrotactile force may be output while a user has selected one item in a menu system, but not generated when a user selects a different item in a menu system.

Figure 9H depicts a periodic virtual detent profile. The periodic force effect profile may comprise a sine wave, square wave, or triangular wave profile. In one example of a
5 triangular virtual detent, the intensity of a virtual detent may increase and decrease linearly over time. A periodic virtual detent may last for a set period of time.

General

The foregoing description of embodiments of the invention has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit
10 the invention to the precise forms disclosed. Numerous modifications and adaptations thereof will be apparent to those skilled in the art without departing from the spirit and scope of the present invention.

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

CROSS-REFERENCES TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application No. 60/877,333 entitled "Virtual Detents through Vibrotactile Feedback," filed December 27, 2006, the entirety of which is hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention generally relates to vibrotactile feedback. More particularly, the present invention relates to methods and systems for providing virtual detents through vibrotactile feedback.

BACKGROUND

Traditional mechanical device controls include switches, knobs, levels, sliders, faders, and the like. In the past, such controls have been essentially mechanical in nature, e.g., a knob turning a shaft coupled to a potentiometer to control an electrical input to a device such as a radio or audio amplifier, a knob turning a shaft coupled to a fan control or heating/air conditioning control in an automobile, or a lever controlling the opening and closing of a vent in an automobile.

With many traditionally mechanical functions being replaced by electronics, operation of electronic controls has been made less intuitive to users. For example, without click-stops or "detents," or otherwise a sense of mechanical resistance, it may be difficult to obtain a similar experience from an electronic substitute for a traditional mechanical control device or even effectively and efficiently operate such a device. A detent, such as a mechanical detent, can refer to the resistance of rotation of a wheel or shaft. A detent can be used to divide a rotation into discrete increments, or may be used to arrest rotation in a direction. For instance, a mechanical detent can be constructed from a notched wheel and a small gravity or spring-actuated lever.

SUMMARY

Embodiments of the present invention disclosed herein provide methods and systems for providing virtual detents through vibrotactile feedback.

One embodiment of the invention is a method comprising the steps of receiving an input signal that comprises information associated with the manipulation of a surface of a touch-sensitive input device, and generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect comprising a virtual detent to the surface of the input device, with the vibrotactile effect configured to simulate mechanical feedback. ~~In another embodiment, a computer-~~

_____ In another embodiment, a computer-readable medium (such as, for example, random access memory or a computer disk) comprises code for carrying out such a method.

Another embodiment of the invention is a system comprising ~~an~~ touch-sensitive input device and a processor that is in communication with the touch-sensitive input device and that is configured to receive an input signal comprising information associated with the manipulation of the touch-sensitive input device. The processor may further be configured to generate a detent signal based at least in part on the manipulation of the input device. The system may further comprise an actuator coupled to the input device. The actuator may be in communication with the processor and configured to produce to the surface of the touch-sensitive input device a vibrotactile effect comprising a virtual detent based at least in part on the detent signal and configured to simulate mechanical feedback.

Further details of embodiments of the invention are set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the invention are better understood when the following Detailed Description is read with reference to the accompanying drawings, wherein:

Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention;

Figure 2 is a block diagram illustrating a second system for providing virtual detents through vibrotactile feedback in one embodiment of the invention;

Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention;

Figure 4 is an illustration of a second device for providing virtual detents through vibrotactile feedback in a comparative example~~one embodiment of the present invention~~;

Figure 5 is a flow diagram illustrating a first method for virtual detents through vibrotactile feedback;

Figure 6 is a flow diagram illustrating a second method for virtual detents through vibrotactile feedback;

Figure 7 is a flow diagram illustrating a third method for virtual detents through vibrotactile feedback;

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through vibrotactile feedback; and

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention provide methods and systems for virtual detents through vibrotactile feedback. In one illustrative embodiment, a ~~touch-sensitive surface~~ ~~rotary knob input device is rotated~~ manipulated. A sensor detects the ~~rotation manipulation~~ of the ~~rotary knob surface~~ and sends an input signal to a processor. The input signal comprises information related to the ~~rotation manipulation~~ of the ~~rotary knob surface~~, such as how far the knob has been turned. The processor determines whether to manipulate an audio system based at least in part on the input signal. The processor further determines whether to generate a signal configured to cause an actuator to vibrate the ~~rotary knob surface~~, the vibration based at least in part on the signal.

This example is given to introduce the reader to the general subject matter discussed. The invention is not limited to this example. Below, examples of methods and systems for virtual detents through vibrotactile feedback are described.

Illustrative Devices for Enhanced Haptic Feedback

In one illustrative embodiment of a device configured to provide virtual detents through vibrotactile feedback, a portable music player may be configured to play music through a speaker and produce a virtual detent on a touch pad with an actuator. In one such embodiment, the portable music player may comprise a touch pad configured to generate an input signal to a processor based on a user contact. The processor may analyze the input signal and determine whether to manipulate the audio system and whether to generate a vibrotactile effect. If the processor determines a vibrotactile effect should be generated, the processor may generate a signal. The signal may be configured to cause the actuator to produce a vibrotactile effect to the touch pad in the form of a virtual detent.

Such an illustrative embodiment may be advantageously employed to simulate mechanical detents through vibrotactile feedback. Such simulated mechanical detents, or virtual detents, may provide useful feedback to a user. For example, a virtual detent may indicate the successful change in volume of a sound system. As another example, the absence of a virtual detent may indicate that a climate system is not turned on, or that it has reached the highest threshold of operation.

These further examples are given to introduce the reader to the general subject matter discussed herein. The invention is not limited to these examples. The following sections describe various embodiments of systems and methods for providing virtual detents through vibrotactile feedback.

Example of a First System for Virtual Detents through Vibrotactile Feedback

Referring now to the figures in which like numerals indicate like elements throughout the several figures, Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention. In the
5 embodiment shown, the system comprises an input device 102, a sensor 104, a processor 106, an actuator 108, and a system to be manipulated 110.

The Input Device and Sensor

Systems of the invention comprise an input device 102 and a sensor 104. The input device 102 shown in Figure 1 is configured to provide an input signal to the processor when
10 the input device 102 is manipulated. In other embodiments, sensor 104 can generate an input signal when the sensor 104 detects manipulation of the input device 102.

In a comparative example (The input device 102 can be, for example, a mechanical input device. Examples of mechanical input devices include a rotary knob coupled to an encoder. Encoders of the input device 102 may comprise an optical encoder or a potentiometer.
15 In other embodiments according to the invention, the input device 102 may be a non-mechanical input device. For example, the input device 102 may be a touch-sensitive device, such as a touch pad or a touch screen.

The input device 102 is in communication with a sensor 104. The sensor detects movement of the input device 102. A sensor 104 can be configured to detect the movement
20 of a rotary knob, or other aspects of manipulation of the input device 102, such as position, velocity, acceleration, torque, rate of rotation, or the time of rotation.

Sensor 104 shown in Figure 1 comprises a contact-type sensor, such as a switch, a resistive sensor, a capacitive sensor, an infrared sensor, or an optical sensor. Alternatively, sensor 104 may comprise a non-contact sensor such as a field effect sensor or a proximity
25 sensor, and can be a surface or sub-surface sensor.

The Processor

The system illustrated in Figure 1 comprises a processor 106. The processor 106 may be configured to receive input signals from an input device 102 or a sensor 104 and to generate signals to an actuator 108. The signals may be configured to cause the actuator 108 to produce
30 a vibrotactile effect. Further, the processor can generate signals provided to a system to be manipulated 110.

In one embodiment, a dedicated processor 106 may receive input signals and generate signals. Although there is a single processor shown in Figure 1, the system may comprise a plurality of processors. The processor 106 may be configured to perform a variety of tasks.

device, and vibrates the input device at a periodic intensity when a temperature system is being controlled.

In one embodiment, a combination of vibrotactile effects is linked as a vibrotactile theme. A vibrotactile theme can correspond with an individual function or system. One theme can comprise a combination of single clicks and double clicks to represent simulated mechanical feedback for a system being changed or a threshold being reached. Another theme can comprise a combination of a constant, low intensity vibration with a hard stop virtual detent effect. While the first theme can be assigned to one system, such as a climate system the second theme can be assigned to a second system, such as a stereo system.

Figure 4 is an illustration of a ~~second~~ device for providing virtual detents through vibrotactile feedback in ~~a comparative example~~ one embodiment of the present invention. The device in Figure 4 comprises a mechanical device, specifically a rotary knob 400. While the comparative example ~~embodiment~~ shown in Figure 4 comprises a rotary knob 400, other embodiments may comprise other input devices. In some other comparative ~~example~~ embodiments, the input device may comprise a linear or rotary encoder, a potentiometer, or a fader. Alternatively, ~~other embodiments~~ according to the present invention may comprise non-mechanical input devices, such as a touch-sensitive pad or a touch-sensitive screen.

The rotary knob 400 is configured to rotate in a rotary degree of freedom about an axis extending through the knob. In some ~~embodiments~~ comparative examples, the rotary knob may also be configured to move in a plane perpendicular to or along the rotary axis. The rotary knob 400 is coupled to a mounting surface 402. The mounting surface may be a surface on a control panel, dashboard, car console, mouse, joystick, industrial equipment, medical equipment, or any consumer electronics device.

A user interacts with the rotary knob 400 by rotating the knob in a clockwise or counter-clockwise direction. One or more actuators 406 can be coupled to the rotary knob 400 to generate vibrotactile feedback. As the knob is rotated, vibrotactile feedback may be generated in the form of virtual detents. For example, as the knob is rotated, an effect such as a hard stop may be generated by vibrating the knob.

The rotary knob 400 can be coupled to a sensor 408. Sensor 408 can detect movements in the rotary knob 400, and transmit data to a processor 106. A shaft 404 may connect the actuator 406 and sensor 408 with the rotary knob 400.

As shown in Figure 4, a rotary knob 400 is a generally cylindrical object. Other devices for providing virtual detents may have various designs, including but not limited to conical shapes, spherical shapes, oval shapes, cubical shapes, etc. The rotary knob 400 may have one or more textures on its surface, including but not limited to bumps, lines, grooves,

other types of grips, or projections or members extending from the device's surface. Such shapes and textures may allow a user to easily grip or contact the knob and rotate it.

The rotary knob 400 may be configured to control a system. For example, the rotary knob 400 may be located on a stereo receiver, and configured to control the volume of the stereo. In one embodiment comparative example, the rotary knob 400 may control a plurality of systems, such as a car's temperature system, navigation system, and/or communication system. For example, a user can pull a knob to a first elevation in order to control the temperature system of the car. To control a different system, a user may push the knob down to a different elevation. In another embodiment comparative example, a user selects a system to be controlled via a menu system navigated by the rotary knob 400 or other controls.

Examples of Methods for Virtual Detents through Vibrotactile Feedback

Figure 5 is a flow diagram illustrating a first method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 502, the sensor generates an input signal based at least in part on a manipulation of an input device.

In step 502, the processor 106 receives an input signal comprising information associated with the manipulation of an input device 102. In step 504, the processor 106 generates a signal configured to cause an actuator to produce a vibrotactile effect to the input device 102, the vibrotactile effect comprising a simulated mechanical detent.

The processor 106 can receive and generate signals as digital signals or analog signals, via wireless or wired connections. The input signal can comprise information related to a manipulation of the input device 102. For instance, the information related to the manipulation of the input device may be positional data, for example, comprising information related to the change in position of the input device. In another example, the input signal may comprise information related to the speed of the change in position of the input device as well as the change in position of the input device. As a further example, the input signal comprises information related to the direction of a continuous user contact with a rotary touch pad along with the speed at which the rotary touch pad is contacted.

In step 504, a signal is generated by the processor. The signal can be configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, and based at least in part on the detent signal. The signal comprises information relating to a specific virtual detent to be generated by an actuator.

MAIN REQUEST

Claims:

1. A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of a surface of a touch-sensitive input device (306), and
 - 5 ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the surface of the touch-sensitive input device;

further comprising:

 - 10 iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles to generate a vibrotactile signal;
 - characterised in that said determination is based at least in part on the input signal (102, 202, 306, 400) and the vibrotactile effect is
 - 15 configured to simulate mechanical feedback.
2. The method of claim 1, **further comprising :-**
 - i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - 20 ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and generating (504, 604, 706) the vibrotactile signal.
3. The method of claim 2, **further comprising** determining whether to generate a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.
- 25 4. A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 3.
- 30 5. A system comprising:
 - i) a touch-sensitive input device (306);
 - ii) at least one actuator (108, 208, 406) coupled to the touch-sensitive input device

MAIN REQUEST

- iii) a processor (106, 206) in communication with the touch-sensitive input device and said at least one actuator and configured to:
- 5 a) receive (500) an input signal comprising information associated with a manipulation (802) of the touch-sensitive input device (102, 202, 400); and,
- b) generate (504, 604, 706) a vibrotactile signal configured to cause said actuator (108) to produce a vibrotactile effect (806) to a surface of the touch-sensitive input device and the vibrotactile effect is configured to simulate mechanical feedback;
- 10 **wherein;**
- iv) the processor (106, 206):
- a) comprises memory (216) configured to store virtual detent profiles, and
- 15 b) is configured to effect the method of any of claims 1 to 3.
6. The system of claim 5, **wherein** the processor (106, 206) is further configured to generate (706) a system signal to control a system (110, 210) based at least in part on a manipulation of the input device (102, 202, 306, 400).
- 20 7. The system of claim 5 or claim 6, **wherein** the at least one actuator (406) is coupled to a housing (302, 402) of the input device (306, 400).
8. The system of any of claims 5 to 7, **wherein** a sensor (104, 204, 408) is configured to detect manipulation of the input device (102, 202, 400) and generate the input signal.
- 25

MAIN REQUEST

Claims:

1. A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of a surface of a touch-sensitive input device (102, 202, 306, 400), and
 - 5 ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the surface of the touch-sensitive input device;
further comprising:
 - 10 iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles to generate a vibrotactile signal;
characterised in that said determination is based at least in part on the
input signal (102, 202, 306, 400) and the vibrotactile effect is
15 configured to simulate mechanical feedback.
2. The method of claim 1, **further comprising :-**
 - i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - 20 ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and generating (504, 604, 706) the vibrotactile signal.
3. The method of claim 2, **further comprising** determining whether to generate
25 a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.
4. ~~The method of any of claims 1 to 3, wherein the information associated with manipulation (802) of an input device (102, 202, 306, 400) comprises information associated with the rotation of a rotary knob (400), activation of a touch pad (3067) or the sliding of a fader.~~
30
5. A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 34.

MAIN REQUEST

56. A system comprising:

- i) ~~a~~ touch-sensitive input device (~~102, 202, 306, 400~~);
- ii) at least one actuator (108, 208, 406) coupled to the touch-sensitive input device
- iii) a processor (106, 206) in communication with the touch-sensitive input device and said at least one actuator and configured to:
 - a) receive (500) an input signal comprising information associated with a manipulation (802) of the touch-sensitive input device (~~102, 202, 400~~); and,
 - b) generate (504, 604, 706) a vibrotactile signal configured to cause said actuator (108) to produce a vibrotactile effect (806) to ~~the~~ a surface of the touch-sensitive input device and the vibrotactile effect is configured to simulate mechanical feedback;

wherein;

- iv) the processor (106, 206):
 - a) comprises memory (216) configured to store virtual detent profiles, and
 - b) is configured to effect the method of any of claims 1 to 34.

67. The system of claim 56, **wherein** the processor (106, 206) is further configured to generate (706) a system signal to control a system (110, 210) based at least in part on a manipulation of the input device (102, 202, 306, 400).

78. The system of claim 65 or claim 67, **wherein** the at least one actuator (406) is coupled to a housing (302, 402) of the input device (306, 400).

89. The system of any of claims 56 to 78, **wherein** a sensor (104, 204, 408) is configured to detect manipulation of the input device (102, 202, 400) and generate the input signal.



Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	8002823
Application number	EP07863260.1
Date of receipt	29 October 2019
Receiving Office	European Patent Office, The Hague
Your reference	FP-10-0597
Applicant	All applicants as on file
Documents submitted	package-data.xml epf1038.pdf (1 p.) DESC-1.pdf\Clean Description.pdf (19 p.) CLMS-1.pdf\Main Request - Clean.pdf (2 p.) ep-sfd-request.xml ORAL-1.pdf\Written Submissions.pdf (2 p.) DESC-HWA-1.pdf\Tracked Description.pdf (6 p.) CLMS-HWA-1.pdf\Main Request - Tracked.pdf (2 p.)
Submitted by	CN=Arthur Boff 24434
Method of submission	Online
Date and time receipt generated	29 October 2019, 15:58 (CET)
Message Digest	E3:9C:62:71:CE:95:CA:C4:F5:0A:AD:9A:CF:0A:58:72:9C:8A:AC:F2

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/

By Online Filing

European Patent Office
80298 Munich
Germany

Our reference: FP-10-0597

29th October 2019

Dear Sirs,

**Re: European Patent Application No. 07863260.1
In the Name of Immersion Corporation
“VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK”**

I write in response to the summons to oral proceedings on this case. Please find accompanying a set of amended claims submitted as a Main Request, in a clean version and a version with tracked changes. Please also find an amended description to bring the application into line with the amended claims. Support for the amendments will be found throughout the PCT application as-filed; in the as-published PCT particular support can be found at page 3 lines 14-22, page 4 lines 12-16, page 7 lines 31-33, and page 12 lines 7-10.

The overall effect of the amendment is to direct the patent specifically to the provision of virtual detents on touch-sensitive input devices, such as touchpads or touchscreens, setting aside the examples of mechanical controls such as rotary knobs. (Note that whilst a rotary knob is referenced in relation to the description of Figure 9A-H, these figures are illustrative examples of virtual detents, which are still used in the present invention, and in this context the “rotary knob” is to be understood as an exemplary analogy.)

This overcomes the objections of novelty and lack of inventive step in relation to D1 and D6. Both D1 and D6 relate to providing haptic effects to actual, physical rotary knobs, as opposed to touch-sensitive surfaces or virtual rotary knobs displayed on a touchscreen or the like; therefore the restriction that the input device is a touch-sensitive input device, user input is via the surface of the touch-sensitive device, and haptic feedback is provided to the touch-sensitive device confers on the independent claims novelty over the prior art.

In terms of inventive step, the present invention provides to a touch surface simulated mechanical feedback. This enables the use of the programmable virtual detents as described in the invention specifically, and more generally the simulation of mechanical feedback at a touch surface overcomes a major limitation of a touch surface – namely, that without directly watching an associated display, it can be difficult to know whether one’s touch input has actually been registered and extremely difficult to exert any sort of fine control over input.

With simulated mechanical feedback, this sort of fine input control becomes possible, even when a user is not directly looking at the control in question. Thus, the invention enables for touch-controlled devices the same sort of fine control that previously only physical input devices such as turnable knobs

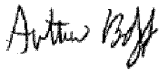
could provide. The skilled person beginning from common prior knowledge and the disclosure of D1 and D6 would be more likely to add a physical knob to a device to provide this type of control, since the skilled person at the priority date of the application would have the expectation that physical controls are more amenable to fine control than touch-based input devices are.

It is therefore requested that the Division cancel oral proceedings and issue notification of intent to grant on the present case on the basis of the main request.

However, in the event that the Division is not persuaded yet to issue the Rule 71(3) communication, but believes that the main request is close to being ready with only minor amendments, it is suggested that it would be procedurally more efficient and less costly for all parties if the oral proceedings were cancelled and prosecution continued in writing or via telephone conference (representative's office number is +44 20 7822 8883).

In the event that the Division is not persuaded to issue the Rule 71(3) communication or otherwise continue prosecution in writing or via telephone, the request for oral proceedings is maintained.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'Arthur Boff', written in a cursive style.

Phillips & Leigh LLP
Association no. 380
Signed Arthur Boff – European Patent Attorney

7. JUN. 2019 15:34



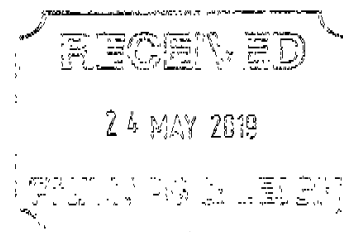
NO. 029 P. 1/1
European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?
Contact Customer Services at www.epo.org/contact



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME UNI

AB + Acc *



Date
21.05.2019

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1221 / 2126667
Applicant/Proprietor Immersion Corporation	

EPA/EPO/OEB Formblatt/Form/Formulaire : 2008, 2906, US6636197

Empfangsbescheinigung über den Zugang des vorstehend bezeichneten Schriftstücks
Acknowledgement of receipt of the document specified above
Récépissé du document spécifié ci-dessus

Unter Bezugnahme auf die Mitteilung im ABI EPA 7/2010, 377 wird gebeten, die Empfangsbescheinigung mit Empfangsdatum und Unterschrift zu versehen und **umgehend** an das EPA zurückzusenden:

* With reference to the Notice in OJ EPO 7/2010, 377, you are requested to date and sign the acknowledgement of receipt and return it to the EPO **immediately**: *

Conformément au communiqué paru au JO OEB 7/2010, 377, vous êtes prié d'indiquer sur le récépissé la date de réception du document, de signer le récépissé et de le renvoyer **sans délai** à l' OEB:

- über die Online-Dienste des EPA (als Anlage zu EPA Form 1038) / through EPO Online Services (as annex to EPO Form 1038) / par les services en ligne de l'OEB (en tant que pièce jointe au formulaire OEB 1038),
- per Fax / by fax / par téléfax (+49 (0) 89 2399-4465 or +31 (0) 70 340-3016)
- oder per Post / or by post / ou par courrier.

Empfangen am / Received on / Reçu le :

24/5/19

Unterschrift / Signature:

Phillips & Leigh

Empfangsberechtigter/authorised recipient/
le destinataire ou la personne dûment mandatée

Rücksende-Adresse / Return address / Adresse de retour
(Umschlag / envelope / enveloppe ISO C4 / DL / C6/C5 / C6)

DEUTSCHLAND
80298 MÜNCHEN
Europäisches Patentamt

Rücksende-Adresse / Return address / Adresse de retour

EPA/EPO/OEB Form 2936 08.10



European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME UNI

Date

21.05.2019

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1221 / 2126667
Applicant/Proprietor Immersion Corporation	

Summons to attend oral proceedings pursuant to Rule 115(1) EPC

You are hereby summoned to attend oral proceedings arranged in connection with the above-mentioned European patent application.

The matters to be discussed are set out in the communication accompanying this summons (EPO Form 2906).

The oral proceedings, which will not be public, will take place before the Examining Division

on 29.11.19 at 09.30 hrs at the EPO in Rijswijk.
Rijswijk New Main, Patentlaan 2, NL-2288 EE Rijswijk (ZH)

The actual room number and dedicated waiting area will be indicated to you at the reception desk, Patentlaan 2.

You are asked to report at the reception desk in good time before the starting time mentioned above.

No changes to the date of the oral proceedings can be made, except on serious grounds (see OJ EPO 2009, 68). If you do not appear as summoned, the oral proceedings may continue without you (R. 115(2) EPC, see also OJ EPO 2008, 471).

Your attention is drawn to Rule 4 EPC, regarding the language of the oral proceedings, and to Special edition No. 3 OJ EPO 2007, L.1, concerning the filing of authorisations for company employees and lawyers acting as representatives before the EPO.

The final date for making written submissions and/or amendments (R. 116 EPC) is 29.10.19.

Please note that the oral proceedings will always take place as scheduled unless you are otherwise informed. The EPO will generally not send a reminder or a further communication prior to the date of oral proceedings.

1st Examiner:
Baldan, Marco

2nd Examiner:
Ballerstein, Jens

Chairman:
Arranz, José

Date

Application No. 07863260.1

For the Examining Division



Annexes:

Confirmation of receipt (Form 2936)
Communication (EPO Form 2906)

US6636197



European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Phillips & Leigh LLP
Temple Chambers
3-7 Temple Avenue
London EC4Y 0DA
ROYAUME UNI

Date

21.05.2019

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1221 / 2126667
Applicant/Proprietor Immersion Corporation	

EPA/EPO/OEB Formblatt/Form/Formulaire : 2008, 2906, US6636197

Empfangsbescheinigung über den Zugang des vorstehend bezeichneten Schriftstücks
Acknowledgement of receipt of the document specified above
Récépissé du document spécifié ci-dessus

Unter Bezugnahme auf die Mitteilung im ABI EPA 7/2010, 377 wird gebeten, die Empfangsbescheinigung mit Empfangsdatum und Unterschrift zu versehen und **umgehend** an das EPA zurückzusenden:

With reference to the Notice in OJ EPO 7/2010, 377, you are requested to date and sign the acknowledgement of receipt and return it to the EPO **immediately**:

Conformément au communiqué paru au JO OEB 7/2010, 377, vous êtes prié d'indiquer sur le récépissé la date de réception du document, de signer le récépissé et de le renvoyer **sans délai** à l' OEB:

- **über die Online-Dienste des EPA** (als Anlage zu EPA Form 1038) / **through EPO Online Services** (as annex to EPO Form 1038) / **par les services en ligne de l'OEB** (en tant que pièce jointe au formulaire OEB 1038),
- **per Fax / by fax / par téléfax** (+49 (0) 89 2399-4465 or +31 (0) 70 340-3016)
- oder per Post / or by post / ou par courrier.

Empfangen am / Received on / Reçu le :

Unterschrift / Signature:

Empfangsberechtigter/authorised recipient/
le destinataire ou la personne dûment mandatée

Rücksende-Adresse / Return address / Adresse de retour
(Umschlag / envelope / enveloppe ISO C4 / DL / C6/C5 / C6)

DEUTSCHLAND
80298 MÜNCHEN
Europäisches Patentamt

Rücksende-Adresse / Return address / Adresse de retour

Datum
Date 21.05.2019
Date

Blatt
Sheet 1
Feuille

Anmelde-Nr:
Application No: 07 863 260.1
Demande n°:

The examination is being carried out on the **following application documents**

Description, Pages

1-19 as published

Claims, Numbers

1-9 filed in electronic form on 27-11-2017

Drawings, Sheets

1/10-10/10 as published

1.1 Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure.

- D1 US 2006/038781 A1 (LEVIN MICHAEL D [US]) 23 February 2006 (2006-02-23)
- D2 WO 97/25657 A1 (LEX COMPUTER & MANAGEMENT [US]) 17 July 1997 (1997-07-17)
- D3 US 6 128 006 A (ROSENBERG LOUIS B [US] ET AL) 3 October 2000 (2000-10-03)
- D4 US 2005/151720 A1 (CRUZ-HERNANDEZ JUAN M [CA] ET AL CRUZ-HERNANDEZ JUAN MANUEL [CA] ET AL) 14 July 2005 (2005-07-14)
- D5 US 6 686 911 B1 (LEVIN MICHAEL D [US] ET AL) 3 February 2004 (2004-02-03)

1.2 The following document is cited by the Examiner. A copy of the document is annexed to the communication and the numbering will be adhered to in the rest of the procedure.

Datum
Date 21.05.2019
Date

Blatt
Sheet 2
Feuille

Anmelde-Nr:
Application No: 07 863 260.1
Demande n°:

D6 US 6 636 197 B1 (GOLDENBERG ALEX S [US] ET AL) 21 October 2003
(2003-10-21)

2.1 The applicant has sent a letter dated 27.11.2017, referred to as L in the following, filing an amended set of claims and supporting argumentation in reply to a previous communication dated 25.08.2017.

2.2 The arguments presented by the applicant in L have been carefully considered. However, the examining division still considers that the present application does not meet the requirements of the EPC. In view of the current state of the proceedings, Oral Proceedings are considered appropriate to discuss the objections concerning the application.

3. The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claim 1 is not new within the meaning of Article 54(1) and (2) EPC.

3.1 Document D1 discloses (the references in parentheses applying to this document):

a method comprising:

i) receiving an input signal comprising information associated with a manipulation of an input device (paragraph 50: "*Various methods and devices utilizing the present invention may be employed. For instance, one method according to the present invention comprises receiving a sensor signal from a sensor in communication with a manipulandum, identifying an effect parameter associated with the sensor signal in a locally-stored haptic effect profile, and generating an output signal based, at least in part, on the effect*

parameter. The sensor may sense a movement of the manipulandum in communication therewith, and the sensor signal may indicate such a movement."), and

ii) generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect to the input device (paragraph 39: "For example, the processor 206 may create effects, such as detents, between or at the location settings (128) found around the circumference of the location control knob (112) described with reference to FIG. 1. The processor 206 may create additional effects as well, including, for example, bumps, vibrations and stops by applying output signals 216 comprising various currents to the actuator 204 shown in FIG. 2.");

further comprising:

iii) storing a plurality of stored virtual detent profiles (paragraphs 36, 37, 54, 26: "The haptic effect profile in the embodiment shown may be downloaded to the memory 208 by flashing it onto an EEPROM using a signal comprising a voltage commonly used to program, erase, and reprogram memory devices in a personal computer.", "An effect parameter may be configured to define a characteristic, such as a magnitude, a duty cycle, a period, a waveform, or a duration, of a haptic effect based, at least in part, on the effect parameter. The processor 206 may identify the effect parameter(s) associated with the sensor signal in the haptic effect profile on the memory 208.", "The locally-stored haptic effect profile may comprise a haptic effect profile or selectable plurality thereof stored in a non-volatile memory.", "The haptic effect profile associated with the location control knob 112 may comprise, for example, effect parameters from which a processor device may generate output signals configured to provide a detent effect when the indicator 116c points to one of the five location settings 128.");

iv) determining one of said plurality of stored virtual detent profiles to generate a vibrotactile signal (paragraph 50: "For instance, one method according to the present invention comprises receiving a sensor signal from a sensor in communication with a manipulandum, identifying an effect parameter associated with the sensor signal in a locally-stored haptic effect profile, and generating an output signal based, at least in part, on the effect parameter."); and,

v) wherein said determination is based at least in part on the input signal and/or on the status of the input device (paragraph 53: "For instance, a processor, such as the example processor (206) of FIG. 2, may determine from the sensor signal (214) whether the control knob (202) manipulandum has been

turned to its furthest extremity", "In one such embodiment, the effect parameter may be identified in relation to the determined state. In another such embodiment, the output signal may be generated in relation to the determined state.").

3.2 The applicant's argument submitted in L cannot be followed as discussed in the following.

3.3 The applicant states, correctly, that in document D1 the haptic profiles are not determined by the input signal, as in the solution proposed in claim 1, but are selected by the user, e.g. with a switch.

3.4 It is however to be noted that document D1 discloses haptic effects, associated with effect parameters. Such effect parameters correspond, technically and functionally, to the profiles of the present application, the only difference being the wording used to identify them. In fact, as stated in paragraph 37, an effect parameter is defined as "*An effect parameter may be configured to define a characteristic, such as a magnitude, a duty cycle, a period, a waveform, or a duration, of a haptic effect*", therefore all the features defining an haptic effect. It is also noted that the selection of the effect parameters is based on the input signal.

3.5 It is also noted that the profiles, as defined in document D1, are in fact sets of effect parameters which can be selected by the user.

The subject-matter of claim 1 is therefore not new (Article 54(1) and (2) EPC).

4. Furthermore, the present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claim 1 is not new within the meaning of Article 54(1) and (2) EPC.

4.1 Document D6 discloses (the references in parentheses applying to this document):

a method comprising:

i) receiving an input signal comprising information associated with a manipulation of an input device (column 7, lines 26-31: *"The sensor used for the knob has two primary purposes: to provide position and direction information (and, in some embodiments, velocity and/or acceleration information) to a local or host processor in order to create realistic haptic effects (for those effects that are position based)"*), and

ii) generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect to the input device (column 12, lines 1-2: *"The force process can command distinct force sensations, such as vibrations"*);

further comprising:

iii) storing a plurality of stored virtual detent profiles (column 13, lines 1-3; column 12, lines 62-63: *"Available force effects can include springs, dampers, textures, vibrations, detents, jolts or pulses, textures, inertia, friction, obstructions (barriers), or dynamic force effects."*, *"For example, the local memory may only be able to hold eight effects at once"*);

iv) determining one of said plurality of stored virtual detent profiles to generate a vibrotactile signal (column 12, lines 23-31: *"A preferred implementation for controlling force sensations utilizes a host controller, such as a host microprocessor, and a local processor, such as a microprocessor, as described above. The host microprocessor can implement the environment, application, and/or the device functions with which the user is interacting, such as a displayed interface menu, the operation of controlled functions, etc. The host microprocessor can send high-level commands to the local microprocessor to output a particular force effect."*); and,

v) wherein said determination is based at least in part on the input signal and/or on the status of the input device (column 13, lines 14-17: *"A basic force sensation is force detents that are output at particular predefined or regularly-spaced rotational positions of the knob to inform the user how much the knob has rotated and/or to designate a particular position of the knob."*).

4.2 It is noted that in document D6 the profiles are defined as force effects, consequently, the reasoning, discussed with regard to document D1 at § 3 above, can be applied, mutatis mutandis, also to document D6.

The subject-matter of claim 1 is therefore not new (Article 54(1) and (2) EPC).

5. The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 5 and 6, which therefore is also considered not new.

6. Dependent claims 2-4 and 7-9 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the EPC in respect of novelty and/or inventive step for the following reasons.

6.1 With regard to claims 2, 3, 7, 9: the features of these claims are typical of any input device used to control a system as is the case of document D1 which disclose input devices to control a HVAC system. Such features are disclosed by document D1 at paragraphs 15 to 20 as well as by the passages cited at § 3.1 above.

6.2 With regard to claim 4: the input devices listed in such claim are very well known in the field and, at least the knob, is also disclosed by documents D1 and D6.

6.3 With regard to claim 8: coupling a haptic actuator to the housing is also well known as well as disclosed by document D1 at paragraph 51.

7.1 It is not at present apparent which part of the application could serve as a basis for a new, allowable claim.

7.2 Furthermore, at least some of the objections raised above are such that there appears to be no possibility of overcoming them by amendment. Refusal of the application under Article 97(2) EPC is therefore to be expected.

7.3 Should the applicant wish to present argumentation or amendments for the division's consideration in the hope that the need for Oral Proceedings be obviated then this should be done prior to the date set in the Summons for Oral Proceedings (Rule 116(1) EPC). The applicant should at all times be aware that such amendments will be allowed into the procedure at the examining division's discretion (Rule 137(3) EPC).

7.4 When filing amended claims the applicant should at the same time bring the description into conformity with the amended claims. Care should be taken during revision, especially of the introductory portion and of any statements of problem or advantage, not to add subject-matter which extends beyond the content of the application as originally filed (Article 123(2) EPC).

7.5 In order to facilitate the examination of the conformity of the amended application with the requirements of Article 123(2) EPC, the applicant should clearly identify the amendments made, irrespective of whether they concern amendments by addition, replacement or deletion, and indicate the passages of the application as filed on which these amendments are based (see Guidelines E-II, 1).

7.6 Whilst the examining division is aware of the need for economy and the costs linked to the presence of parties at Oral Proceedings, as well as the costs borne by the EPO, it is their view that this is the most appropriate course of action in the present case. Should the applicant so wish, an appealable decision on the file as it stands may be requested. Such decision is given in standard form, referring to the previous communications including objections which must be made in writing (see Guidelines C-V-15 and E-IX-4.4). In the event of a timely request and issuance of such decision, the Oral Proceedings would no longer take place. The applicant should realize that filing further argumentation and/or amendments in response to the summons to Oral Proceedings may preclude the examining division from acceding to such a request.



European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Phillips & Leigh LLP
5 Pemberton Row
London EC4A 3BA
ROYAUME UNI

Date
02.05.18

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1221 / 2126667
Applicant/Proprietor Immersion Corporation	

Communication of amended entries concerning the representative (R. 143(1)(h) EPC)

As requested, for the above-mentioned European patent application / European patent the entries concerning the representative have been amended as follows:

Phillips & Leigh LLP
5 Pemberton Row
London EC4A 3BA
GB

The amendment will be recorded in the Register of European Patents.

For the Examining Division





**Deletion from the list of professional
representatives before the EPO**

Europäisches Patentamt
München

20. April 2018

Dir. 5.2.3

European Patent Office
Directorate 5.2.3 – Legal Division
80298 Munich
GERMANY

From (please indicate address)

Robert Dale Weston
6 The Drive Hellingly
Hailsham
East Sussex
BN27 4AF
United Kingdom

Tel. +447968950537

Fax

E-mail r.weston@sky.com

I. Request for deletion under Rule 154(1) EPC



I hereby request that my name be deleted from the list of professional representatives with effect from the date of receipt of the present request at the EPO or from the following subsequent date

Date



I understand that, in accordance with Article 134a(2) EPC, my membership of the Institute of Professional Representatives before the European Patent Office (epi) will also cease on that date. I am also aware that I can request re-entry on the list of professional representatives under Rule 154(3) EPC.



My details

Surname	First name	Representative No.	Date and signature
Weston	Robert	00037500	20 April 2018 <i>R. Weston</i>

II. Deletion under Rule 154(2)(a) EPC (death of professional representative)



I wish to inform the EPO of the death of the following professional representative

Surname	First name	Representative No.	Date of death



Evidence (e.g. copy of death certificate) is enclosed.



Details of person providing the information

Surname	First name	Representative No. (if applicable)	Date and signature



Relationship to deceased (e.g. spouse, relative, colleague)

III. Important note

If no new representative has been appointed in pending proceedings before the EPO, all communications from the EPO will be notified directly to the party concerned (applicant/proprietor/opponent/intervener).



Letter accompanying subsequently filed items

Representative:

PHILLIPS & LEIGH LLP
380
5 Pemberton Row
London EC4A 3BA
United Kingdom

Phone: +442078228888
Fax: +442078228899
E-mail: mail@pandl.com

80298 Munich
Germany
Tel. +49(0)89 2399-0 | Fax -4465

P.O. Box 5818
2280 HV Rijswijk
Netherlands
Tel. +31(0)70 340-2040 | Fax -3016

10958 Berlin
Germany
Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number

07863260.1

Applicant's or representative's reference

FP-10-0597

	Description of document	Original file name	Assigned file name
1	Reply to examination report	Letter to EPO.pdf	EXRE3-1.pdf
2	Amended claims (clean copy)	Clean claims.pdf	CLMS-1.pdf
3	Amended claims with annotations	Tracked claims.pdf	CLMS-HWA-1.pdf

	Payment	
1	Mode of payment	Not specified

Signatures

Place: London, GB
Date: 27 November 2017
Signed by: Arthur Boff 24434
Association: PHILLIPS & LEIGH LLP
Representative name: Arthur Boff
Capacity: (Representative)

FP-10-0597

By On-line Filing

European Patent Office
80298 Munich
Germany

Our Reference:
FP-10-0597

27th November 2017

Dear Sirs,

**Re: European Patent Application No. 07863260.1
In the Name of Immersion Corporation**

I write in response to the Article 94(3) response issued on this case on the 25th August 2017. Please find accompanying a set of claims in a clean version and in a version with tracked changes.

It will be noted that independent claim 1 has been amended to specify that the determination of which of the plurality of stored virtual detent profiles to use in generating a vibrotactile signal is based in part on the input signal. (The term “and/or on the status of the input device” has been removed.)

The cited paragraph 0053 of D1 states that the processor of the device described there “may determine from the sensor signal whether the control knob manipulandum has been turned to its furthest extremity”. However, this is in the context of outputting a haptic effect associated with an effect parameter, and has absolutely nothing to do with the selection of a virtual detent profile. The virtual detent profiles of the present invention are analogous to, and are a specific type of, the haptic effect profiles of D1. Whilst D1 discloses that there may be multiple selectable haptic effect profiles, it at no point discloses that this selection may be based on the input signal.

To emphasise this, I note that there are several parts of D1 where it does disclose how a haptic effect profile is to be selected. For instance, in D1 paragraph 0021 it specifies that the haptic effect profile can be selected via a selector switch (as described further in paragraph 46). In other embodiments described therein the selector may (as per D1 paragraph 0060) comprise a piece of solder soldered between electrical contact points on a circuit board, so as to permanently select a particular haptic effect profile. At no point does D1 discuss selection of the haptic effect profile being based on the input signal.

The independent claims as amended are therefore novel over D1. For reasons outlined in the previous letter of 17th June 2013 the independent claims are also inventive, since D2 and D3 do not disclose selection of a profile being based on an input signal.

In the event that the examiner believes that the provided amendments place the application in a suitable state for grant, I request issuance of the Rule 71(3) communication on this case. In the event that the examiner believes that minor amendments are still required, I ask that the examiner telephone

Continuation / 2

Our ref: **FP-10-0597**

me via (+44) 20 7822 8888 in order to discuss the case. In the event that the examiner believes that any such minor amendments would be better handled in writing, or that there remains significant issues with the case, I request that examination continue in writing. In the event that the examiner intends to issue a rejection on the case, I request oral proceedings.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'Arthur Boff', written in a cursive style.

Phillips & Leigh LLP
Association of Representatives no. 380
Signed Dr. Arthur Boff

Claims:

1. A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of an input device (102, 202, 306, 400), and
 - 5 ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the input device;
further comprising:
 - iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles
10 to generate a vibrotactile signal;
characterised in that said determination is based at least in part on the input signal (102, 202, 306, 400).
2. The method of claim 1, **further comprising :-**
 - 15 i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and generating (504, 604, 706) the vibrotactile signal.
20
3. The method of claim 2, **further comprising** determining whether to generate a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.
- 25 4. The method of any of claims 1 to 3, **wherein** the information associated with manipulation (802) of an input device (102, 202, 306, 400) comprises information associated with the rotation of a rotary knob (400), activation of a touch-pad (3067) or the sliding of a fader.
- 30 5. A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 4.
6. A system comprising:
 - i) an input device (102, 202, 306, 400);

- ii) at least one actuator (108, 208, 406) coupled to the input device
 - iii) a processor (106, 206) in communication with the input device and said at least one actuator and configured to:
 - a) receive (500) an input signal comprising information associated with a manipulation (802) of the input device (102, 202, 400); and,
 - b) generate (504, 604, 706) a vibrotactile signal configured to cause said actuator (108) to produce a vibrotactile effect (806) to the input device;
- 10 **wherein;**
- iv) the processor (106, 206):
 - a) comprises memory (216) configured to store virtual detent profiles, and
 - b) is configured to effect the method of any of claims 1 to 4.
- 15
7. The system of claim 6, **wherein** the processor (106, 206) is further configured to generate (706) a system signal to control a system (110, 210) based at least in part on a manipulation of the input device (102, 202, 306, 400).
- 20 8. The system of claim 6 or claim 7, **wherein** the at least one actuator (406) is coupled to a housing (302, 402) of the input device (306, 400).
9. The system of any of claims 6 to 8, **wherein** a sensor (104, 204, 408) is configured to detect manipulation of the input device (102, 202, 400) and generate the input signal.
- 25

Claims:

1. A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of an input device (102, 202, 306, 400), and
 - 5 ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the input device;
further comprising:
 - iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles
10 to generate a vibrotactile signal;
characterised in that said determination is based and,
~~v) basing said determination at least in part on the input signal and/or on the status of the input device (102, 202, 306, 400).~~
- 15 2. The method of claim 1, **further comprising :-**
 - i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and
20 generating (504, 604, 706) the vibrotactile signal.
3. The method of claim 2, **further comprising** determining whether to generate a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.
25
4. The method of any of claims 1 to 3, **wherein** the information associated with manipulation (802) of an input device (102, 202, 306, 400) comprises information associated with the rotation of a rotary knob (400), activation of a touch-pad (3067) or the sliding of a fader.
30
5. A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 4.
6. A system comprising:

- i) an input device (102, 202, 306, 400);
 - ii) at least one actuator (108, 208, 406) coupled to the input device
 - iii) a processor (106, 206) in communication with the input device and
said at least one actuator and configured to:
 - 5 a) receive (500) an input signal comprising information associated
with a manipulation (802) of the input device (102, 202, 400);
and,
 - b) generate (504, 604, 706) a vibrotactile signal configured to
cause said actuator (108) to produce a vibrotactile effect (806)
10 to the input device;
- wherein;**
- iv) the processor (106, 206):
 - a) comprises memory (216) configured to store virtual detent
profiles, and
 - 15 b) is configured to effect the method of any of claims 1 to 4.
7. The system of claim 6, **wherein** the processor (106, 206) is further configured
to generate (706) a system signal to control a system (110, 210) based at least
in part on a manipulation of the input device (102, 202, 306, 400).
- 20
8. The system of claim 6 or claim 7, **wherein** the at least one actuator (406) is
coupled to a housing (302, 402) of the input device (306, 400).
9. The system of any of claims 6 to 8, **wherein** a sensor (104, 204, 408) is
25 configured to detect manipulation of the input device (102, 202, 400) and
generate the input signal.



Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	5821880	
Application number	EP07863260.1	
Date of receipt	27 November 2017	
Receiving Office	European Patent Office, The Hague	
Your reference	FP-10-0597	
Applicant	All applicants as on file	
Documents submitted	package-data.xml epf1038.pdf (1 p.) CLMS-1.pdf\Clean claims.pdf (2 p.)	ep-sfd-request.xml EXRE3-1.pdf\Letter to EPO.pdf (2 p.) CLMS-HWA-1.pdf\Tracked claims.pdf (2 p.)
Submitted by	CN=Arthur Boff 24434	
Method of submission	Online	
Date and time receipt generated	27 November 2017, 12:27 (CET)	
Message Digest	9E:F9:B2:20:1E:40:77:D4:C7:50:D2:C7:61:29:57:93:A2:BB:94:5E	

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/



European Patent Office
Postbus 5818
2280 HV Rijswijk
NETHERLANDS
Tel: +31 70 340 2040
Fax: +31 70 340 3016



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
ROYAUME-UNI

Formalities Officer
Name: Van Rijssel, Debbie
Tel: +31 70 340 - 4719
or call
+31 (0)70 340 45 00

Substantive Examiner
Name: Baldan, Marco
Tel: +31 70 340 - 2809

Application No. 07 863 260.1 - 1879	Ref. FP-10-0597	Date 25.08.2017
Applicant Immersion Corporation		

Communication pursuant to Article 94(3) EPC

The examination of the above-identified application has revealed that it does not meet the requirements of the European Patent Convention for the reasons enclosed herewith. If the deficiencies indicated are not rectified the application may be refused pursuant to Article 97(2) EPC.

You are invited to file your observations and insofar as the deficiencies are such as to be rectifiable, to correct the indicated deficiencies within a period

of 4 months

from the notification of this communication, this period being computed in accordance with Rules 126(2) and 131(2) and (4) EPC. One set of amendments to the description, claims and drawings is to be filed within the said period on separate sheets (R. 50(1) EPC).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

In case you withdraw the application within the above-mentioned period, the examination fee will be refunded at a rate of 50% (Art. 11 (b) RFees).

Failure to comply with this invitation in due time will result in the application being deemed to be withdrawn (Art. 94(4) EPC).



Baldan, Marco
Primary Examiner
For the Examining Division

Enclosure(s): 4 page/s reasons (Form 2906)

Datum
Date 25.08.2017
Date

Blatt
Sheet 1
Feuille

Anmelde-Nr:
Application No: 07 863 260.1
Demande n°:

The examination is being carried out on the **following application documents**

Description, Pages

1-19 as published

Claims, Numbers

1-9 filed in electronic form on 14-09-2009

Drawings, Sheets

1/10-10/10 as published

1. Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure.

- D1 US 2006/038781 A1 (LEVIN MICHAEL D [US]) 23 February 2006 (2006-02-23)
- D2 WO 97/25657 A1 (LEX COMPUTER & MANAGEMENT [US]) 17 July 1997 (1997-07-17)
- D3 US 6 128 006 A (ROSENBERG LOUIS B [US] ET AL) 3 October 2000 (2000-10-03)
- D4 US 2005/151720 A1 (CRUZ-HERNANDEZ JUAN M [CA] ET AL CRUZ-HERNANDEZ JUAN MANUEL [CA] ET AL) 14 July 2005 (2005-07-14)
- D5 US 6 686 911 B1 (LEVIN MICHAEL D [US] ET AL) 3 February 2004 (2004-02-03)

To meet the requirements of Rule 42(1)(b) EPC, the document D1 should be identified in the description and its relevant contents should be indicated.

2. The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claim 1 is not new within the meaning of Article 54(1) and (2) EPC.

2.1 Document D1 discloses (the references in parentheses applying to this document):

a method comprising:

i) receiving an input signal comprising information associated with a manipulation of an input device (paragraph 50: "*Various methods and devices utilizing the present invention may be employed. For instance, one method according to the present invention comprises receiving a sensor signal from a sensor in communication with a manipulandum, identifying an effect parameter associated with the sensor signal in a locally-stored haptic effect profile, and generating an output signal based, at least in part, on the effect parameter. The sensor may sense a movement of the manipulandum in communication therewith, and the sensor signal may indicate such a movement.*"), and

ii) generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect to the input device (paragraph 39: "*For example, the processor 206 may create effects, such as detents, between or at the location settings (128) found around the circumference of the location control knob (112) described with reference to FIG. 1. The processor 206 may create additional effects as well, including, for example, bumps, vibrations and stops by applying output signals 216 comprising various currents to the actuator 204 shown in FIG. 2.*");

further comprising:

iii) storing a plurality of stored virtual detent profiles (paragraphs 36, 37, 54, 26: "*The haptic effect profile in the embodiment shown may be downloaded to the memory 208 by flashing it onto an EEPROM using a signal comprising a voltage commonly used to program, erase, and reprogram memory devices in a personal computer.*", "*An effect parameter may be configured to define a characteristic, such as a magnitude, a duty cycle, a period, a waveform, or a duration, of a haptic effect based, at least in part, on the effect parameter. The processor 206 may identify the effect parameter(s) associated with the sensor signal in the haptic effect profile on the memory 208.*", "*The locally-stored haptic effect profile may comprise a haptic effect profile or selectable*

plurality thereof stored in a non-volatile memory.", "The haptic effect profile associated with the location control knob 112 may comprise, for example, effect parameters from which a processor device may generate output signals configured to provide a detent effect when the indicator 116c points to one of the five location settings 128.");

iv) determining one of said plurality of stored virtual detent profiles to generate a vibrotactile signal (paragraph 50: *"For instance, one method according to the present invention comprises receiving a sensor signal from a sensor in communication with a manipulandum, identifying an effect parameter associated with the sensor signal in a locally-stored haptic effect profile, and generating an output signal based, at least in part, on the effect parameter."*); and,

v) basing said determination at least in part on the input signal and/or on the status of the input device (paragraph 53: *"For instance, a processor, such as the example processor (206) of FIG. 2, may determine from the sensor signal (214) whether the control knob (202) manipulandum has been turned to its furthest extremity", "In one such embodiment, the effect parameter may be identified in relation to the determined state. In another such embodiment, the output signal may be generated in relation to the determined state."*).

The subject-matter of claim 1 is therefore not new (Article 54(1) and (2) EPC).

2.2 The applicant's argument submitted in the letter dated 17.06.2013 cannot be followed. It appears that the term "haptic profile" is interpreted differently according to whether it is used in the prior art documents or in the present application, however, being such term quite broad the closest prior art has been considered as disclosing all the features of claim 1.

3. The same reasoning applies, *mutatis mutandis*, to the subject-matter of the corresponding independent claims 5 and 6, which therefore is also considered not new.

4. It is to be noted that claim 1 also lack inventive step, Article 56 EPC, in view of, e.g. documents D2 or D3, since such documents disclose all the features of such claim with the only difference that the feedback effect is not vibrotactile.

5. Dependent claims 2-4 and 7-9 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the EPC in respect of novelty and/or inventive step for the following reasons:

- with regard to claims 2, 3, 7, 9: the features of such claims are also disclosed by document D1, see the passages cited at § 2.1 above,
- with regard to claim 4: the input devices listed in such claim are very well known in the field and, at least the knob, is also disclosed by document D1,
- with regard to claim 8: such feature is also disclosed by document D1 at paragraph 51.

6.1 When filing amended claims the applicant should at the same time bring the description into conformity with the amended claims. Care should be taken during revision, especially of the introductory portion and of any statements of problem or advantage, not to add subject-matter which extends beyond the content of the application as originally filed (Article 123(2) EPC).

6.2 In order to facilitate the examination of the conformity of the amended application with the requirements of Article 123(2) EPC, the applicant should clearly identify the amendments made, irrespective of whether they concern amendments by addition, replacement or deletion, and indicate the passages of the application as filed on which these amendments are based (see Guidelines E-II, 1).



Application No.: 07863260.1

Substantive examination has started on 18.08.17 (see Notice from the European Patent Office dated 29.01.2013, OJ EPO 2013, 153).

For the Examining Division



European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
ROYAUME UNI

Date
26.04.17

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1879 / 2126667
Applicant/Proprietor Immersion Corporation	

Expected start of examination

Please be informed that according to current work planning, substantive examination of the above-mentioned application is expected to begin on or after 26.06.17

If the European patent application is withdrawn, refused or deemed to be withdrawn before substantive examination has begun, the examination fee is refunded at a rate of 100% (Article 11(a) RFees as amended with effect from 1 July 2016).

For the Examining Division





European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?

Contact Customer Services at www.epo.org/contact



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
ROYAUME UNI

Date

21.08.15

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1959 / 2126667
Applicant/Proprietor Immersion Corporation	

C o m m u n i c a t i o n

concerning the registration of amendments relating to

- ☐ a transfer (R. 22 and 85 EPC)
- ☒ entries pertaining to the applicant / the proprietor (R. 143(1)(f) EPC)

As requested, the entries pertaining to the applicant of the above-mentioned European patent application / to the proprietor of the above-mentioned European patent have been amended to the following:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC
MT NL PL PT RO SE SI SK TR
Immersion Corporation
50 Rio Robles
San Jose CA 95134/US

The registration of the changes has taken effect on 07.07.15.

In the case of a published application / a patent, the change will be recorded in the Register of European Patents and published in the European Patent Bulletin (Section I.12 / II.12).

Your attention is drawn to the fact that, in the case of the registration of a transfer, any automatic debit order only ceases to be effective from the date of its express revocation (cf. point 14(c) of the Arrangements for the automatic debiting procedure, supplementary publication 3 - OJ EPO 2015).

Receiving Section / For the Examining Division / For the Opposition Division / For the Legal Division *)



*) See note.

Note

This communication is issued by/for the department with whom responsibility lies. The Legal Division is responsible for the registration of transfers, changes of name (Articles 71, 72 and 74 EPC and Rules 22 and 85 EPC) as well as for the rectification of the designation of the inventor (Rule 21 EPC) (see Decision of the President of the EPO, OJ EPO 2013, 600). In all other cases, the Receiving Section, the Examining Division or the Opposition Division is responsible, depending on the stage in proceedings.



Letter accompanying subsequently filed items

Representative:

PHILLIPS & LEIGH
380
5 Pemberton Row
London EC4A 3BA
United Kingdom

Phone: +442078228888
Fax: +442078228899
E-mail: mail@pandl.com

80298 Munich
Germany
Tel. +49(0)89 2399-0 | Fax -4465

P.O. Box 5818
NL-2280 HV Rijswijk
Netherlands
Tel. +31(0)70 340-2040 | Fax -3016

10958 Berlin
Germany
Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number

02748179.5

Applicant's or representative's reference

M5945

	Description of document	Original file name	Assigned file name
1	Document concerning the applicant	Declaration--Immersion Address Change.pdf	APPRMISC-1.pdf
2	Request for change of address	Letter To EPO - Changing of Address 070715.pdf	APPRCHOA-1.pdf

Signatures

Place: **London, England**
Date: **07 July 2015**
Signed by: **Martin Hammler 6638**
Association: **PHILLIPS & LEIGH**
Representative name: **Martin Hammler**
Capacity: **(Representative)**

M5945

DECLARATION OF CHANGE OF ADDRESS

To whom it may concern:

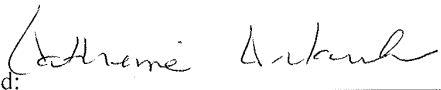
1. I, Catherine C. Maresh am Senior IP Counsel of Immersion Corporation ("Immersion") and am authorized to make this Declaration on Immersion's behalf.

2. Immersion is a corporation organized and existing under the laws of the State of Delaware, U.S.A. and currently has its headquarters situated at the address:

50 Rio Robles
San Jose
CA 95134
/ US

3. Immersion has previously had its headquarters at 2158 Paragon Drive, San Jose, CA 95131 / US, which was changed to 801 Fox Lane, San Jose, CA 95131 / US, which was changed to 30 Rio Robles, San Jose, CA 95134 / US, which on May, 18, 2015 was changed to the current address recited in paragraph 2 above.

4. I believe that the facts and matters contained in this Declaration of change of address are true.

Signed:  (Signature)

Catherine C. Maresh

Date: June 9, 2015

By EPOline

European Patent Office
80298 Munich
Germany

Our Ref.: M5945 MH

7th July 2015

Dear Sirs,

**Re: Change of Address – Bulk Request
In The Name Of Immersion Corporation
Our ref: M5945**

I write to inform you that the above applicant for numerous European patent applications, Immersion Corporation, has moved from the address detailed below:

30 Rio Robles
San Jose
CA 95134
U.S.A.

To a new address, as detailed below:

**50 Rio Robles
San Jose
CA 95134
U.S.A.**

(having also had previous addresses at 801 Fox Lane, San Jose, CA 95131, US and 2158 Paragon Drive, San Jose, CA 95131, US).

I request that the new address be recorded in the European Patent Register against the following applications: -

02748179.5	08838626.3	11156535.4	10776006.8	13178283.1	14180576.2	15166146.9
05852722.7	08744547.4	09792834.5	10779869.6	13192388.0	14183976.1	13780438.1
06837613.6	98957367.0	10736451.5	10787610.4	13192385.6	14183978.7	15169837.0
07755062.2	09723637.6	10712202.0	12166891.7	14158123.1	14183980.3	15169840.4
07838222.3	10179675.3	10712199.8	11705334.8	14158395.5	14183981.1	
07863260.1	10181422.6	10715618.4	11718590.0	14160148.4	14183983.7	
05026072.8	10181405.1	10712198.0	11710085.9	14160149.2	14184000.9	
05023800.5	09790410.6	10712201.2	12191217.4	14159278.2	14196166.4	
99930559.2	09790414.8	10712200.4	12192688.5	14159603.1	14200436.5	
99971568.3	09790403.1	11193424.6	13168126.4	14164621.6	14200449.8	
08169812.8	09790406.4	10760482.9	14151307.7	14166094.4	15151346.2	
07853900.4	09790404.9	10771231.7	14151328.3	14174979.6	15158365.5	

Continuation / 2

Our ref: M5945

Please find enclosed herewith a Declaration of Change of Address as evidence of the new address.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'M Hammler'.

Martin Hammler
Phillips & Leigh
Association of Professional Representatives no. 380

Enc. Declaration of Change of Address



Letter accompanying subsequently filed items

Representative:

PHILLIPS & LEIGH
380
5 Pemberton Row
London EC4A 3BA
United Kingdom

Phone: +4420 7822 8888
Fax: +4420 7822 8899
E-mail: mail@pandl.com

80298 Munich
Germany
Tel. +49(0)89 2399-0 | Fax -4465

P.O. Box 5818
NL-2280 HV Rijswijk
Netherlands
Tel. +31(0)70 340-2040 | Fax -3016

10958 Berlin
Germany
Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number

07863260.1

Applicant's or representative's reference

FP-10-0597

	Description of document	Original file name	Assigned file name
1	Maintenance of the application	covering letter for june 2013 submission.pdf	MEPA-1.pdf

Signatures

Place: London, England
Date: 18 June 2013
Signed by: GB, Phillips & Leigh, M. Hammler 6638
Association: PHILLIPS & LEIGH
Capacity: (Representative)

FP-10-0597



Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	2177608	
Application number	EP07863260.1	
Date of receipt	18 June 2013	
Receiving Office	European Patent Office, The Hague	
Your reference	FP-10-0597	
Applicant	All applicants as on file	
Documents submitted	package-data.xml epf1038.pdf (1 p.)	ep-sfd-request.xml MEPA-1.pdf\covering letter for june 2013 submission.pdf (2 p.)
Submitted by	CN=M. Hammler 6638,O=Phillips & Leigh,C=GB	
Method of submission	Online	
Date and time receipt generated	18 June 2013, 13:40 (CEST)	
Message Digest	BA:65:D5:53:31:0D:F1:8F:8B:15:7C:59:A2:36:7A:0C:6A:46:5E:D0	

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/

By Online Filing

European Patent Office
80298 Munich
Germany

Our reference: FP-10-0597

17th June 2013

Dear Sirs,

Re: EP application no. EP07863260.1 in the name of Immersion Corporation

We write in response to the Rule 70(2) and 70a(2) communication issued on the above case on the 18th of December 2012.

We hereby indicate that we wish to proceed with the European patent application in question.

Our response to the search report's objections are as follows. We disagree that document D1 discloses the subject matter of claim 1. In particular, we disagree with the suggestion that D1 discloses a plurality of stored virtual detent profiles from which a determination is made based on an input signal as to which detent profile to utilise in generating a vibrotactile signal. Paragraph 0053 relates to a determination based on an input signal, but it does not relate to a determination of a particular virtual detent profile from a stored plurality of said profiles; it relates, rather, to the determination of a particular "effect parameter" which determines which haptic effect should be output. As mentioned in paragraph 0036, the "haptic effect profile" of D1 comprises a plurality of effect parameters. In this case the "haptic effect profile" of D1 is a single virtual detent, and the "effect parameters" select a vibrotactile output mandated by a particular virtual detent. In other words, D1 does not disclose an input signal determining which of a plurality of virtual detents are utilised, but merely applies an input signal to a preselected haptic effect profile and derives a vibrotactile output from it.

Likewise, D2 discloses a device with multiple "torque profiles", but in D2 the determination of which profile to use is not based on the input signal but is either determined by an application or manually selected by a user (page 14 lines 5-9). D2 does not discuss a "torque profile" or virtual detent which is *selected* based on an input signal, it merely discloses applying an input signal to a preselected torque profile or virtual detent.

Similarly, US6128006 mentions programmable detents but does not specify that the detent profile can be selected based on the input signal.

Consequently, the novelty objection in the supplementary search report is not correct since it does not cite any art in which the specific virtual detent profile to be used is determined at least in part by an input signal; in the examples shown the input signal is merely used to select an output effect from a preselected virtual detent profile.

The technical effect of selecting a virtual detent profile based on the input signal is that it allows a different range of virtual detents to be used depending on how a user manipulates the input device.

Phillips & Leigh is a partnership, under the laws of England and Wales, of
James Charles Boff, Martin Franz Hammler, Clare Alison Cornell and Nashim Imam
Phillips & Leigh is regulated in the United Kingdom by the Intellectual Property Regulation Board

5 Pemberton Row London EC4A 3BA Tel +44 (0)20 7822 8888 Fax +44 (0)20 7822 8899 mail@pandl.com

A list of partners is available at www.pandl.com

See, for instance, the example given on page 15 lines 1-6 of the PCT application. In the prior art systems manipulating a device quickly – for instance, by rapidly turning a dial from its lowest level to its highest level – would simply result in the haptic effects called for by the preselected virtual detent profiles to play in rapid succession, whereas in the system of the present invention the selection of an appropriate virtual detent profile allows the device to provide controls which respond much more realistically to the user's manipulations. The technical effect is to increase the verisimilitude of the electronic controls in question compared with the mechanical controls they are based on. Based on the prior art, the skilled person would be more likely to simply research better individual virtual detent profiles rather than having the inventive leap of allowing for the virtual detent profile utilised to be determined in part by the input signal. Consequently, claim 1 and dependent claims have inventive step.

In the event that the examiner does not choose to proceed to grant at this stage we request further opportunity to discuss the case, preferably in writing or via telephone conference with the examiner. We reserve the right to request oral proceedings in the event of refusal.

Yours faithfully,

Phillips & Leigh
Association No. 380



European Patent Office
Postbus 5818
2280 HV RIJSWIJK
NETHERLANDS
Tel. +31 (0)70 340-2040
Fax +31 (0)70 340-3016



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
ROYAUME UNI

**For any questions about
this communication:**

Tel.: +31 (0)70 340 45 00

Date
18.12.12

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1245 / 2126667 PCT/US2007026355
Applicant/Proprietor Immersion Corporation	

Communication pursuant to Rules 70(2) and 70a(2) EPC

A supplementary European search report has been drawn up concerning the above-identified European patent application (publication number: 2126667).

Since the request for examination has been filed (R. 70(1), 159(1)(f), Art. 94(1) EPC) prior to the transmission of the supplementary European search report, you are hereby invited to indicate within

six months

of notification of this communication whether you wish to proceed further with the European patent application.

If you do not indicate in due time that you wish to proceed further with the European patent application, it **will be deemed to be withdrawn** (R. 70(3) EPC).

You are invited, within the above-mentioned six-month period, to comment on the objections raised in the opinion accompanying the European search report and/or to file any amendments to the description, claims and drawings correcting any deficiencies noted in the opinion (R. 70a(2), R. 137(2) EPC; Guidelines for Examination in the EPO, B-XI, 8).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

Should the reply to the invitation pursuant to Rule 70a(2) EPC be filed in an admissible non-EPO language, a translation is to be submitted within one month of its filing (R. 6(2) EPC).

Should you not comply with this invitation within the time limit, the application **will be deemed to be withdrawn** in accordance with Rule 70a(3) EPC.

Receiving Section



Registered letter

EPO Form 1224 11.12 (RTB/ESOP01=N) DMEX



European Patent Office
Postbus 5818
2280 HV RIJSWIJK
NETHERLANDS
Tel. +31 (0)70 340-2040
Fax +31 (0)70 340-3016



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
ROYAUME UNI

**For any questions about
this communication:**

Tel.: +31 (0)70 340 45 00

Date
29.11.12

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1245 / 2126667 PCT/US2007026355
Applicant/Proprietor Immersion Corporation	

Communication

The extended European search report is enclosed.

The extended European search report includes, pursuant to Rule 62 EPC, the supplementary European search report (Art. 153(7) EPC) and the European search opinion.

Copies of documents cited in the European search report are attached.

☒ 0 additional set(s) of copies of such documents is (are) enclosed as well.

Refund of the search fee

If applicable under Article 9 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.

Should you wish to further prosecute this application in the examination phase, your attention is drawn to the provisions of Rule 70a EPC. An invitation to respond to the extended European search report will be issued shortly (R. 70(2) EPC).



**SUPPLEMENTARY
EUROPEAN SEARCH REPORT**

Application Number
EP 07 86 3260

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2006/038781 A1 (LEVIN MICHAEL D [US]) 23 February 2006 (2006-02-23) * paragraph [0002] - paragraph [0003] * * paragraph [0012] - paragraph [0071] * * figures 1-4 *	1-9	INV. G06F3/01
X	WO 97/25657 A1 (LEX COMPUTER & MANAGEMENT [US]) 17 July 1997 (1997-07-17) * page 11, line 2 - page 32, line 3 * * figures 2-13d *	1-9	
X	US 6 128 006 A (ROSENBERG LOUIS B [US] ET AL) 3 October 2000 (2000-10-03) * column 4, line 17 - column 22, line 61 * * figures 1-9 *	1-9	
X	US 2005/151720 A1 (CRUZ-HERNANDEZ JUAN M [CA] ET AL CRUZ-HERNANDEZ JUAN MANUEL [CA] ET AL) 14 July 2005 (2005-07-14) * paragraph [0022] - paragraph [0047] * * figures 1-8 *	1-9	
X	US 6 686 911 B1 (LEVIN MICHAEL D [US] ET AL) 3 February 2004 (2004-02-03) * column 4, line 7 - column 23, line 35 * * figures 1-8 *	1-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			G06F
The supplementary search report has been based on the last set of claims valid and available at the start of the search.			
Place of search The Hague		Date of completion of the search 22 November 2012	Examiner Baldan, Marco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.82 (P04C04)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 86 3260

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-11-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006038781 A1	23-02-2006	NONE	
WO 9725657 A1	17-07-1997	AU 1567697 A	01-08-1997
		CA 2242840 A1	17-07-1997
		DE 69635380 D1	08-12-2005
		EP 0876639 A1	11-11-1998
		EP 1628176 A2	22-02-2006
		JP 4023824 B2	19-12-2007
		JP 4870205 B2	08-02-2012
		JP 4997339 B2	08-08-2012
		JP 2000503153 A	14-03-2000
		JP 2007323666 A	13-12-2007
		JP 2010108513 A	13-05-2010
		JP 2011216116 A	27-10-2011
		US 5889670 A	30-03-1999
		US 5889672 A	30-03-1999
		US 6195592 B1	27-02-2001
		US 6876891 B1	05-04-2005
		US 2002072814 A1	13-06-2002
		WO 9725657 A1	17-07-1997
US 6128006 A	03-10-2000	AT 482446 T	15-10-2010
		EP 2246770 A2	03-11-2010
		US 6128006 A	03-10-2000
US 2005151720 A1	14-07-2005	US 2005151720 A1	14-07-2005
		US 2008055244 A1	06-03-2008
		US 2008073131 A1	27-03-2008
US 6686911 B1	03-02-2004	US 6686911 B1	03-02-2004
		US 2004100440 A1	27-05-2004

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

The examination is being carried out on the **following application documents**

Description, Pages

1-19 as published

Claims, Numbers

1-9 filed in electronic form on 14-09-2009

Drawings, Sheets

1/10-10/10 as published

1. Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure.

- D1 US 2006/038781 A1 (LEVIN MICHAEL D [US]) 23 February 2006 (2006-02-23)
- D2 WO 97/25657 A1 (LEX COMPUTER & MANAGEMENT [US]) 17 July 1997 (1997-07-17)
- D3 US 6 128 006 A (ROSENBERG LOUIS B [US] ET AL) 3 October 2000 (2000-10-03)
- D4 US 2005/151720 A1 (CRUZ-HERNANDEZ JUAN M [CA] ET AL CRUZ-HERNANDEZ JUAN MANUEL [CA] ET AL) 14 July 2005 (2005-07-14)
- D5 US 6 686 911 B1 (LEVIN MICHAEL D [US] ET AL) 3 February 2004 (2004-02-03)

To meet the requirements of Rule 42(1)(b) EPC, the document D1 should be identified in the description and its relevant contents should be indicated.

2. The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claim 1 is not new within the meaning of Article 54(1) and (2) EPC.

2.1 Document D1 discloses (the references in parentheses applying to this document):

a method comprising:

- i) receiving an input signal comprising information associated with a manipulation of an input device (paragraph 50), and
- ii) generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect to the input device (paragraphs 2, 13, 50);

further comprising:

- iii) storing a plurality of stored virtual detent profiles (paragraphs 36-37, 54);
- iv) determining one of said plurality of stored virtual detent profiles to generate a vibrotactile signal (paragraph 50); and,
- v) basing said determination at least in part on the input signal and/or on the status of the input device (paragraph 53).

2.2 Although document D1 does not explicitly mention the use of a vibrotactile effect in the embodiments description, it is clear from the combination of paragraphs 2 and 13 that this type of effect is comprised in the disclosure of D1.

The subject-matter of claim 1 is therefore not new (Article 54(1) and (2) EPC).

3. The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 5 and 6, which therefore is also considered not new.

4. It is to be noted that claim 1 also lack inventive step, Article 56 EPC, in view of, e.g. documents D2 or D3, since such documents disclose all the features of such claim with the only difference that the feedback effect is not vibrotactile.

5. Dependent claims 2-4 and 7-9 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the EPC in respect of novelty and/or inventive step since they refer to features which are very well known in the field of haptic devices and/or are disclosed by the prior art documents cited in the search report, see also documents D1-D5 and the corresponding passages cited in the search report.

6.1 When filing amended claims the applicant should at the same time bring the description into conformity with the amended claims. Care should be taken during revision, especially of the introductory portion and of any statements of problem or advantage, not to add subject-matter which extends beyond the content of the application as originally filed (Article 123(2) EPC).

6.2 In order to facilitate the examination of the conformity of the amended application with the requirements of Article 123(2) EPC, the applicant should clearly identify the amendments made, irrespective of whether they concern amendments by addition, replacement or deletion, and indicate the passages of the application as filed on which these amendments are based (see Guidelines E-II, 1).

If the applicant considers it appropriate, these indications could be submitted in handwritten form on a copy of the relevant parts of the application as filed.



European Patent Office
Postbus 5818
2280 HV RIJSWIJK
NETHERLANDS
Tel. +31 (0)70 340-2040
Fax +31 (0)70 340-3016



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
ROYAUME UNI

**For any questions about
this communication:**

Tel.: +31 (0)70 340 45 00

Date
01.10.12

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1245 / 2126667
Applicant/Proprietor Immersion Corporation	

Communication

concerning the registration of amendments relating to

- ☐ a transfer (R. 22 and 85 EPC)
- ☒ entries pertaining to the applicant / the proprietor (R. 143(1)(f) EPC)

As requested, the entries pertaining to the applicant of the above-mentioned European patent application / to the proprietor of the above-mentioned European patent have been amended to the following:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC
MT NL PL PT RO SE SI SK TR
Immersion Corporation
30 Rio Robles
San Jose, CA 95134/US

The registration of the changes has taken effect on 28.08.12.

In the case of a published application / a patent, the change will be recorded in the Register of European Patents and published in the European Patent Bulletin (Section I.12 / II.12).

Your attention is drawn to the fact that, in the case of the registration of a transfer, any automatic debit order only ceases to be effective from the date of its express revocation (cf. point 14(c) of the Arrangements for the automatic debiting procedure, Supplement to OJ EPO 3/2009).

Receiving Section



Client Data Registration Tel.: +49 (0)89 2399 2780
--



Letter accompanying subsequently filed items

Sender:

PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
United Kingdom

Phone: +4420 7822 8888

Fax: +4420 7822 8899

E-mail: mail@pandl.com

80298 Munich
Germany
Tel. +49(0)89 2399-0 | Fax -4465

P.O. Box 5818
NL-2280 HV Rijswijk
Netherlands
Tel. +31(0)70 340-2040 | Fax -3016

10958 Berlin
Germany
Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number

07863260.1

Applicant's or representative's reference

FP-10-0597

	Description of document	Original file name	Assigned file name
1	Document concerning the applicant	Immersion Corp. Evidence Of Change Of Address.pdf	APPRMISC-1.pdf
2	Document concerning the applicant	23rd August 2012 - Letter To EPO Changing Immersion Address.pdf	APPRMISC-2.pdf

Signatures

Place: **England**
Date: **28 August 2012**
Signed by: **GB, Phillips & Leigh, R. McDougall 14979**
Association: **PHILLIPS & LEIGH**
Capacity: **(Representative)**

[Secretary of State](#)[Administration](#)[Elections](#)[Business Programs](#)[Political Reform](#)[Archives](#)[Registries](#)**Business Entities (BE)**

Online Services

- [Business Search](#)
- [Disclosure Search](#)
- [E-File Statements](#)
- [Processing Times](#)

Main Page**Service Options****Name Availability****Forms, Samples & Fees****Annual/Biennial Statements****Filing Tips****Information Requests**
(certificates, copies & status reports)**Service of Process****FAQs****Contact Information**

Resources

- [Business Resources](#)
- [Tax Information](#)
- [Starting A Business](#)
- [International Business Relations Program](#)

Customer Alerts

- [Business Identity Theft](#)
- [Misleading Business Solicitations](#)

Business Entity Detail

Data is updated weekly and is current as of Friday, July 20, 2012. It is not a complete or certified record of the entity.

Entity Name:	IMMERSION CORPORATION
Entity Number:	C2175932
Date Filed:	09/13/1999
Status:	ACTIVE
Jurisdiction:	DELAWARE
Entity Address:	30 RIO ROBLES
Entity City, State, Zip:	SAN JOSE CA 95134
Agent for Service of Process:	INCORPORATING SERVICES, LTD.
Agent Address:	720 14TH STREET
Agent City, State, Zip:	SACRAMENTO CA 95814

* Indicates the information is not contained in the California Secretary of State's database.

- If the status of the corporation is "Surrender," the agent for service of process is automatically revoked. Please refer to California Corporations Code [section 2114](#) for information relating to service upon corporations that have surrendered.
- For information on checking or reserving a name, refer to [Name Availability](#).
- For information on ordering certificates, copies of documents and/or status reports or to request a more extensive search, refer to [Information Requests](#).
- For help with searching an entity name, refer to [Search Tips](#).
- For descriptions of the various fields and status types, refer to [Field Descriptions and Status Definitions](#).

[Modify Search](#)[New Search](#)[Printer Friendly](#)[Back to Search Results](#)[Privacy Statement](#) | [Free Document Readers](#)

Copyright © 2012 California Secretary of State

PHILLIPS & LEIGH
PATENT AND TRADE MARK ATTORNEYS

By Electronic Filing

European Patent Office
Erhardstrasse
D-80298
München
Germany

Our Ref.: FP-10-0597/RCM/vw

23rd August 2012

Dear Sirs,

**Re: European Patent Application Number: 07863260.1
In The Name Of Immersion Corporation**

I write to inform you that the applicant for the above-referenced European patent application, Immersion Corporation, has moved from the address detailed below:

801 Fox Lane
San Jose, CA 95131 / US

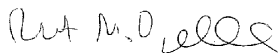
To a new address, as detailed below:

**30 Rio Robles
San Jose
CA 95134
U.S.A.**

Please find enclosed herewith evidence of the new address, as taken from the California Secretary of State Business Search website.

I look forward to this change being realized on the European register.

Yours faithfully,



Phillips & Leigh
Association of Professional Representatives no. 380
Signed by Robert McDougall



Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	1781842
Application number	EP07863260.1
Date of receipt	28 August 2012
Receiving Office	European Patent Office, The Hague
Your reference	FP-10-0597
Applicant	All applicants as on file
Documents submitted	package-data.xml epf1038.pdf (1 p.) APPRMISC-2.pdf23rd August 2012 - Letter To EPO Changing Immersion Address.pdf (1 p.) ep-sfd-request.xml APPRMISC-1.pdfImmersion Corp. Evidence Of Change Of Address.pdf (1 p.)
Submitted by	CN=R. McDougall 14979,O=Phillips & Leigh,C=GB
Method of submission	Online
Date and time receipt generated	28 August 2012, 17:30 (CEST)
Message Digest	C7:57:15:D5:C3:24:87:34:8D:9A:A2:05:06:3D:75:97:07:2B:DE:CB

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/



European Patent Office
Postbus 5818
2280 HV RIJSWIJK
NETHERLANDS
Tel. +31 (0)70 340-2040
Fax +31 (0)70 340-3016



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
GRANDE BRETAGNE

**For any questions about
this communication:**

Tel.: +31 (0)70 340 45 00

Date
04.11.09

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1245 / 2126667 PCT/US2007026355
Applicant/Proprietor Immersion Corporation	

Communication of European publication number and information on the application of Article 67(3) EPC

The provisional protection under Article 67(1) and (2) EPC in the individual Contracting States becomes effective only when the conditions referred to in Article 67(3) EPC have been fulfilled (for further details, see information brochure of the European Patent Office "National Law relating to the EPC" and additional information in the Official Journal of the European Patent Office).

A request has been made for extension of the patent to: AL BA HR MK RS
See Official Journal 1-2/1994 for further information on provisional protection.

Pursuant to Article 153(3) EPC the publication under Article 21 PCT of an international application for which the European Patent Office is a designated or elected Office takes the place of the publication of a European patent application.

The bibliographic data of the above-mentioned Euro-PCT application will be published on 02.12.09 in Section I.1 of the European Patent Bulletin. The European publication number is 2126667.

In all future communications to the European Patent Office, please quote the application number plus Directorate number.

Receiving Section





Letter accompanying subsequently filed items

Sender:

Mr. Robert D. WESTON
Phillips & Leigh
5 Pemberton Row
London EC4A 3BA
United Kingdom

Phone: +44 (0) 207 822 8888

Fax: +44 (0) 207 822 8899

E-mail: mail@pandl.com

80298 Munich
Germany
Tel. +49(0)89 2399-0 | Fax -4465

P.O. Box 5818
NL-2280 HV Rijswijk
Netherlands
Tel. +31(0)70 340-2040 | Fax -3016

10958 Berlin
Germany
Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number

07863260.1

Applicant's or representative's reference

FP-10-0597

	Description of document	Original file name	Assigned file name
1	Letter relating to the search and examination procedure	10Sep2009 FP-10-0597 EPO.pdf	EPLETT-1.pdf
2	Amended claims	Claims v_3_ as filed.pdf	CLMSPAMD-1.pdf
3	Amended claims	Claims v_3_ informal as filed.pdf	CLMSPAMD-2.pdf

	Payment	
1	Mode of payment	Not specified

Annotations

Signatures

Place: London, England
Date: 14 September 2009
Signed by: UK, Phillips & Leigh, R. Weston 6631
Capacity: (Representative)

Claims:

1. A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of an input device (102, 202, 306, 400), and
 - 5 ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the input device;
further comprising:
 - iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles
10 to generate a vibrotactile signal; and,
 - v) basing said determination at least in part on the input signal and/or on the status of the input device (102, 202, 306, 400).
2. The method of claim 1, **further comprising :-**
 - 15 i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and generating (504, 604, 706) the vibrotactile signal.
20
3. The method of claim 2, **further comprising** determining whether to generate a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.
- 25 4. The method of any of claims 1 to 3, **wherein** the information associated with manipulation (802) of an input device (102, 202, 306, 400) comprises information associated with the rotation of a rotary knob (400), activation of a touch-pad (3067) or the sliding of a fader.
- 30 5. A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 4.
6. A system comprising:
 - i) an input device (102, 202, 306, 400);

- ii) at least one actuator (108, 208, 406) coupled to the input device
 - iii) a processor (106, 206) in communication with the input device and said at least one actuator and configured to:
 - a) receive (500) an input signal comprising information associated with a manipulation (802) of the input device (102, 202, 400); and,
 - b) generate (504, 604, 706) a vibrotactile signal configured to cause said actuator (108) to produce a vibrotactile effect (806) to the input device;
- 10 **wherein;**
- iv) the processor (106, 206):
 - a) comprises memory (216) configured to store virtual detent profiles, and
 - b) is configured to effect the method of any of claims 1 to 4.
- 15
7. The system of claim 6, **wherein** the processor (106, 206) is further configured to generate (706) a system signal to control a system (110, 210) based at least in part on a manipulation of the input device (102, 202, 306, 400).
- 20 8. The system of claim 6 or claim 7, **wherein** the at least one actuator (406) is coupled to a housing (302, 402) of the input device (306, 400).
9. The system of any of claims 6 to 8, **wherein** a sensor (104, 204, 408) is configured to detect manipulation of the input device (102, 202, 400) and generate the input signal.
- 25

Claims:

1. *based on as-filed claims 1, 3 or 4, 7 and subject-matter at page 5 lines 30-34*
A method comprising:
 - i) receiving (500) an input signal comprising information associated with a manipulation (802) of an input device (102, 202, 306, 400), and
 - ii) generating (504, 604, 706) a vibrotactile signal configured to cause an actuator (108) to produce a vibrotactile effect (806) to the input device;**further comprising:**
 - iii) storing a plurality of stored virtual detent profiles;
 - iv) determining (704) one of said plurality of stored virtual detent profiles to generate a vibrotactile signal; and,
 - v) basing said determination at least in part on the input signal and/or on the status of the input device (102, 202, 306, 400).

2. *based on as-filed claim 2*
The method of claim 1, **further comprising :-**
 - i) generating a system signal (708) associated with a system (110, 210) to be manipulated;
 - ii) basing the system signal at least in part on the input signal; and
 - iii) substantially simultaneously generating (708) the system signal and generating (504, 604, 706) the vibrotactile signal.

3. *based on as-filed claims 5 and 6*
The method of claim 2, **further comprising** determining whether to generate a system signal (708) based at least in part on a status of the system (110, 210) to be manipulated.

4. *based on as-filed claim 8 and subject-matter at page 11 lines 25-27*
The method of any of claims 1 to 3, **wherein** the information associated with manipulation (802) of an input device (102, 202, 306, 400) comprises information associated with the rotation of a rotary knob (400), activation of a touch-pad (3067) or the sliding of a fader.

5. *based on as-filed claim 10 and is dependent upon any of amended method claims 1 to 4.*

A computer-readable medium on which is encoded program code to effect the method of any of claims 1 to 4.

5

6. *based on as-filed claim 15 and subject-matter at page 11 lines 5-7 and is dependent upon any of amended method claims 1 to 4.*

A system comprising:

- i) an input device (102, 202, 306, 400);
- 10 ii) at least one actuator (108, 208, 406) coupled to the input device
- iii) a processor (106, 206) in communication with the input device and said at least one actuator and configured to:
 - a) receive (500) an input signal comprising information associated with a manipulation (802) of the input device (102, 202, 400);
 - 15 and,
 - b) generate (504, 604, 706) a vibrotactile signal configured to cause said actuator (108) to produce a vibrotactile effect (806) to the input device;

wherein;

- 20 iv) the processor (106, 206):
 - a) comprises memory (216) configured to store virtual detent profiles, and
 - b) is configured to effect the method of any of claims 1 to 4.

- 25 7. *based on as-filed claim 16*

The system of claim 6, **wherein** the processor (106, 206) is further configured to generate (706) a system signal to control a system (110, 210) based at least in part on a manipulation of the input device (102, 202, 306, 400).

- 30 8. *based on as-filed claim 18*

The system of claim 6 or claim 7, **wherein** the at least one actuator (406) is coupled to a housing (302, 402) of the input device (306, 400).

FP-10-0597

Claims v(3) – Informal Copy with Comments

9. *based on as-filed claim 19 and subject-matter at page 4 lines 10-11*

The system of any of claims 6 to 8, **wherein** a sensor (104, 204, 408) is configured to detect manipulation of the input device (102, 202, 400) and generate the input signal.

5

PHILLIPS & LEIGH
PATENT AND TRADE MARK ATTORNEYS

BY EPOOnline

The European Patent Office
P.B. 5818
Patentlaan 2
2280 HV Rijswijk (ZH)
Netherlands

Our reference: FP-10-0597/RDW/laa

10th September 2009

Office Action – Response due 4th September 2009 (+10 mailing 14th September 2009)

Dear Sirs

Re: European Patent Application No. 07863260.1 – 1245
In the name of Immersion Corporation

I refer to the Communication pursuant to Rules 161 and 162 EPC dated 4th August 2009 and file herewith replacement amended claims 1-9. I note that no extra claim fees are due.

These claims have been amended to European format and in view of the IPRP dated issued 30th June 2009.

In addition to documents D1 - Grant (US2006/0119573) and D2 - Huang (US 6,917,867) cited in the International Search, I also draw the Examiner's attention to document D3 - WO 03/012557 (Immersion Corporation).

The International Examiner has rejected all the as-filed claims as being obvious over D1 in view of D2; alleging that D1 discloses all the claimed features save for that of a "virtual detent" and that D2 discloses virtual detents. D3 discloses "programmable feel sensations can be output on the wheel, such as detents, spring forces, or the like." [para 0006]

Claim 1 has been amended to specify:

- iii) storing a plurality of stored virtual detent profiles;
- iv) determining (704) one of said plurality of stored virtual detent profiles to generate a vibrotactile signal; and,
- v) basing said determination at least in part on the input signal and/or on the status of the input device (102, 202, 306, 400).

As acknowledged by the International Examiner, D1 does not disclose "Virtual Detents"; D2 and D3 do disclose "Virtual Detents".

However, D2 does not disclose a *plurality of virtual detent profiles*, the passage cited by the International Examiner discloses:

"In a second aspect of the present invention, the operator input device 10 may be programmed to provide at least two *detent* functions in one of the first and second directions. In other words, multiple *detents* may be provided as the operator interface mechanism 12 is moved in

the same direction.”
[Col5 lines 63-67]

“This is illustrated in the sample graph 48 of FIG. 4. The graph shows displacement of the operator interface mechanism 12 versus the resistive force applied by the first or second brake. As shown, a minimal force may be applied to; the operator interface mechanism 12 when it is in the neutral position. The top half of the graph, trace 38B represents the resistive force as the operator interface mechanism 12 travels in a direction away from the neutral position. The bottom half of the graph, trace 40B, represents the resistive force as the operator interface mechanism 12 travels toward the neutral position. As shown, as the operator interface mechanism 12 is moved in any direction, *multiple detents may be provided, i.e., programmed into the operator input device 10*. In the illustrated embodiment, as the operator interface mechanism 12 is moved in the first direction from the neutral position (to the right in FIG. 4), *three detents 52A, 52B, 52C are provided*. As the operator interface mechanism 12 is returned to the neutral position, *two detents may be provided 54A, 54B*. As the operator interface mechanism 12 is moved in the second direction from the neutral position (to the left in FIG. 4), *three detents 56A, 56B, 56C are provided*. As the operator interface mechanism 12 is returned to the neutral position, *two detents may be provided 58A, 58B*. Although, the graph 50 is shown as 25 being symmetrical, i.e., *three detents up and 2 detents down on each side*, it should be noted that *any number, including zero, of detents may be provided* in any one direction and on either side of the neutral position. Furthermore, as shown, *one or more of the detents 52A, 52C, 52C, 54A, 54B, 56A, 56B, 56C, 58A, 58B*, may have an associated detent pre-feel function.”
[Col 6 lines1-31]

In D2 the term “detent function” is disclosed at:

“The resistive force provides a detent function and a detent pre-feel function to the operator interface mechanism.”

[Col 1 lines 49-51]

“The resistive force provides at least two detent functions in one of the first and second directions.”

[Col 2 lines 1-3]

“The resistive force opposes the force applied to the operator interface mechanism by the operator and provides a detent function to the operator interface mechanism. The detent function is defined with respect to a programmable position of the operator interface mechanism. The brake controller receives the input signal and responsively sets the programmable position.”

[Col 2 lines 22-28]

“The resistive force opposes the force applied to the operator interface mechanism by the operator and provides a detent function.”

[Col 2 lines 46-48]

It is clear from these passages that *detent function* is different from *virtual detent profile* and that *detent function* disclosed solely in the context of *resistance*.

Detents per see are separately disclosed; see for example:

“The brake controller 18 may be programmed with a map to provide a *detent or virtual detent function* which correlates the brake position signal with the position signal and/or the other sensor signals.”

[Col 4 lines 24-28]

“As discussed below, besides providing a *virtual detent* the operator input device 10 may be programmed to provide tactile feedback to the operator under other conditions.”

[Col 5 lines 33-35]

“As shown, as the operator interface mechanism 12 is moved in any direction, *multiple detents* may be provided, i.e., programmed into the operator input device 10.”

[Col 6 lines 11-14]

“In order to program a *detent*, the operator actuates the operator interface mechanism 12 until the desired position is achieved. The operator then places the operator input device 10 into a programming mode.”

[Col 6 lines 36-38]

“After the programming mode has been entered and the operator interface mechanism 12 is placed in the desired position, the operator then may actuate the input mechanism 60 again to program the *detent*.”

[Col 6 lines 39-45]

The term “virtual detent profile” has been adopted in amended claim 1 to distinguish from “virtual detent” and from “detent function” and occurs some 18 times in the as-filed specification (WO 2008/085487).

D1 does not disclose *virtual detent* and, as evidenced by the above analysis, D2 does not disclose “determining one of a *plurality of stored virtual detent profiles* to generate a vibrotactile signal”. Indeed it is moot whether D2 discloses *stored detent functions*, although *different detent functions* are disclosed.

D3 does not disclose *stored virtual detent profile*; indeed the terms *memory* or *store* are nowhere to be found in D3.

A main advantage of the present invention is:

“The system illustrated in Figure 1 comprises a system to be manipulated 110. One or more systems to be manipulated 110 can each receive system signals from the processor 106. The system to be manipulated 110 may comprise a system capable of electrical or electromechanical control, such as and without limitation, a stereo system, a video system, a climate system (e.g. air conditioning and/or heating), a navigation system, automotive systems, wireless communication devices, security systems, a television, a video game system, a washing machine or a drying machine, or an oven.

In one embodiment, the system to be manipulated 110 may comprise a single system, such as a lighting system. In another embodiment, the system to be manipulated 110 may comprise a complex system comprising one or more elements. For example, the system to be manipulated 110 may be a heating and cooling system.”

[Page 9 lines 17-27].

This *adaptive system functionality* is nowhere disclosed in D1, D2 or D2 and the invention claimed in amended claim 1 exhibits a clear inventive step with respect to these documents.

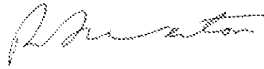
Amended claims 2 – 4 are directly or indirectly dependent upon amended claim 1 and, if for no other reason, validated by such dependency. Amended claim 5 is to a computer-readable medium and is dependent upon any of claims 1 to 4. Amended claim 6 is to a system and is dependent upon any of

Continuation / 4

Our ref: **FP-10-0597/RDW/laa**

claims 1 to 4. Amended claims 7 – 9 are directly or indirectly dependent upon amended claim 6 and, if for no other reason, validated by such dependency.

Yours faithfully

A handwritten signature in black ink, appearing to read 'R. Weston', with a stylized flourish at the end.

WESTON, Robert D.
Authorised Representative



Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	649978	
Application number	EP07863260.1	
Date of receipt	14 September 2009	
Receiving Office	European Patent Office, The Hague	
Your reference	FP-10-0597	
Applicant	All applicants as on file	
Documents submitted	package-data.xml epf1038.pdf (1 p.) CLMSPAMD-1.pdfClaims v_3_ as filed.pdf (2 p.)	ep-sfd-request.xml EPLETT-1.pdf10Sep2009 FP-10-0597 EPO.pdf (4 p.) CLMSPAMD-2.pdfClaims v_3_ informal as filed.pdf (3 p.)
Submitted by	CN=R. Weston 6631,O=Phillips & Leigh,C=UK	
Method of submission	Online	
Date and time receipt generated	14 September 2009, 12:38 (CEST)	
Message Digest	DB:FB:54:54:31:04:A8:49:4C:1F:0C:5B:67:98:79:22:07:2D:19:AD	

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/



European Patent Office
Postbus 5818
2280 HV RIJSWIJK
NETHERLANDS
Tel. +31 (0)70 340-2040
Fax +31 (0)70 340-3016



Weston, Robert Dale
PHILLIPS & LEIGH
5 Pemberton Row
London EC4A 3BA
GRANDE BRETAGNE

**For any questions about
this communication:**

Tel.: +31 (0)70 340 45 00

Date
04-08-2009

Reference FP-10-0597	Application No./Patent No. 07863260.1 - 1245 PCT/US2007026355
Applicant/Proprietor Immersion Corporation	

Communication pursuant to Rules 161 and 162 EPC

(1) Amendment of application documents, especially the claims (R. 161 EPC)

The above mentioned international (Euro-PCT) application has entered the European phase.

Under Articles 28, 41 PCT, Rules 52, 78 PCT and Rule 137(2) to (4) EPC, the applicant may amend the application documents after receiving the international search report.

Whether or not he has already done so, he now has a further opportunity to file amended claims or other application documents within a non-extendable period of ONE MONTH after notification of the present communication (R. 161 EPC).

The claims applicable on expiry of the above time limit, i.e. those filed on entry into the European phase or in response to the present communication, will form the basis for the calculation of any claims fee to be paid (see page 2) and for any supplementary search to be carried out under Article 153(7) EPC (R. 161 EPC).

--2/

(2) Claims fees under Rule 162 EPC

If the application documents on which the European grant procedure is to be based comprise more than fifteen claims, a claims fee shall be payable for the sixteenth and each subsequent claim within the period provided for in Rule 159(1) EPC.

- ☐ Based on the application documents currently on file, all necessary claims fees have already been paid (or the documents do not comprise more than 15 claims).
- ☐ All necessary fees will be/have been debited automatically according to the automatic debit order.
- ☒ The claims fees due for the claims ¹⁶ to ¹⁹ were not paid within the above-mentioned period.

Any non-paid claims fee, either based on the current set of claims or on any amended claims to be filed pursuant to Rule 161 EPC (see page 1), may still be validly paid within a non-extendable period of **one month** after notification of this communication (R. 162(2) EPC).

If a payment is made for only some of the claims, it must be indicated for which claims it is intended. If a claims fee is not paid in due time, the claim concerned is deemed to be abandoned (R. 162(4) EPC).

If claims fees have already been paid, but on expiry of the above-mentioned period there is a new set of claims containing fewer fee-incurring claims than previously, the claims fees in excess of those due under Rule 162(2), 2nd sentence EPC will be refunded (R. 162(3) EPC).

You are reminded that any supplementary search under Article 153(7) EPC will relate only to the last set of claims applicable on expiry of the above period AND will be confined to those fee-incurring claims for which fees have been paid in due time.

The present amount of the claims fee is

EUR 200 for the 16th and each subsequent claim up to the limit of 50
EUR 500 for the 51st and each subsequent claim

Note to users of the automatic debiting procedure

Unless the EPO receives prior instructions to the contrary, the fees for all claims incurring fees will be debited on the last day of the period for payment. For further details see the Arrangements for the automatic debiting procedure, Supplement to OJ EPO 3/2009.

Receiving Section

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44bis)

Applicant's or agent's file reference IMM253.PCT	FOR FURTHER ACTION	See item 4 below
International application No. PCT/US2007/026355	International filing date (<i>day/month/year</i>) 27 December 2007 (27.12.2007)	Priority date (<i>day/month/year</i>) 27 December 2006 (27.12.2006)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant IMMERSION CORPORATION		

1.	This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 <i>bis</i> .1(a).																								
2.	This REPORT consists of a total of 4 sheets, including this cover sheet. In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.																								
3.	This report contains indications relating to the following items: <table style="width: 100%;"> <tr> <td style="width: 10%; text-align: center;">☒</td> <td style="width: 30%;">Box No. I</td> <td style="width: 60%;">Basis of the report</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. II</td> <td>Priority</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. III</td> <td>Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. IV</td> <td>Lack of unity of invention</td> </tr> <tr> <td style="text-align: center;">☒</td> <td>Box No. V</td> <td>Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VI</td> <td>Certain documents cited</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VII</td> <td>Certain defects in the international application</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VIII</td> <td>Certain observations on the international application</td> </tr> </table>	☒	Box No. I	Basis of the report	☐	Box No. II	Priority	☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	☐	Box No. IV	Lack of unity of invention	☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement	☐	Box No. VI	Certain documents cited	☐	Box No. VII	Certain defects in the international application	☐	Box No. VIII	Certain observations on the international application
☒	Box No. I	Basis of the report																							
☐	Box No. II	Priority																							
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability																							
☐	Box No. IV	Lack of unity of invention																							
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement																							
☐	Box No. VI	Certain documents cited																							
☐	Box No. VII	Certain defects in the international application																							
☐	Box No. VIII	Certain observations on the international application																							
4.	The International Bureau will communicate this report to designated Offices in accordance with Rules 44bis.3(c) and 93bis.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44bis .2).																								

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Date of issuance of this report 30 June 2009 (30.06.2009) Authorized officer Masashi Honda e-mail: pt08.pct@wipo.int
--	---

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To: STEVEN GARDNER
KILPATRICK STOCKTON LLP
1001 WEST FOURTH STREET
WINSTON-SALEM, NC 27101

Date of mailing
(day/month/year) **22 MAY 2008**

Applicant's or agent's file reference
IMM253.PCT

FOR FURTHER ACTION

See paragraph 2 below

International application No.
PCT/US 07/26355

International filing date (day/month/year)
27 December 2007 (27.12.2007)

Priority date (day/month/year)
27 December 2006 (27.12.2006)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G06F 3/01 (2008.04)
USPC - 715/702

Applicant **IMMERSION CORPORATION**

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US
Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-3201

Date of completion of this opinion
22 April 2008 (22.04.2008)

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US 07/26355

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - ☒ the international application in the language in which it was filed.
 - ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:
 - a. type of material
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing
 - ☐ contained in the international application as filed
 - ☐ filed together with the international application in electronic form
 - ☐ furnished subsequently to this Authority for the purposes of search
4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

PCT/US 07/26355

Box No. V	Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement																											
1. Statement <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; vertical-align: top;">Novelty (N)</td> <td style="width: 10%; vertical-align: top;">Claims</td> <td style="width: 40%; border-bottom: 1px solid black;">1-19</td> <td style="width: 20%; text-align: right; vertical-align: bottom;">YES</td> </tr> <tr> <td></td> <td style="vertical-align: top;">Claims</td> <td style="border-bottom: 1px solid black;">none</td> <td style="text-align: right; vertical-align: bottom;">NO</td> </tr> <tr> <td style="vertical-align: top;">Inventive step (IS)</td> <td style="vertical-align: top;">Claims</td> <td style="border-bottom: 1px solid black;">none</td> <td style="text-align: right; vertical-align: bottom;">YES</td> </tr> <tr> <td></td> <td style="vertical-align: top;">Claims</td> <td style="border-bottom: 1px solid black;">1-19</td> <td style="text-align: right; vertical-align: bottom;">NO</td> </tr> <tr> <td style="vertical-align: top;">Industrial applicability (IA)</td> <td style="vertical-align: top;">Claims</td> <td style="border-bottom: 1px solid black;">1-19</td> <td style="text-align: right; vertical-align: bottom;">YES</td> </tr> <tr> <td></td> <td style="vertical-align: top;">Claims</td> <td style="border-bottom: 1px solid black;">none</td> <td style="text-align: right; vertical-align: bottom;">NO</td> </tr> </table>					Novelty (N)	Claims	1-19	YES		Claims	none	NO	Inventive step (IS)	Claims	none	YES		Claims	1-19	NO	Industrial applicability (IA)	Claims	1-19	YES		Claims	none	NO
Novelty (N)	Claims	1-19	YES																									
	Claims	none	NO																									
Inventive step (IS)	Claims	none	YES																									
	Claims	1-19	NO																									
Industrial applicability (IA)	Claims	1-19	YES																									
	Claims	none	NO																									
2. Citations and explanations: Claims 1-19 lack inventive step under PCT Article 33(3) as being obvious over US 2006/0119573 A1 to Grant et al. (hereinafter "Grant") in view of US 6,917,867 B2 to Huang et al. (hereinafter 'Huang'). As per claims 1, 10 and 15, Grant discloses a method (and system and corresponding program code, see para [0006]) comprising: receiving an input signal comprising information associated with a manipulation of an input device (see para [0016]), and generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect to the input device (see para [0017]) but does not specifically disclose the vibrotactile effect comprising a virtual detent. Huang, however, discloses the vibrotactile effect comprising a virtual detent (col 4, ln 25-48). It would have been obvious to one of ordinary skill in the art to combine the teachings of Grant with Huang because adding virtual detents enables providing vibrotactile signals when useful in situations when actual mechanical structure is not available, thereby increasing the functionality of Grant. As per claims 2 and 11, Grant further discloses generating a system signal associated with a system to be manipulated (see para [0016]), the system signal based at least in part on the input signal (see para [0016]), and wherein generating a system signal and generating the vibrotactile signal occur substantially simultaneously (see para [0016]-[0017]). As per claim 3, Grant further discloses wherein the vibrotactile signal is based at least in part on the input signal (see para [0016]). As per claim 4, Huang further discloses wherein the vibrotactile signal is further based in part on the status of the input device (col 2, ln 51 to col 3, ln 4). As per claims 5 and 12, Grant further discloses determining whether to generate a signal (see para [0016]-[0017] and [0021]). As per claim 6, Grant further discloses wherein determining whether to generate a signal is based at least in part on a status of the system to be manipulated (whether cell phone is receiving a call, see para [0016]-[0017]). As per claim 7, Huang further discloses determining one of a plurality of virtual detents to generate (col 5, ln 63-67). As per claim 8, Huang further discloses wherein the information associated with the manipulation of an input device comprises information associated with the rotation of a rotary knob or the sliding of a fader (col 3, ln 56 to col 4, ln 3 and col 4, ln 54-60). As per claims 9 and 14, Grant discloses a method (and corresponding program code, see para [0006]) comprising: detecting a change in position of an input device (detect incoming call, see para [0016]); and generating a detent signal based at least in part on the change in position (generates driving signal, see para [0016]), the detent signal configured to cause an actuator to produce a vibrotactile effect to the input device (see para [0017]) but does not specifically disclose the vibrotactile effect comprising a virtual detent, the vibrotactile effect based at least in part on the detent signal. Huang, however, discloses the vibrotactile effect comprising a virtual detent, the vibrotactile effect based at least in part on the detent signal (col 4, ln 25-48). It would have been obvious to one of ordinary skill in the art to combine the teachings of Grant with Huang because adding virtual detents enables providing vibrotactile signals when useful in situations when actual mechanical structure is not available, thereby increasing the functionality of Grant. As per claim 13, Huang further discloses determining a virtual detent to generate (col 4, ln 25-48 and col 5, ln 63-67). As per claim 16, Grant further discloses wherein the processor is further configured to control a system based at least in part on a manipulation of the input device (see para [0016] and Fig 1). As per claim 17, Huang further discloses wherein the processor is further configured to determine whether to generate a detent signal (col 4, ln 25-48 and col 5, ln 63-67). As per claim 18, Grant further discloses wherein the at least one actuator is coupled to a housing of the input device (see para [0046] and Fig 1). As per claim 19, Huang further discloses wherein the input device comprises a sensor (abstract). Claims 1-19 have industrial applicability as defined by PCT Article 33(4), because the subject matter can be made or used in industry.																												

Form PCT/ISA/237 (Box No. V) (April 2007)

the application documents published by the International Bureau (with all claims, description and drawings), where applicable with amended claims under Art. 19 PCT unless replaced by the amendments attached. <i>Where necessary, clarifications should be attached as 'Other documents'</i>	☒ ☐
6.2 Proceedings before the EPO as elected Office (PCT II) are to be based on the following documents: the documents on which the international preliminary examination report is based, including any annexes unless replaced by the amendments attached. <i>Where necessary, clarifications should be attached as 'Other documents'</i> If the EPO as International Preliminary Examining Authority has been supplied with test reports, these may be used as the basis of proceedings before the EPO.	☐ ☐ ☐
7. Translations Translations in one of the official languages of the EPO (English, French, German) are attached as crossed below: <i>* In proceedings before the EPO as designated or elected Office (PCT I + II):</i> Translation of the international application (description, claims, any text in the drawings) as originally filed, of the abstract as published and of any indication under Rule 13bis.3 and 13bis.4 PCT regarding biological material Translation of the priority application(s) (to be filed only at the EPO's request, Rule 53(3) EPC) It is hereby declared that the international application as originally filed is a complete translation of the previous application (Rule 53(3) EPC) <i>* In addition, in proceedings before the EPO as designated Office (PCT I):</i> Translation of amended claims and any statement under Art. 19 PCT, if the claims as amended are to form the basis for the proceedings before the EPO (see Section 6). <i>* In addition, in proceedings before the EPO as elected Office (PCT II):</i> Translation of annexes to the international preliminary examination report	☐ ☐ ☐ ☐ ☐ ☐ ☐
8. Biological material The invention uses and/or relates to biological material deposited under Rule 31 EPC. The particulars referred to in Rule 31(1)(c) EPC (if not yet known, the depositary institution and the identification reference(s)) [number, symbols, etc.] of the depositor are given in the international publication or in the translation submitted in Section 7 on: page(s) / line(s) The receipt(s) of deposit issued by the depositary institution is (are) enclosed. will be filed later. Waiver of the right to an undertaking from the requester pursuant to Rule 33(2) EPC attached.	☐ ☐ ☐ ☐ ☐
9. Nucleotide and amino acid sequences The items pursuant to Rules 5.2 and 13ter PCT, Rules 30 and 163(3) EPC are already with the EPO. The sequence listing is attached in PDF format. The sequence listing does not include matter which goes beyond the content of the application as filed. The sequence listing data is also attached in computer-readable form in accordance with WIPO Standard 25. The sequence listing data in computer-readable form in accordance with WIPO Standard 25 is identical to the sequence listing in PDF format.	☐ ☐ ☐ ☐ ☐
10. Designation fees All the contracting states party to the EPC at the time of filing of the international patent application and designated in the international application are deemed to be designated (see Article 79(1) EPC). AT BE BG CH&LI CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LT LU LV	☒

MC MT NL PL PT RO SE SI SK TR 10.1 It is currently intended to pay fewer than seven designation fees, for the following contracting states: 10.2 If contracting states are indicated in Section 10.1, it is agreed that for the contracting states not thus indicated no communication under Rule 112(1) EPC be issued and further processing be excluded.	☐ ☐																																																												
11. Extension of the European patent This application is deemed to be a request to extend the European patent application and the European patent granted in respect of it to all the non-contracting states to the EPC designated in the international application and with which extension agreements are in force on the date on which the international application is filed. However, the extension only takes effect if the prescribed extension fee is paid. It is currently intended to pay the extension fee for the following states: AL BA RS HR MK Note: Under the automatic debiting procedure, extension fees will only be debited for states indicated here, unless the EPO is instructed otherwise before expiry of the period for payment.	☒																																																												
12. List of enclosed documents <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">Description of document</th> <th style="width: 30%;">Original file name</th> <th style="width: 40%;">Assigned file name</th> </tr> </thead> <tbody> <tr> <td colspan="3"> 13. Mode of payment: Debit from deposit account Currency EUR The European Patent Office is hereby authorised, to debit from the deposit account with the EPO any fees and costs indicated on the fees page. Deposit account number 28050057 Account holder Phillips & Leigh </td> </tr> <tr> <td colspan="3"> 14. Any refunds should be made to the following EPO deposit account: Number and account holder Phillips & Leigh, 28050057 </td> </tr> </tbody> </table>		Description of document	Original file name	Assigned file name	13. Mode of payment: Debit from deposit account Currency EUR The European Patent Office is hereby authorised, to debit from the deposit account with the EPO any fees and costs indicated on the fees page. Deposit account number 28050057 Account holder Phillips & Leigh			14. Any refunds should be made to the following EPO deposit account: Number and account holder Phillips & Leigh, 28050057																																																					
Description of document	Original file name	Assigned file name																																																											
13. Mode of payment: Debit from deposit account Currency EUR The European Patent Office is hereby authorised, to debit from the deposit account with the EPO any fees and costs indicated on the fees page. Deposit account number 28050057 Account holder Phillips & Leigh																																																													
14. Any refunds should be made to the following EPO deposit account: Number and account holder Phillips & Leigh, 28050057																																																													
15. Fees <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 45%;">Description of fee</th> <th style="width: 10%;">Factor/reduction applied</th> <th style="width: 15%;">Fee schedule</th> <th style="width: 20%;">Amount to be paid</th> </tr> </thead> <tbody> <tr> <td>15-1</td> <td>002 Fee for (supplementary) European search for applications filed on/after 01.07.2005</td> <td>-190</td> <td>1 050.00</td> <td>860.00</td> </tr> <tr> <td>15-2</td> <td>005e Designation fee for all Contracting States designated</td> <td>1</td> <td>500.00</td> <td>500.00</td> </tr> <tr> <td>15-3</td> <td>006 Examination fee (EP and Euro-PCT with supplementary European search report)</td> <td>1</td> <td>1 405.00</td> <td>1 405.00</td> </tr> <tr> <td>15-4</td> <td>020 Filing fee - entry EP phase (Rule 159(1)(c) EPC)</td> <td>1</td> <td>100.00</td> <td>100.00</td> </tr> <tr> <td>15-5</td> <td>404 Extension fee for Albania</td> <td>1</td> <td>102.00</td> <td>102.00</td> </tr> <tr> <td>15-6</td> <td>406 Extension fee for former Yugoslav Republic of Macedonia (EPC contracting state from 01.01.2009)</td> <td>1</td> <td>102.00</td> <td>102.00</td> </tr> <tr> <td>15-7</td> <td>407 Extension fee for Croatia (EPC contracting state from 01.01.2008)</td> <td>1</td> <td>102.00</td> <td>102.00</td> </tr> <tr> <td>15-8</td> <td>408 Extension fee for Bosnia and Herzegovina</td> <td>1</td> <td>102.00</td> <td>102.00</td> </tr> <tr> <td>15-9</td> <td>409 Extension fee for Serbia</td> <td>1</td> <td>102.00</td> <td>102.00</td> </tr> <tr> <td>15-10</td> <td>520 Additional fee for the 36th and each subsequent page - Euro-PCT application -</td> <td>0</td> <td>12.00</td> <td>0.00</td> </tr> <tr> <td colspan="2" style="text-align: right;">Total:</td> <td></td> <td>EUR</td> <td>3 375.00</td> </tr> </tbody> </table>			Description of fee	Factor/reduction applied	Fee schedule	Amount to be paid	15-1	002 Fee for (supplementary) European search for applications filed on/after 01.07.2005	-190	1 050.00	860.00	15-2	005e Designation fee for all Contracting States designated	1	500.00	500.00	15-3	006 Examination fee (EP and Euro-PCT with supplementary European search report)	1	1 405.00	1 405.00	15-4	020 Filing fee - entry EP phase (Rule 159(1)(c) EPC)	1	100.00	100.00	15-5	404 Extension fee for Albania	1	102.00	102.00	15-6	406 Extension fee for former Yugoslav Republic of Macedonia (EPC contracting state from 01.01.2009)	1	102.00	102.00	15-7	407 Extension fee for Croatia (EPC contracting state from 01.01.2008)	1	102.00	102.00	15-8	408 Extension fee for Bosnia and Herzegovina	1	102.00	102.00	15-9	409 Extension fee for Serbia	1	102.00	102.00	15-10	520 Additional fee for the 36th and each subsequent page - Euro-PCT application -	0	12.00	0.00	Total:			EUR	3 375.00
	Description of fee	Factor/reduction applied	Fee schedule	Amount to be paid																																																									
15-1	002 Fee for (supplementary) European search for applications filed on/after 01.07.2005	-190	1 050.00	860.00																																																									
15-2	005e Designation fee for all Contracting States designated	1	500.00	500.00																																																									
15-3	006 Examination fee (EP and Euro-PCT with supplementary European search report)	1	1 405.00	1 405.00																																																									
15-4	020 Filing fee - entry EP phase (Rule 159(1)(c) EPC)	1	100.00	100.00																																																									
15-5	404 Extension fee for Albania	1	102.00	102.00																																																									
15-6	406 Extension fee for former Yugoslav Republic of Macedonia (EPC contracting state from 01.01.2009)	1	102.00	102.00																																																									
15-7	407 Extension fee for Croatia (EPC contracting state from 01.01.2008)	1	102.00	102.00																																																									
15-8	408 Extension fee for Bosnia and Herzegovina	1	102.00	102.00																																																									
15-9	409 Extension fee for Serbia	1	102.00	102.00																																																									
15-10	520 Additional fee for the 36th and each subsequent page - Euro-PCT application -	0	12.00	0.00																																																									
Total:			EUR	3 375.00																																																									
16. Annotations																																																													
17. Signature(s) of applicant(s) or representative Place: London, England Date: 24 June 2009 Signed by: UK, Phillips & Leigh, R. Weston 6631 Capacity: (Representative)																																																													



Acknowledgement of receipt

We hereby acknowledge receipt of the form for entry into the European phase (EPO as designated or elected Office) as follows:

Submission number	601860	
PCT application number	PCT/US2007/026355	
EP application number	07863260.1	
Date of receipt	24 June 2009	
Receiving Office	European Patent Office, The Hague	
Your reference	FP-10-0597	
Applicant		
Country		
Documents submitted	package-data.xml application-body.xml	ep-euro-pct.xml epf1200.pdf (3 p.)
Submitted by	CN=R. Weston 6631,O=Phillips & Leigh,C=UK	
Method of submission	Online	
Date and time receipt generated	24 June 2009, 12:48 (CEST)	
Message Digest	AD:EA:A8:E9:42:F1:E4:76:4A:33:DF:91:47:C0:66:53:60:78:DD:13	

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/



European Patent Office
Postbus 5818
2280 HV RIJSWIJK
NETHERLANDS
Tel. +31 (0)70 340-2040
Fax +31 (0)70 340-3016



GARDNER, Steven et al.
Kilpatrick Stockton LLP
1001 West Fourth Street
Winston-salem, North Carolina 27101
ETATS-UNIS D'AMERIQUE

**For any questions about
this communication:**

Tel.: +31 (0)70 340 45 00

Date
25.05.09

Reference	Application No./Patent No. 07863260.1 - 1245 PCT/US2007026355
Applicant/Proprietor Immersion Corporation	

Entry into the European phase before the European Patent Office

The following information describes the procedural steps required for entry into the European phase before the European Patent Office (EPO). You are advised to read it carefully because failure to take the necessary action in due time can lead to a loss of rights.

1. The above mentioned international patent application has been given the **European application No. 07863260.1**.

2. Applicants **without a residence or their principal place of business** in an EPC Contracting State may themselves initiate European processing of their international applications, provided they do so before expiry of the 31st month from the priority date.

During the European phase before the EPO as designated or elected Office, however, such applicants **must** be represented by a professional representative (Art. 133(2) and Art. 134(1) and (8) EPC).

Where, at the expiry of the time period laid down in Rule 163(5) EPC, the requirements of Article 133(2) EPC have not been complied with, the European patent application **will be refused**, pursuant to Rule 163(6) EPC.

Please note that a professional representative authorised to act before the EPO and who acted for the applicant during the international phase does not automatically become the representative for the European phase. Applicants are therefore strongly advised to appoint in good time any representative they wish to initiate the European phase for them; otherwise the EPO has to send all communications directly to the applicant.

3. Applicants **with a residence or their principal place of business** in an EPC Contracting State are not obliged to appoint for the European phase a professional representative authorised to act before the EPO. However, in view of the complexity of the procedure it is recommended that they do so.
4. Applicants and professional representatives are also strongly advised to initiate the European phase using **EPO Form 1200**. It is available free of charge from the EPO or via the EPO website at <http://www.epo.org>. Similarly, it can be or generated with the epoline® Online Filing Software, obtainable free of charge from the EPO (<http://www.epoline.org>) The use of the form is not compulsory.

5. Where the EPO acts as designated or elected Office (Art. 22(1) and (3) and 39(1) PCT), to enter the European phase before the EPO, the **following acts** must be performed by the applicant within **31 months** from the date of filing of the international application or (where applicable) the earliest priority date:

- a) Supply a translation of the international application into an EPO official language, if the International Bureau did not publish the application in such language (Art. 22(1) PCT and R. 159(1)(a) EPC);
- b) Specify the application documents, as originally filed or as amended, on which the European grant procedure is to be based (R. 159(1)(c) EPC);
- c) Pay the filing fee and, where applicable, the additional fee for a European patent application comprising more than 35 pages (R. 159(1)(c) EPC, Art. 2, items 1, 1a Rules relating to Fees);
- d) Pay the search fee where a supplementary European search report has to be drawn up (R. 159(1)(e) EPC);
- e) Pay the designation fee if the time limit laid down in Rule 39(1) EPC (i.e. six months after publication of the international search report) has expired before the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(d) EPC);
- f) File the written request for examination and pay the examination fee if the time limit laid down in Rule 70(1) EPC has expired before the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(f) EPC);
- g) Pay the renewal fee in respect of the third year, if the fee has fallen due (see Rule 51(1) EPC) before expiry of the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(g) EPC);
- h) File, where applicable, the certificate of exhibition referred to in Article 55(2) and Rule 25 EPC (R. 159(1)(h) EPC);
- i) Pay the claims fees for the sixteenth and each subsequent claim when the application documents on which the European grant procedure is to be based comprise more than fifteen claims (R. 162(1) EPC). For applications entering the European phase on or after 1 April 2009, a higher amount is payable for the 51st and each subsequent claim (Decision of the Administrative Council of 14 December 2007 amending the Rules relating to Fees, OJ EPO 2008, 10).

If either the translation of the international application or the request for examination is not filed in time, or if the filing fee, the additional fee, the search fee, the designation fee or the examination fee is not paid in due time, the application shall be deemed to be withdrawn (R. 160(1) EPC).

6. Payment of fees

The amounts of fees are set out in the Schedule of fees and expenses, which is published from time to time as a supplement to the Official Journal of the EPO. Applicants should always check the fee amounts applying at the time of payment.

Payments can be validly made by any person. Permissible methods of payment are laid down in Article 5 RFees. Please note that payment cannot be made by cheque sent to the EPO.

For information on the calculation of the additional fee for applications comprising more than 35 pages, see Notice from the European Patent Office dated 26 January 2009 concerning the 2009 fee structure, OJ EPO 2/2009, 118, and Guidelines for Examination in the EPO, April 2009, A-III, 13.2. For an overview of search and examination fees, see Notice from the European Patent Office of 11 February 2008 (OJ EPO 2008, 130).

The above and further fee-related information is available on the EPO website (<http://www.epo.org>).

7. If the applicant had appointed a representative during the application's international phase, the present Form will be sent to the representative, asking him to inform the applicant accordingly.

All subsequent communications will be sent to the applicant, or - if the EPO is informed of his appointment in time - to the applicant's European representative.

8. For more details about time limits and procedural acts before the EPO as designated or elected Office, see the EPO brochure "How to get a European patent", Guide for applicants - Part 2, PCT procedure before the EPO - "Euro-PCT".

This brochure, the list of professional representatives before the EPO as well as Form 1200 are available on the Internet under <http://www.epo.org>.

Receiving Section



Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US2007/026355

International filing date: 27 December 2007 (27.12.2007)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/877,333
Filing date: 27 December 2006 (27.12.2006)

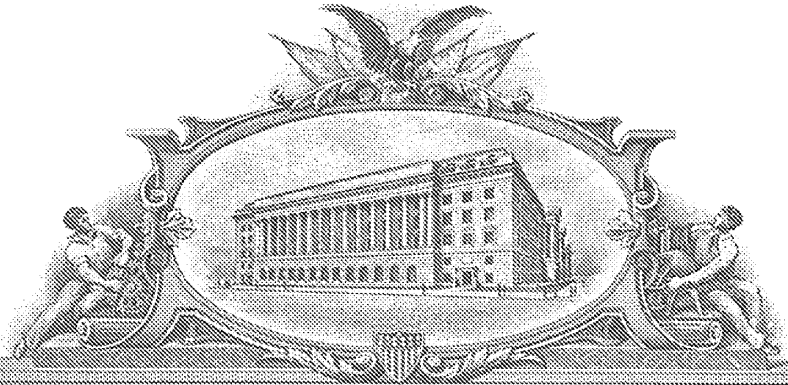
Date of receipt at the International Bureau: 27 January 2008 (27.01.2008)

Remark: Priority document submitted or transmitted to the International Bureau in
compliance with Rule 17.1(a) or (b)



World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

34289



THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

January 27, 2008

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: 60/877,333

FILING DATE: December 27, 2006

RELATED PCT APPLICATION NUMBER: PCT/US07/26355

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US60/877,333



Certified by

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

17236 U.S. PTO
122706

PTO/SB/16 (07-06)

Approved for use through 01/31/2007. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV 517 992 961 US

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Michael D.	Levin	Los Altos, CA

Additional inventors are being named on the _____ separately numbered sheets attached hereto

TITLE OF THE INVENTION (500 characters max):

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☒ The address corresponding to Customer Number: 34300

OR

☐ Firm or Individual Name

Address

City	State	Zip
Country	Telephone	Email

ENCLOSED APPLICATION PARTS (check all that apply)

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number of CDs _____

☒ Drawing(s) Number of Sheets 4

☐ Other (specify) _____

☒ Specification (e.g. description of the invention) Number of Pages 10

Fees Due: Filing Fee of \$200 (\$100 for small entity). If the specification and drawings exceed 100 sheets of paper, an application size fee is also due, which is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

METHOD OF PAYMENT OF THE FILING FEE AND APPLICATION SIZE FEE FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fee and application size fee (if applicable).

☒ Payment by credit card. Form PTO-2038 is attached

☐ The Director is hereby authorized to charge the filing fee and application size fee (if applicable) or credit any overpayment to Deposit Account Number: _____

200.00 **TOTAL FEE AMOUNT (\$)**

A duplicative copy of this form is enclosed for fee processing.

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PROVISIONAL APPLICATION COVER SHEET

Page 2 of 2

PTO/SB/16 (07-06)

Approved for use through 01/31/2007. OMB 0651-0032

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.



No.



Yes, the name of the U.S. Government agency and the Government contract number are:

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

SIGNATURE

Christopher W. Bosken

Date December 27, 2006

TYPED or PRINTED NAME Christopher W. Bosken

REGISTRATION NO. 58,887
(if appropriate)

TELEPHONE (336) 607-7366

Docket Number: 51851/338712

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

FEE TRANSMITTAL for FY 2005		Complete if Known	
		Application Number	To Be Assigned
		Filing Date	Herewith
		First Named Inventor	Michael D. Levin
		Examiner Name	To Be Assigned
☐ Applicant claims small entity status. See 37 CFR 1.27		Art Unit	To Be Assigned
TOTAL AMOUNT OF PAYMENT (\$) 200.00		Attorney Docket No.	IMM253P (51851/338712)

METHOD OF PAYMENT (check all that apply)
☐ Check ☒ Credit Card ☐ Money Order ☐ None ☐ Other (please identify) : _____

☒ Deposit Account Deposit Account Number: 16-1435 Deposit Account Name: _____

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below☐ Charge fee(s) indicated below, except for the filing fee☒ Charge any additional fee(s) or underpayments of fee(s)☒ Credit any overpayments

Under 37 CFR 1.16 and 1.17

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.
FEE CALCULATION**1. BASIC FILING, SEARCH, AND EXAMINATION FEES**

Application Type	FILING FEES		SEARCH FEES		EXAMINATION FEES		Fees Paid (\$)
	Fee (\$)	Small Entity Fee(\$)	Fee(\$)	Small Entity Fee(\$)	Fee(\$)	Small Entity Fee(\$)	
Utility	300	150	500	250	200	100	_____
Design	200	100	100	50	130	65	_____
Plant	200	100	300	150	160	80	_____
Reissue	300	150	500	250	600	300	_____
Provisional	200	100	0	0	0	0	_____

2. EXCESS CLAIM FEES**Fee Description**

Each claim over 20 (including Reissues)

Small Entity

Fee (\$) Fee (\$)

Each independent claim over 3 (including Reissues)

50 25

Multiple dependent claims

200 100

Total Claims

360 180

-20 or HP= _____ x _____ = _____

Multiple Dependent Claims

Fee (\$) Fee Paid (\$)

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims

-3 or HP= _____ x _____ = _____

HP = highest number of independent claims paid for, if greater than 3.

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
10	- 100 = _____	/ 50 = _____ (round up to a whole number) x _____ = _____	_____	_____

4. OTHER FEE(S)

Non-English Specification, \$130 fee (no small entity discount)

Fees Paid (\$)

Other (e.g., late filing surcharge) : _____

SUBMITTED BY

Signature	<i>Christopher W. Bosken</i>	Registration No. (Attorney/Agent)	58,887	Telephone	(336) 607-7366
Name (Print/Type)	Christopher W. Bosken	Date	December 27, 2006		

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing this form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

EXPRESS MAIL CERTIFICATE

"Express Mail" label number: EV 517 992 961 US

Date of Deposit: December 27, 2006

Type of Document(s): Provisional Patent Application Cover Sheet;
Fee Transmittal (*in duplicate*);
Specification (10 pages);
Drawings (4 sheets);
Credit Card Payment Form (PTO-2038)
for \$200.00; and
Return postcard.

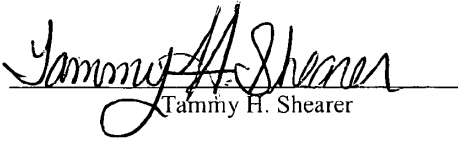
Serial No.: Unassigned

Date Filed: Herewith

Applicant: Michael D. Levin

Title: Virtual Detents Through Vibrotactile Feedback

I hereby certify that the documents identified above are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and are addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.



Tammy H. Shearer

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

FIELD OF THE INVENTION

[001] The present invention relates generally to input devices that provide haptic feedback. The present invention more particularly relates to systems and methods for virtual detents through vibrotactile feedback method.

BACKGROUND

[002] Traditional mechanical device controls include switches, knobs, levels and the like. In the past, such controls have been essentially mechanical in nature, e.g., a knob turning a shaft coupled to a potentiometer to control an electrical input to a device such as a radio or audio amplifier, a knob turning a shaft coupled to a fan control or heating/air conditioning control in an automobile, a lever controlling the opening and closing of a vent in an automobile, etc.

[003] With many traditionally mechanical functions being replaced by electronics, operation of electronic controls has been made less intuitive to users. For example, without click-stops or “detents,” or otherwise a sense of mechanical resistance, it may be difficult to obtain a similar experience from an electronic substitute for a traditional mechanical control device or even effectively and efficiently operate such a device.

[004] Accordingly, what is needed is a cost-effective device and method to provide effective haptic effects to an input device.

SUMMARY OF INVENTION

[005] Embodiments of the present invention provide systems and methods for virtual detents through vibrotactile feedback.

[006] In one embodiment, an actuator is controlled to produce a vibrotactile feedback effect in synchronization with sensed motion on an input. The vibrotactile feedback is perceived by the user to be similar to the feel of a mechanical detent. In another embodiment, a plurality of actuators are controlled to produce vibrotactile feedback effects.

[007] Some embodiments of the invention may be used in products that utilize input devices without mechanical feedback. An illustrative application would be to simulate rotary or linear encoders and potentiometers or faders. This could be a cost effective way to eliminate the precision mechanical detent components required in some applications. Such embodiments can also provide enhanced functionality over mechanically produced detents.

[008] The vibrotactile feedback provided by such an embodiment can aid a user in selection of menus, level control (i.e. volume, speed, or strength), tone control (i.e. bass, treble, hue, balance, or fade), frequency control, climate control, and navigation of lists. The vibrotactile feedback may be synchronized with changes in a system, such as an audio system.

DETAILED DESCRIPTION

An Illustrative Device for Providing Virtual Detents Through Vibrotactile Feedback

[009] One embodiment of the present invention simulates mechanical detents through vibrotactile feedback. Figure 1 is a top plan view of a rotary input control device of such an

embodiment. The device 100 in Figure 1 is a media device which includes a body 102 having a graphical user interface display 104 as well as an input device 106.

[0010] In the embodiment shown, the input device 106 is a knob capable of being rotated clockwise or counterclockwise. In other embodiments, the input device 106 may have various designs, including, but not limited, to conical shapes, spherical shapes, oval shapes, dials, cubical shapes, rods, etc. In other embodiments, the input device may have one or more textures on its circumferential surface, including but not limited to, bumps, lines, grooves, or other grips, or even projections or members extending from the circumferential surface. Such shapes and textures may allow a user to easily grip or contact the input device 106 and rotate it a desired amount. Alternatively, the input device 106 may be a vertical or horizontal slider, or a touchpad.

[0011] In the embodiment shown, as a user rotates the input device 106, vibrotactile feedback in the form of virtual mechanical detents are provided to the knob. For example, as a user rotates the knob to adjust the volume, virtual mechanical indents are provided to the knob. As a further example, once the volume is at a maximum or minimum level, no virtual mechanical detents may be provided, indicating to the user that a threshold level has been reached.

Illustrative Examples of Virtual Detent Profiles

[0012] A simulated mechanical detent, or virtual detent, may be a hard stop perceived by a user as the user manipulates an input device. The perception of a virtual detent might be a jolt or bump. The virtual detent may be closer to a hard stop, serving to provide a strong resistance to further manipulation of the input device, or the virtual detent may be a soft stop that provides some resistance to the user which may be overcome by applying enough force on the input device.

[0013] Figures 2A, 2B, 2C, 2D, 2E, 2F, 2G, and 2H each illustrate examples of a detent profile in one or more embodiments. In Figures 2A-2H, the input device 106 is shown as a knob on the right along with a representation of the vibrotactile feedback profile corresponding to the input device 106 shown on the left. It should be noted that the following vibrotactile feedback profiles are merely examples and that the input device 106 may be configured to output other vibrotactile feedback profiles not specifically described. It should be noted that the input device 106 may output a combination of two or more of the vibrotactile effect profiles based on the application.

[0014] Figure 2A depicts a virtual detent effect haptic profile in accordance with one embodiment. As shown in Figure 2A, virtual detents A-E may emulate the feel and function of mechanical detents.

[0015] Figure 2B depicts a hard stop haptic effect profile in accordance with one embodiment. Virtual hard stops may be used to emulate the feel and function of mechanical hard stops, and may be selectively output by the input device 106 based on the application of the input device 106.

[0016] Figure 2C depicts a hill effect haptic profile in accordance with one embodiment. A hill is a plateau style of wide detent. A hill effect could be used for menu wrap-around features as well as informing the user that he or she has moved from a last menu item to a first menu item. The hill effect may also be used to indicate a return from a sub-menu back to the main menu or to signal the crossing of a boundary.

[0017] Figure 2D depicts a compound effect haptic profile in accordance with one embodiment. A compound effect includes two or more effects such as barriers and detents. Compound effects help designers to closely match tactile sensations to operational steps, which may enhance usability. For the example shown in Figure 2D, the compound effect,

which would be appropriate for Fade Control on a car stereo, may include small detents (shown as “A” and “C”) with a deeper center detent (shown as “B”) and barriers on each end.

[0018] Figure 2E depicts a spring effect haptic profile in accordance with one embodiment. The spring effect force profile provides a good return-to-default position like that used for shuttle control to regulate speed. In the embodiment shown in Figure 2E, the input device 106 has a virtual spring at position A. It should be noted, however, that the input device 106 may have virtual springs in various positions on the input device 106. As the input device 106 is sensed being rotated toward position A in Figure 2E, a gradual resistive force is applied to input device 106. As the movement of the input device 106 approaches position A, the resistive force applied the input device 106 will approach infinity such that the user is no longer able to move the input device 106. If the user releases the input device 106 the input device 106 may spring back to its default position C.

[0019] Figure 2F depicts a damper effect force profile in accordance with one embodiment. A damper effect is a force that increases or decreases with controller speed. Damper effects create the sensation of drag or weight and may be used to emulate the feel of high-quality controls such as those found on expensive audio equipment. A damper effect might also emulate a jog control used to move through music tracks, menu items, video frames, or data stacks. The damping force may be used to slow the input device 106 down or provide feedback to the user that the input device 106 is near the end selection on a menu list.

[0020] Figure 2G depicts a constant force effect profile in accordance with an embodiment. A constant force effect is a continuous force independent of the instantaneous position of the input device 106. In other words, the force applied by the actuator does not necessarily change as the input device 106 is rotated toward or away from a certain position, such as spring force or damping effects. The constant force profile may be used by the device to simulate dynamics such as gravity, friction, or momentum.

[0021] Figure 2H depicts a periodic force effect profile in accordance with one embodiment. A periodic force effect is a vibration lasting for a set period of time, whereby the vibration has a sine, square, or triangular wave characteristic. In one embodiment, the wave characteristics of the vibration are randomly generated.

An Illustrative Diagram for Providing Virtual Detents Through Vibrotactile Feedback

[0022] Figure 3 is a block diagram of one embodiment of the invention. A virtual detent system according to the embodiment shown in Figure 1 comprises an input device 302, at least one actuator 304, a processor 306, and at least one system to be manipulated 308 (shown as systems 308a, 308b, and 308c).

[0023] In the embodiment shown, the processor 306 is in communication with the input device 302, the at least one system to be manipulated 308, and the at least one actuator 304. The processor 306 may be configured to receive an input signal from the input device 302, transmit a system signal to a system to be manipulated 308, and transmit an actuator signal to the actuator 304. In one embodiment, the system signal may be based at least in part on the input signal. In a further embodiment, the actuator signal may be based at least in part on the input signal. In one embodiment, the system signal and/or the actuator signal may be transmitted in response to the input signal.

The Processor

[0024] The processor comprises a computer-readable medium, such as a random access memory (RAM) coupled to the processor. The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs for generating haptic effects. Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable

gate arrays (FPGAs), and state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

[0025] Such processors may comprise, or may be in communication with, media, for example computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, an electronic, optical, magnetic, or other storage or transmission device capable of providing a processor, such as the processor in a web server, with computer-readable instructions. Other examples of media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other forms of computer-readable media may transmit or carry instructions to a computer, such as a router, private or public network, or other transmission device or channel. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein.

The System to be Manipulated

[0026] A virtual detent system according to the present invention may be configured to manipulate a variety of systems. For example, a user might want to adjust the volume of a stereo system, change the channel of a television, or select an item in a menu. Further

examples of changes to a system may include changes in a display, menu selection, climate control, radio or television tuning, control of an electromechanical system, or changes to the volume, speed, strength, frequency, or tone.

The Input Device

[0027] An input device suitable for use in various embodiments of the present invention may comprise a mechanical or non-mechanical device. For example, an input device may be any of a number of mechanical devices such as a potentiometer, a rotary optical encoder, or a linear optical encoder. The input device may also be non-mechanical, such as a touchpad, touch screen, or non-contact sensor.

The Actuator

[0028] In one embodiment, an input device may be coupled to an actuator. In other embodiments, an input device may be coupled to a plurality of actuators. The at least one actuator may be configured to provide a haptic effect to the input device. The at least one actuator may be, for example, an eccentric rotating mass motor (ERM) or a linear resonant actuator (LRA). The at least one actuator may be configured to produce a vibrotactile feedback effect in synchronization with sensed motion on an input.

[0029] The vibrotactile feedback may be programmed to only respond when a valid input is received. For example, vibrotactile feedback in the form of mechanical detents may only occur when the control is enabled and within a valid range. If the controlled function is at a minimum or maximum and the user wishes to exceed this value, the vibrotactile feedback may be disabled, providing valuable information to the user that they are no longer operating in a valid range. Similarly, if the input control is not active or the device is not powered on, the absence of feedback may notify the user of this state. In other embodiments, the vibrotactile feedback responds when invalid input is received.

[0030] The frequency and strength of the simulated detents may also be varied to inform the user of differing levels of control. For example, strength can represent the level of the menu structure (big decision versus small decisions) or amplitude of the function (i.e. volume). High and low strength tactile feedback can be combined to show divisions in a list (i.e. separate names by letter, or numbers at every multiple of 10) or highlighted points in a range (i.e. center position in a balance control). Frequency can represent the speed of navigation, or number of elements in a list.

An Illustrative Method for Providing Virtual Detents Through Vibrotactile Feedback

[0031] Another embodiment of the present invention can be seen in Figure 4. In the first step, an input signal motion is received 402. As an example, an input signal may be generated when a user rotates a knob in order to navigate a menu structure. In one embodiment, an input device may send an input signal to a processor indicating motion on the input device.

[0032] A sensor may provide information regarding aspects of the user's manipulation of an input device, such as torque applied to a knob, rotary position obtained by a knob, time at which an input device is manipulated, velocity of a knob rotation, and acceleration of a knob rotation.

[0033] Next, it is determined whether a user desires to manipulate a system function or parameter 404. For example, the processor may receive an input and determine that a user wants to decrease the volume of an audio system.

[0034] If the user wants to manipulate a system function or parameter, a system signal and an actuator signal may be output 406. In one embodiment, the processor outputs a system signal and an actuator signal.

[0035] Operation of the actuator and manipulation of a system may occur substantially simultaneously. For example, the processor may send a signal to the actuator and to a system to be manipulated at substantially the same time. In particular, the processor may send a signal to an audio system to increase the volume, while substantially simultaneously sending a signal to the actuator, causing the actuator to simulate a vibrotactile detent.

[0036] In a further example, the operation of the actuator may be synchronized with changes in a display. In particular, a user may desire to change levels in a menu. When the processor determines the user wants to navigate the menu system, the processor updates the menu display and simultaneously pulses the actuator to simulate a mechanical detent.

General

[0037] The foregoing description of the embodiments, including preferred embodiments, of the invention has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Numerous modifications and adaptations thereof will be apparent to those skilled in the art without departing from the spirit and scope of the this invention.

EXPRESS MAIL NO. EV517992961US

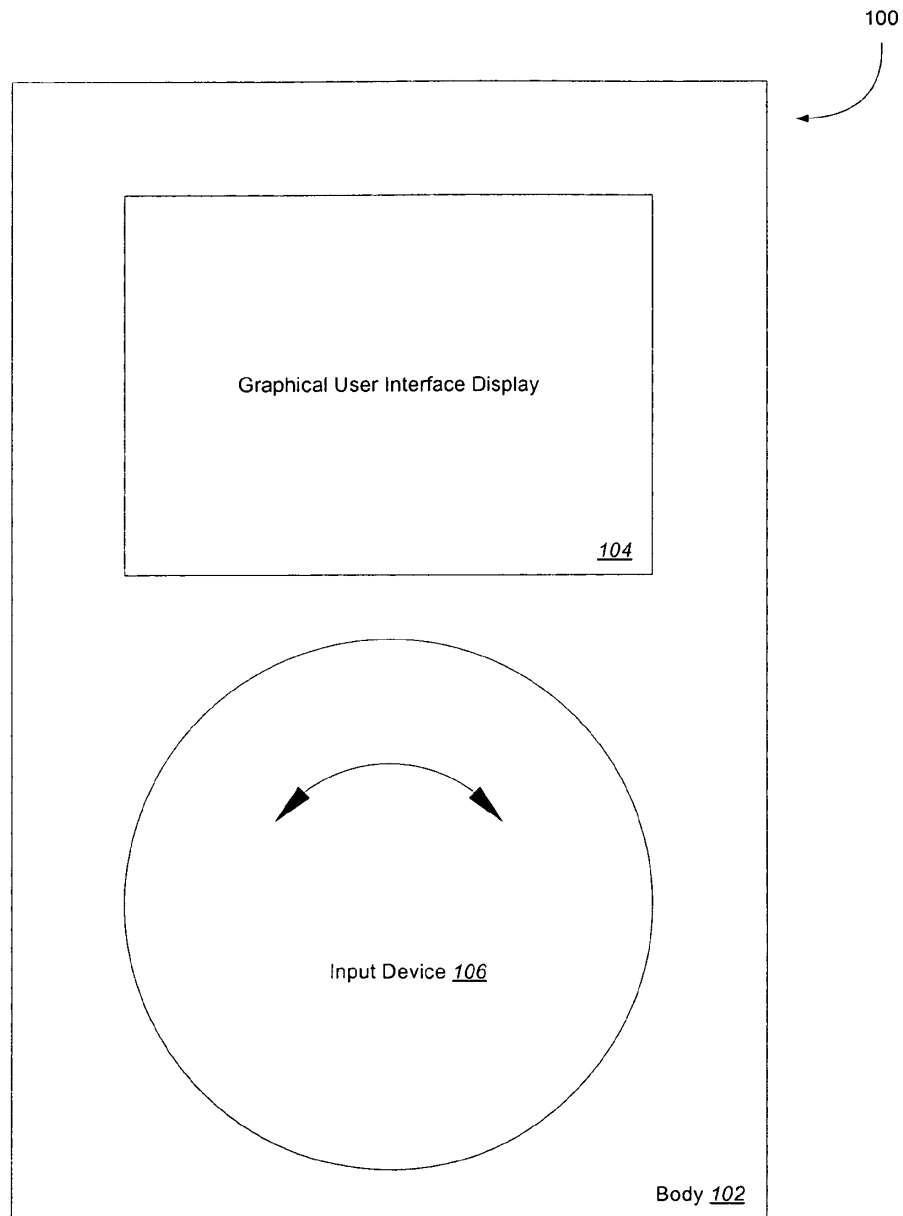


Figure 1

BEST AVAILABLE COPY

EXPRESS MAIL NO. EV517992961US

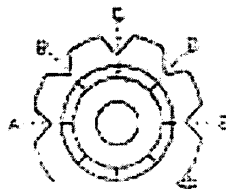
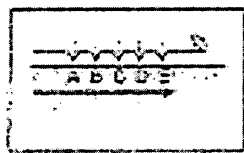


Figure 2A

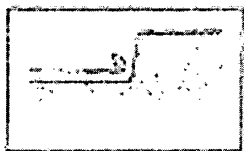


Figure 2B



Figure 2C

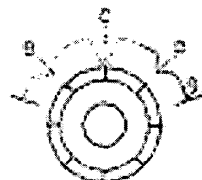
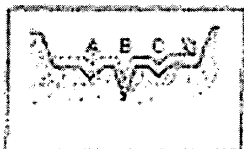


Figure 2D

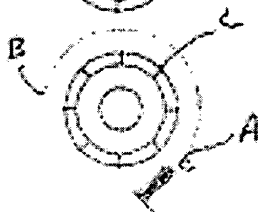
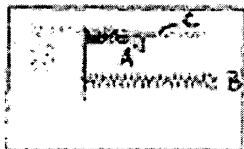


Figure 2E

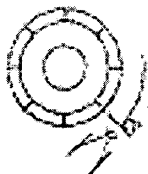
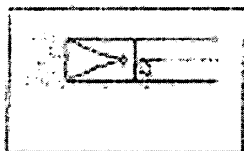


Figure 2F

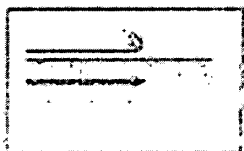


Figure 2G

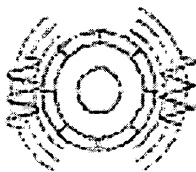
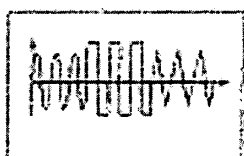


Figure 2H

BEST AVAILABLE COPY

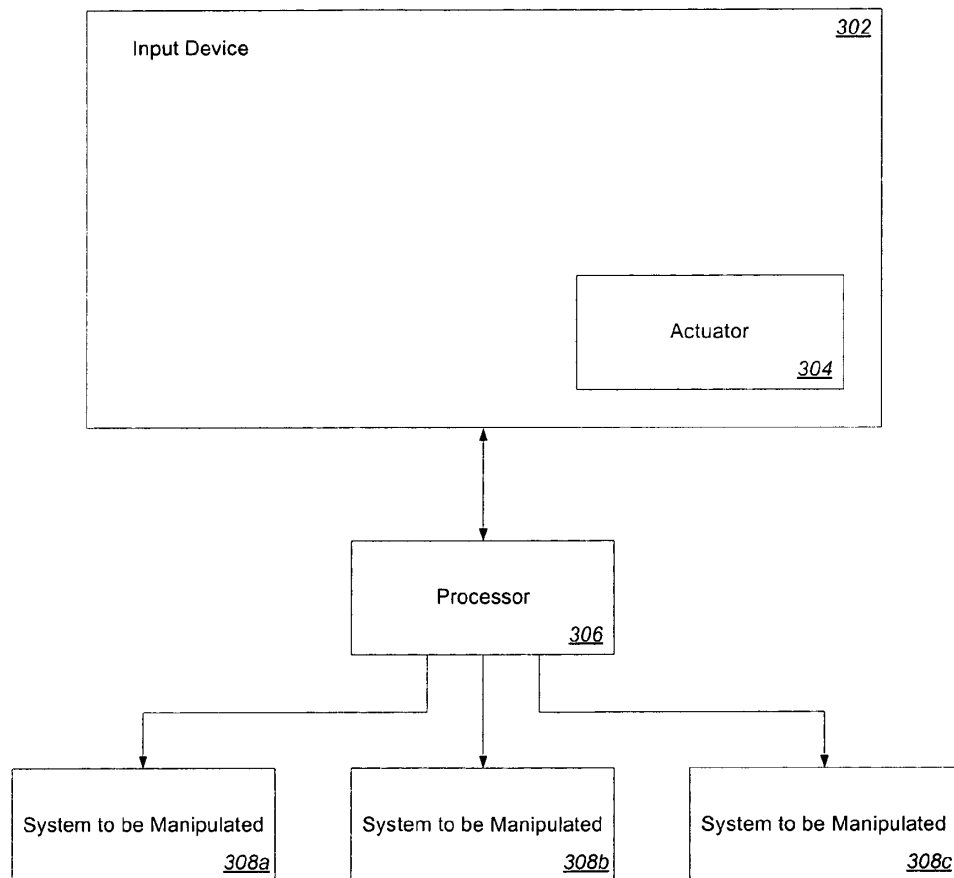


Figure 3

BEST AVAILABLE COPY

EXPRESS MAIL NO. E1/S17992961 US

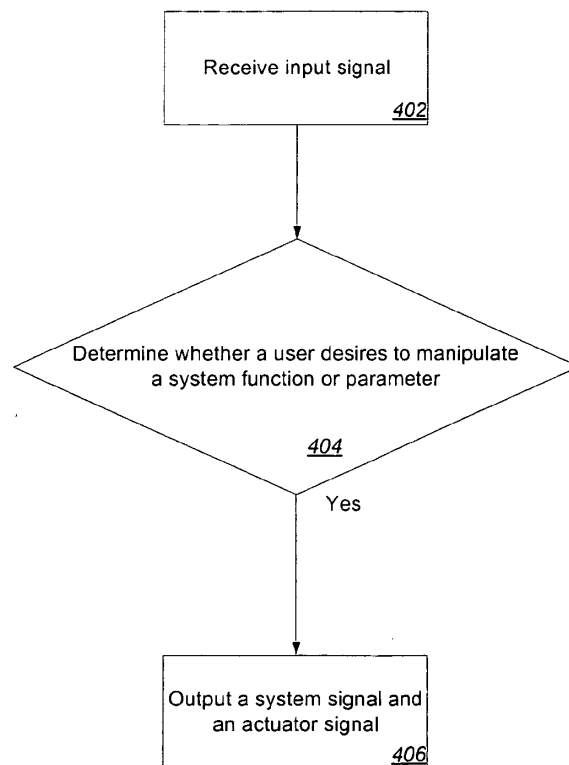


Figure 4

BEST AVAILABLE COPY

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
17 July 2008 (17.07.2008)

PCT

(10) International Publication Number
WO 2008/085487 A1

(51) International Patent Classification:
G06F 3/01 (2006.01)

(21) International Application Number:
PCT/US2007/026355

(22) International Filing Date:
27 December 2007 (27.12.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/877,333 27 December 2006 (27.12.2006) US

(71) Applicant (for all designated States except US): **IMMERSION CORPORATION** [US/US]; 801 Fox Lane, San Jose, California 95131 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **LEVIN, Michael, D.** [US/US]; 1230 Gronwall Court, Los Altos, California 94024 (US).

(74) Agents: **GARDNER, Steven** et al.; Kilpatrick Stockton LLP, 1001 West Fourth Street, Winston-salem, North Carolina 27101 (US).

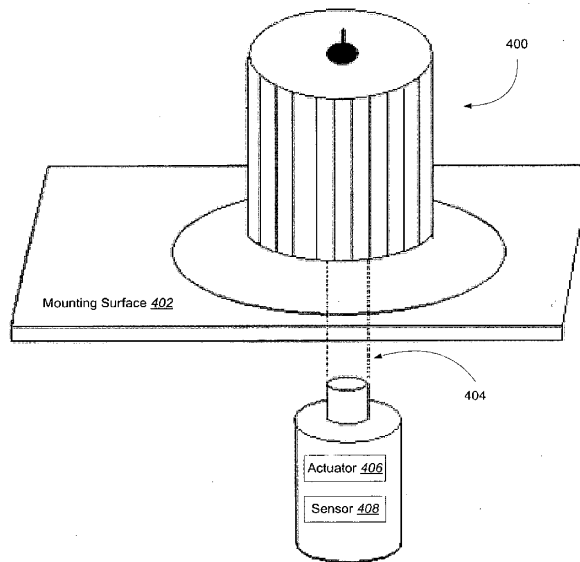
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(54) Title: VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK



(57) Abstract: Systems and methods for virtual detents through vibrotactile feedback are described. One described method includes receiving an input signal comprising information associated with the manipulation of an input device and generating a signal configured to cause an actuator to provide a vibrotactile effect to the input device, the vibrotactile effect comprising a virtual detent.

WO 2008/085487 A1

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

CROSS-REFERENCES TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application No. 60/877,333 entitled "Virtual Detents through Vibrotactile Feedback," filed December 27, 2006, the entirety of which is hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention generally relates to vibrotactile feedback. More particularly, the present invention relates to methods and systems for providing virtual detents through vibrotactile feedback.

BACKGROUND

Traditional mechanical device controls include switches, knobs, levels, sliders, faders, and the like. In the past, such controls have been essentially mechanical in nature, e.g., a knob turning a shaft coupled to a potentiometer to control an electrical input to a device such as a radio or audio amplifier, a knob turning a shaft coupled to a fan control or heating/air conditioning control in an automobile, or a lever controlling the opening and closing of a vent in an automobile.

With many traditionally mechanical functions being replaced by electronics, operation of electronic controls has been made less intuitive to users. For example, without click-stops or "detents," or otherwise a sense of mechanical resistance, it may be difficult to obtain a similar experience from an electronic substitute for a traditional mechanical control device or even effectively and efficiently operate such a device. A detent, such as a mechanical detent, can refer to the resistance of rotation of a wheel or shaft. A detent can be used to divide a rotation into discrete increments, or may be used to arrest rotation in a direction. For instance, a mechanical detent can be constructed from a notched wheel and a small gravity or spring-actuated lever.

SUMMARY

Embodiments of the present invention disclosed herein provide methods and systems for providing virtual detents through vibrotactile feedback.

One embodiment of the invention is a method comprising the steps of receiving an input signal that comprises information associated with the manipulation of an input device, and generating a vibrotactile signal configured to cause an actuator to produce a vibrotactile effect comprising a virtual detent to the input device. In another embodiment, a computer-

readable medium (such as, for example, random access memory or a computer disk) comprises code for carrying out such a method.

Another embodiment of the invention is a system comprising an input device and a processor that is in communication with the input device and that is configured to receive an input signal comprising information associated with the manipulation of the input device. The processor may further be configured to generate a detent signal based at least in part on the manipulation of the input device. The system may further comprise an actuator coupled to the input device. The actuator may be in communication with the processor and configured to produce to the input device a vibrotactile effect comprising a virtual detent based at least in part on the detent signal.

Further details of embodiments of the invention are set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the invention are better understood when the following Detailed Description is read with reference to the accompanying drawings, wherein:

Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention;

Figure 2 is a block diagram illustrating a second system for providing virtual detents through vibrotactile feedback in one embodiment of the invention;

Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention;

Figure 4 is an illustration of a second device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention;

Figure 5 is a flow diagram illustrating a first method for virtual detents through vibrotactile feedback;

Figure 6 is a flow diagram illustrating a second method for virtual detents through vibrotactile feedback;

Figure 7 is a flow diagram illustrating a third method for virtual detents through vibrotactile feedback;

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through vibrotactile feedback; and

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent profiles in various embodiments of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention provide methods and systems for virtual detents through vibrotactile feedback. In one illustrative embodiment, a rotary knob input device is rotated. A sensor detects the rotation of the rotary knob and sends an input signal to a processor. The input signal comprises information related to the rotation of the rotary knob, such as how far the knob has been turned. The processor determines whether to manipulate an audio system based at least in part on the input signal. The processor further determines whether to generate a signal configured to cause an actuator to vibrate the rotary knob, the vibration based at least in part on the signal.

10 This example is given to introduce the reader to the general subject matter discussed. The invention is not limited to this example. Below, examples of methods and systems for virtual detents through vibrotactile feedback are described.

Illustrative Devices for Enhanced Haptic Feedback

In one illustrative embodiment of a device configured to provide virtual detents through vibrotactile feedback, a portable music player may be configured to play music through a speaker and produce a virtual detent on a touch pad with an actuator. In one such embodiment, the portable music player may comprise a touch pad configured to generate an input signal to a processor based on a user contact. The processor may analyze the input signal and determine whether to manipulate the audio system and whether to generate a vibrotactile effect. If the processor determines a vibrotactile effect should be generated, the processor may generate a signal. The signal may be configured to cause the actuator to produce a vibrotactile effect to the touch pad in the form of a virtual detent.

25 Such an illustrative embodiment may be advantageously employed to simulate mechanical detents through vibrotactile feedback. Such simulated mechanical detents, or virtual detents, may provide useful feedback to a user. For example, a virtual detent may indicate the successful change in volume of a sound system. As another example, the absence of a virtual detent may indicate that a climate system is not turned on, or that it has reached the highest threshold of operation.

30 These further examples are given to introduce the reader to the general subject matter discussed herein. The invention is not limited to these examples. The following sections describe various embodiments of systems and methods for providing virtual detents through vibrotactile feedback.

Example of a First System for Virtual Detents through Vibrotactile Feedback

Referring now to the figures in which like numerals indicate like elements throughout the several figures, Figure 1 is a block diagram illustrating a first system for providing virtual detents through vibrotactile feedback in one embodiment of the invention. In the
5 embodiment shown, the system comprises an input device 102, a sensor 104, a processor 106, an actuator 108, and a system to be manipulated 110.

The Input Device and Sensor

Systems of the invention comprise an input device 102 and a sensor 104. The input device 102 shown in Figure 1 is configured to provide an input signal to the processor when
10 the input device 102 is manipulated. In other embodiments, sensor 104 can generate an input signal when the sensor 104 detects manipulation of the input device 102.

The input device 102 can be, for example, a mechanical input device. Examples of mechanical input devices include a rotary knob coupled to an encoder. Encoders of the input device 102 may comprise an optical encoder or a potentiometer. In other embodiments, the
15 input device 102 may be a non-mechanical input device. For example, the input device 102 may be a touch-sensitive device, such as a touch pad or a touch screen.

The input device 102 is in communication with a sensor 104. The sensor detects movement of the input device 102. A sensor 104 can be configured to detect the movement of a rotary knob, or other aspects of manipulation of the input device 102, such as position,
20 velocity, acceleration, torque, rate of rotation, or the time of rotation.

Sensor 104 shown in Figure 1 comprises a contact-type sensor, such as a switch, a resistive sensor, a capacitive sensor, an infrared sensor, or an optical sensor. Alternatively, sensor 104 may comprise a non-contact sensor such as a field effect sensor or a proximity sensor, and can be a surface or sub-surface sensor.
25

The Processor

The system illustrated in Figure 1 comprises a processor 106. The processor 106 may be configured to receive input signals from an input device 102 or a sensor 104 and to generate signals to an actuator 108. The signals may be configured to cause the actuator 108 to produce a vibrotactile effect. Further, the processor can generate signals provided to a
30 system to be manipulated 110.

In one embodiment, a dedicated processor 106 may receive input signals and generate signals. Although there is a single processor shown in Figure 1, the system may comprise a plurality of processors. The processor 106 may be configured to perform a variety of tasks.

For example, the processor 106 may comprise additional program code running on a native cellular phone processor.

The processor 106 may be configured to receive input signals. In some embodiments, the processor 106 may receive input signals from the input device 102. In other
5 embodiments, the processor 106 may receive input signals from the sensor 104. In the embodiment shown in Figure 1, the input device 102, sensor 104 and the processor 106 are in communication via a direct wired digital connection. For example, the input device 102, sensor 104, and the processor 106 may be in communication via a communication bus such as the Universal Serial Bus (USB). In other embodiments, communication between an input
10 device 102, sensor 104 and the processor 106 may be through analog signals and/or may be wireless. For instance, the sensor 104 may be able to use Bluetooth, Wireless USB or Wi-Fi to communicate with the processor 106.

The processor 106 can also generate one or more signals. For example, a processor may generate a signal when a valid input signal is received. In the embodiment shown in
15 Figure 1, as the input device 102 is manipulated, the processor 106 may generate a signal at the same time or immediately after the manipulation. In one embodiment, the processor 106 may process software code running as an application on the processor and utilize the input signal in the context of the software code to generate signals configured to cause virtual
detents.

20 The processor 106 may generate a signal, such as a detent signal, to the actuator 108. The detent signal may be configured to cause an actuator 108 to produce a vibrotactile effect in the form of a virtual detent on the input device 102.

The processor 106 may generate a signal specific to an actuator 108. In one embodiment, the signal may be generated with parameters specific to the actuator 108. For
25 example, the processor may analyze parameters associated with the actuator 108, such as the actuator's resonant frequency, and generate a signal based at least in part on the parameters. Other parameters of the actuator 108 may comprise, for example and without limitation, a resonant frequency of the actuator, a maximum peak-to-peak amplitude or magnitude of the actuator, or a minimum actuator response time.

30 The processor 106 may generate a signal by accessing a detent profile stored in a memory (not shown in Figure 1). In one embodiment, the processor 106 may access a specific detent profile based at least in part on the input signal. In certain embodiments, the processor 106 may determine which of a plurality of simulated mechanical detents to generate. For example, the processor 106 may analyze the input signal and determine that a

hard stop is appropriate. Further, the processor 106 may then access the hard stop virtual detent profile in a memory, and generate a detent signal based on the hard stop virtual detent profile.

5 The processor 106 may be in communication with a system to be manipulated 110 or controlled. In some embodiments, the processor 106 may be configured to generate a system signal. The system signal may be provided to the system to be manipulated 110.

10 The system signal may be based at least in part on the manipulation of the input device. For example, an input device 102 in the form of a rotary knob may be rotated one entire revolution. The processor 106 may receive an input signal indicating the complete rotation of the input device 102 and generate a system signal configured to manipulate a system 110 by maximizing or minimizing a level of the system.

15 While the device shown comprises one processor 106, other devices may comprise two or more processors. Processor 106, as well as other processors incorporated into one or more embodiments of the present invention, may comprise a computer-readable medium, such as a random access memory (RAM) coupled to the processor (not shown in Figure 1). The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs for generating vibrotactile or other haptic effects. Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable gate arrays (FPGAs), and state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

25 Such processors may comprise, or may be in communication with, media, for example computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, an electronic, optical, magnetic, or other storage or transmission device capable of providing a processor with computer-readable instructions. Other examples of media comprise, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other forms of computer-readable media may transmit or carry instructions to a computer, such as a router, private or public network, or other transmission device or

channel. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein. The instructions can comprise code from any suitable computer-programming language, including, for example, assembly code, C, C+, C++, Visual Basic, Java, Python, and JavaScript.

The Actuator

The system illustrated in Figure 1 further comprises one or more actuators 108. Each actuator 108 can be configured to receive a signal from the processor 106 and provide vibrotactile effects to the user in the form of virtual detents. The actuator 108 can vibrate the input device 102 to provide vibrotactile feedback.

The actuator 108 can provide vibrotactile feedback based on signals received from the processor 106. For example, the actuator 108 may be configured to generate a vibration after receiving a detent signal from the processor 106. The actuator 108 can vibrate the input device 102 at substantially the same time the input device is being manipulated.

The actuator 108 may be configured to simulate mechanical feedback through vibrotactile feedback. Specifically, in some embodiments the actuator 108 may be configured to provide the perception of a detent (i.e. a virtual detent) without the traditional means necessary for a mechanical detent. For example, the actuator 108 may be used in place of various mechanical components which traditionally provided tactile feedback, such as springs, brakes or cams. In some embodiments, the vibrotactile feedback may comprise a click effect replicating a mechanical click. In other embodiments, the vibrotactile feedback may not comprise a click effect, but some other effect, such as a spring effect or a barrier effect.

The actuator 108 may be configured to generate vibrotactile feedback with a variety of different characteristics. For example, the actuator may be configured to generate vibrotactile feedback with different frequencies, amplitudes, or waveforms. In one embodiment, the virtual detent may comprise a simulated click generated through a single pulse. In a second embodiment, the virtual detent may comprise a click-and-release effect generated by a double pulse. Figure 9 provides illustrations of various virtual detent profiles.

Because the actuator 108 may be configured to generate vibrotactile feedback, in contrast to mechanical feedback, the actuator 108 may provide vibrotactile feedback to non-mechanical input devices 102, such as a touch-sensitive pad, i.e., a touch pad or touch screen.

The actuator 108 may be configured to generate various types of vibrotactile feedback. For example, the actuator 108 may be configured to produce different virtual detents. The vibrotactile feedback may be generated in various directions. For example, the actuator 108 may vibrate the input device orthogonal to the motion of the input device.

5 The actuator 108 can be any of a variety of different types of force producing devices, including an eccentric rotating mass (ERM) actuator, a multifunctional (MFT) actuator, a linear mass actuator, an electro-magnetic actuator, a motor, a voice coil, a pneumatic or hydraulic actuator, an electro-active polymer, or any other suitable actuator. In one embodiment, actuator 108 may comprise a plurality of actuators of the same or different
10 design. For example, in one embodiment, two actuators may be employed. A first actuator may be configured to provide vibrotactile or other haptic effects having a high frequency of vibration (e.g. greater than 400Hz), while a second actuator may be configured to provide vibrotactile or other haptic effects having a low frequency of vibration (e.g. less than 400Hz).

15 Since some embodiments of the invention may use the actuator 108 to generate vibrotactile feedback, as opposed to mechanical feedback, a smaller actuator may be used than in other devices. For example, actuator 108 may comprise a circular actuator ten (10) millimeters in diameter and three and one half (3.5) millimeters thick.

20 Since the device may comprise a plurality of actuators, the number of actuators 108 may be based on the size and mass of the device. For example, an actuator 108 may be provided for every one hundred (100) grams of mass of the system. In such an example, a system measuring three hundred (300) grams may comprise three actuators. In another example, a cellular phone measuring three hundred (300) grams may only comprise a single but more powerful actuator.

25 In one embodiment, the number of actuators 108 may be based on what surface of the system is being vibrated. For example, if a PDA measures four hundred (400) grams, but only the display will be vibrated, the system may comprise only one actuator 108, especially if the display is isolated from the rest of the device such as by a suspension system. Alternatively, if vibrotactile feedback is provided to the entire PDA, the system may
30 comprise two or more actuators.

Each actuator 108 of a plurality of actuators may be configured to generate vibrotactile feedback to the input device 102. In one embodiment, the vibrotactile feedback generated by each of a plurality of actuators is synchronized.

The actuator 108 can be mounted to a touch-sensitive display, such as a touch screen (not shown in Figure 1). In one embodiment, the actuator 108 is mounted underneath the display, or alternatively, to the edge of the display, or laterally mounted to the display. In embodiments where the actuator 108 is mounted to a display, the display may be mounted in
5 a suspension of compliant material, such as a foam gasket. Mounting a display to a foam gasket may ensure that the display is vibrated alone or with a different strength than the entire device.

In one embodiment, two actuators may be mounted to either side of a display. In one example, both actuators may face the same direction and be in the same phase. In one
10 embodiment, two side-mounted actuators may vibrate a screen side-to-side. Side-mounted actuators may produce consistent forces across a screen, since the screen may be moving in the direction of its rigidity.

In one embodiment, two actuators are mounted behind a display. In one example, both actuators mounted behind the display may face the same direction and can vibrate the
15 display in and out.

The System to Be Manipulated

The system illustrated in Figure 1 comprises a system to be manipulated 110. One or more systems to be manipulated 110 can each receive system signals from the processor 106. The system to be manipulated 110 may comprise a system capable of electrical or
20 electromechanical control, such as and without limitation, a stereo system, a video system, a climate system (e.g. air conditioning and/or heating), a navigation system, automotive systems, wireless communication devices, security systems, a television, a video game system, a washing machine or a drying machine, or an oven.

In one embodiment, the system to be manipulated 110 may comprise a single system,
25 such as a lighting system. In another embodiment, the system to be manipulated 110 may comprise a complex system comprising one or more elements. For example, the system to be manipulated 110 may be a heating and cooling system.

Example of a Second System for Virtual Detents through Vibrotactile Feedback

Figure 2 is a block diagram illustrating a second system for providing virtual detents
30 through vibrotactile feedback in one embodiment of the invention. In the embodiment shown, the system comprises a rotary encoder 202, a sensor 204, a processor 206, and a linear resonant actuator 208. The system further comprises a visual system 210a, an audio system 210b, a climate system 210c, a display 212, a speaker 214, and a memory 216. An example of a visual system 210a is a video game system. An example of an audio system 210b is a

stereo system. An example of a climate system 210c is an air conditioning and heating system.

As shown in Figure 2, the input device can be the rotary encoder 202. The sensor 204 is in communication with the rotary encoder 202 and the processor 206. As the rotary encoder 202 is manipulated, the sensor 204 generates input signals associated with the manipulation, and transmits the input signals to the processor 206.

Once the processor 206 receives an input signal, the processor 206 can determine whether to generate a detent signal and/or a system signal. For example, if the input signal indicates a rotation of a knob in more than 5 degrees of motion, the processor 206 may generate a system signal and a detent signal.

The processor 206 is in communication with the linear resonant actuator 208. The processor 206 can receive input signals comprising information associated with a manipulation of the rotary encoder 206 and generate a signal configured to cause the linear resonant actuator 208 to produce a vibrotactile effect to the rotary encoder 202, the vibrotactile effect comprising a simulated mechanical detent.

As shown in Figure 2, the processor 206 is in communication with three systems: a video system 210a, a stereo system 210b, and a climate system 210c. The processor is also in communication with a display 212 and a speaker 214. The processor may synchronize changes in the display 212, sounds played via a speaker 214, and vibrotactile feedback in the rotary encoder 202.

In other embodiments, the input device may comprise a different device, such as a touch pad. The touch pad (not shown) may be in communication with a sensor 204. The sensor 204 may be configured to detect movement on the touch pad.

The sensor 204 can directly transmit input signals to the processor 206. In a specific example, the sensor 204 may send an input signal to the processor 206 once the rotary encoder is rotated 2 degrees or more.

The processor 206 can be in communication with one or a plurality of systems to be controlled. The processor 206 can cause the display 212 to show a graphical representation of a menu structure. The processor 206 can synchronize vibrotactile feedback with other events, such as changes in the display 212 or sounds played on the stereo system 210b. In one example, as the navigation of a menu system is shown on display 212, the input device may be vibrated while each item on the menu is traversed.

The processor 206 can be configured to determine a specific detent signal to generate. The detent signal may be based at least in part on the system which is actively being

controlled. For example, if the video system 210a is being controlled, the processor 206 may generate one type of detent signal, such as a click effect. Alternatively, if the stereo system 210b is being controlled, the processor 206 may generate a second type of detent signal, such as a hard stop virtual detent.

5 As shown in Figure 2, the processor 206 comprises memory 216. The memory 216 can be a high-speed cache memory, and configured to store vibrotactile feedback effects, such as virtual detent profiles. In one embodiment, the processor can access an effect profile stored in memory 216 after the processor 206 has determined what type of vibrotactile effect to generate.

10 A default library of vibrotactile effects, such as virtual detents, may be stored in the memory 216. For example, the processor 106 may store each virtual detent profile illustrated in Figure 9 in the memory 216. This profile may take the form of computer code. In one embodiment, the processor may be programmed with various types of vibrotactile effects not previously stored in memory 216. For example, each user of the system may author
15 individual vibrotactile effects to store in memory 216. In a second embodiment, the processor 106 may only store vibrotactile effects programmed by a manufacturer. In one embodiment, characteristics of the actuator may be stored in memory 216. For example, the frequency response of a system's actuator may be stored in memory 216.

Virtual Detents Through Vibrotactile Feedback

20 Figure 3 is an illustration of a first device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. Various embodiments of the invention may be used in devices without mechanical feedback. In other embodiments, the invention may be used to supplement mechanical feedback.

 The device in Figure 3 comprises a portable music player 300 having a body 302, a
25 graphical user interface display 304, and a circular touch pad 306. Although the touch pad 306 shown in Figure 3 is circular, in other embodiments the touch pad 306 may be linear, rectangular, or some other configuration. As shown in Figure 3, the input device 306 may be in communication with a display 304. As an example, the input device 306 may be configured to navigate a menu system which may be shown on the display 304. In other
30 embodiments, the input device 306 may not be in communication with a display 304.

 While the embodiment shown in Figure 3 comprises a portable music player, other embodiments may comprise other devices, such as a personal digital assistant (PDA), a portable video player, a portable game system, or a portable navigation device. Other

examples may include other electronic devices or appliances, such as a television, oven, or a lighting system.

5 A user may interact with the portable music player 300 by activating the circular touch pad 306. For example, a user may select an object on a menu displayed on the graphical user interface display 304 by dragging a finger around the circular touch pad 306 in a clockwise or counter-clockwise direction.

10 An actuator (not shown in Figure 3) is coupled to the touch pad. As a user manipulates the circular touch pad 306, vibrotactile feedback in the form of virtual detents are provided to the user when the actuator vibrates the touch pad. The actuator generates virtual detents through vibrotactile feedback, to simulate mechanical feedback.

15 Since the vibrotactile feedback may be programmable and variable, providing different types of vibrotactile feedback on the same input device will provide an enhanced interface. Vibrotactile feedback may aid in the selection of menus, control of levels (such as volume, bass, treble, balance, etc.), and navigation of lists.

20 Vibrotactile feedback may be based on the validity of an input. In one example, vibrotactile feedback is provided when a valid input is received, such as when a control is enabled and within an allowed range. If the controlled function is at or reaches a maximum or a minimum, vibrotactile feedback may be disabled, providing information that the attempted control is outside of the valid range of the system. Similarly, if the system is not active or powered on, the absence of vibrotactile feedback may inform the user of that state.

The frequency and strength of the vibrotactile feedback may also be varied to provide an enhanced interface. In one embodiment, the type of vibrotactile feedback may be based at least in part on the content selected by a user.

25 In one embodiment the frequency and strength of the vibrotactile feedback notifies the user of various levels of control. A stronger virtual detent can indicate a bigger decision in comparison to a weaker virtual detent indicative of a smaller decision. High and low strengths of vibrotactile feedback can indicate divisions in a list (i.e. separate words by letter, or numbers at every multiple of 10). A high or low strength of vibrotactile feedback can also indicate one or more points in a range, for example, the center position of a balance control.

30 The frequency of the vibrotactile feedback may represent the speed of navigation of the user's finger across the touch active surface or across the number of elements in a list.

In one embodiment, each system that is controlled by the input device may be associated with a type or profile of vibrotactile feedback. For example, the actuator vibrates the input device at a constant intensity when an audio system is being controlled by the input

device, and vibrates the input device at a periodic intensity when a temperature system is being controlled.

In one embodiment, a combination of vibrotactile effects is linked as a vibrotactile theme. A vibrotactile theme can correspond with an individual function or system. One theme can comprise a combination of single clicks and double clicks to represent simulated mechanical feedback for a system being changed or a threshold being reached. Another theme can comprise a combination of a constant, low intensity vibration with a hard stop virtual detent effect. While the first theme can be assigned to one system, such as a climate system the second theme can be assigned to a second system, such as a stereo system.

Figure 4 is an illustration of a second device for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. The device in Figure 4 comprises a mechanical device, specifically a rotary knob 400. While the embodiment shown in Figure 4 comprises a rotary knob 400, other embodiments may comprise other input devices. In some other embodiments, the input device may comprise a linear or rotary encoder, a potentiometer, or a fader. Alternatively, other embodiments may comprise non-mechanical input devices, such as a touch-sensitive pad or a touch-sensitive screen.

The rotary knob 400 is configured to rotate in a rotary degree of freedom about an axis extending through the knob. In some embodiments, the rotary knob may also be configured to move in a plane perpendicular to or along the rotary axis. The rotary knob 400 is coupled to a mounting surface 402. The mounting surface may be a surface on a control panel, dashboard, car console, mouse, joystick, industrial equipment, medical equipment, or any consumer electronics device.

A user interacts with the rotary knob 400 by rotating the knob in a clockwise or counter-clockwise direction. One or more actuators 406 can be coupled to the rotary knob 400 to generate vibrotactile feedback. As the knob is rotated, vibrotactile feedback may be generated in the form of virtual detents. For example, as the knob is rotated, an effect such as a hard stop may be generated by vibrating the knob.

The rotary knob 400 can be coupled to a sensor 408. Sensor 408 can detect movements in the rotary knob 400, and transmit data to a processor 106. A shaft 404 may connect the actuator 406 and sensor 408 with the rotary knob 400.

As shown in Figure 4, a rotary knob 400 is a generally cylindrical object. Other devices for providing virtual detents may have various designs, including but not limited to conical shapes, spherical shapes, oval shapes, cubical shapes, etc. The rotary knob 400 may have one or more textures on its surface, including but not limited to bumps, lines, grooves,

other types of grips, or projections or members extending from the device's surface. Such shapes and textures may allow a user to easily grip or contact the knob and rotate it.

The rotary knob 400 may be configured to control a system. For example, the rotary knob 400 may be located on a stereo receiver, and configured to control the volume of the stereo. In one embodiment, the rotary knob 400 may control a plurality of systems, such as a car's temperature system, navigation system, and/or communication system. For example, a user can pull a knob to a first elevation in order to control the temperature system of the car. To control a different system, a user may push the knob down to a different elevation. In another embodiment, a user selects a system to be controlled via a menu system navigated by the rotary knob 400 or other controls.

Examples of Methods for Virtual Detents through Vibrotactile Feedback

Figure 5 is a flow diagram illustrating a first method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 502, the sensor generates an input signal based at least in part on a manipulation of an input device. In step 502, the processor 106 receives an input signal comprising information associated with the manipulation of an input device 102. In step 504, the processor 106 generates a signal configured to cause an actuator to produce a vibrotactile effect to the input device 102, the vibrotactile effect comprising a simulated mechanical detent.

The processor 106 can receive and generate signals as digital signals or analog signals, via wireless or wired connections. The input signal can comprise information related to a manipulation of the input device 102. For instance, the information related to the manipulation of the input device may be positional data, for example, comprising information related to the change in position of the input device. In another example, the input signal may comprise information related to the speed of the change in position of the input device as well as the change in position of the input device. As a further example, the input signal comprises information related to the direction of a continuous user contact with a rotary touch pad along with the speed at which the rotary touch pad is contacted.

In step 504, a signal is generated by the processor. The signal can be configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, and based at least in part on the detent signal. The signal comprises information relating to a specific virtual detent to be generated by an actuator.

The signal may be based at least in part on the input signal, for instance, if the input signal indicates a fast manipulation of the input device, than the detent signal may comprise a high frequency vibrotactile effect. The signal may be based at least in part on a status of a system to be manipulated. In one embodiment, a signal is not generated if a system is off. In
5 another embodiment, if a system is off, than only a signal configured to produce a hard stop is generated.

In one embodiment, the signal is based on a system reaching a maximum or minimum threshold. For example, if a stereo system has reached the highest volume level, than the signal is configured to produce a hard stop virtual detent. Alternatively, if the system to be
10 controlled has reached a threshold no signal is generated. In another example, if the stereo system has not reached the highest or lowest volume level, a signal configured to produce a click effect virtual detent is generated.

The signal generated by the processor 106 may be synchronized with changes in the system 110. For example, a detent signal can be configured to cause a vibrotactile effect at
15 the same time as changes in a display, audio level or frequency, or control of an electromechanical system. The detent signal may also be synchronized with other types of feedback. For example, vibrotactile feedback produced by an actuator in response to the detent signal may be accompanied by an audible click or noise.

Figure 6 is a flow diagram illustrating a second method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 602, a
20 sensor 104 detects a change in position of an input device 102. The sensor 104 can detect the rotation of a knob 400. The sensor 104 may detect, for example, relative changes, or changes from a reference point, in the position of an input device 102.

In step 604, the sensor 104 generates a detent signal. The detent signal can be
25 configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a simulated mechanical detent, the vibrotactile effect based at least in part on the detent signal.

The sensor 104 can be configured to only detect changes above a predetermined threshold. One sensor can be configured to detect movement of a rotary knob in one degree
30 increments. Another sensor can be configured with a higher detection threshold, and only detect rotations of five degrees or more. The detection threshold can correspond to a determination of whether a user intended to manipulate the device, or if the manipulation was accidental or unintended.

One or more sensors 104 can be configured to detect pressure or movement on a touch pad. As an example, three sensors configured to detect changes in force may be coupled to a touch pad. The force sensors may detect input on the touch pad, such as when a user drags a finger across the surface of the touch pad.

5 A processor 106 can generate the detent signal. The detent signal may be based at least in part on the manipulation or change in position of the input device. For example, a first detent signal may correspond to a small change in position of the input device, whereas a second detent signal may correspond to a larger change in position of the input device.

10 Figure 7 is a flow diagram illustrating a third method for providing virtual detents through vibrotactile feedback in one embodiment of the present invention. In step 702, the sensor 104 detects a change in position of an input device. The sensor 104 can detect input from a rotary knob 400, or input via a touch pad or touch screen.

15 In step 704, the processor 106 determines whether to generate a detent signal. The processor 106 may determine whether to generate a detent signal based at least in part on a status of a system to be manipulated 110. For example, the processor 106 may generate a detent signal if the system to be manipulated is turned on. As another example, the processor 106 may not generate a detent signal if the system to be manipulated is turned off.

 In step 706, the processor 106 generates a detent signal. The processor 106 can generate the detent signal as a digital signal sent to the actuator 108.

20 In step 708, the processor 106 generates a system signal. The system signal can be configured to manipulate a system to be controlled, such as an audio system, a video system, a climate system, or a menu system. As examples, the system signal can change the volume of a stereo system, increase the output of a heater or air conditioner, or zoom in on a map.

25 In step 710, if the processor determines not to generate a detent signal, then the processor may wait for a new change in position of the input device 710.

30 The processor 106 can generate detent signals and systems signals the system signal as digital signals or analog signals. The processor 106 can generate the detent signal 706 and the system signal 708 substantially simultaneously. In one embodiment, the system to be controlled is manipulated at substantially the same time as the vibrotactile feedback is generated on the input device. In some embodiments, a user may experience a virtual detent as a system is being manipulated, giving the user the impression of mechanical detents.

 The system signal can be based at least in part on an input signal. In one embodiment, an input signal may indicate that the input device is being manipulated with a quick motion. A corresponding system signal may manipulate the system to be controlled in

a like fashion. In one example, a rotary knob is quickly rotated. A processor may generate a system signal to a stereo system with a radio, the system signal moving through radio frequencies in large increments.

Figure 8 is a flow diagram illustrating a fourth method for virtual detents through
5 vibrotactile feedback. In step 802, an input device, such as a knob or a touch pad, is manipulated. A user can rotate a knob, or drag her finger across a touch pad. In response to the user input, a system is manipulated 804. Finally, a vibrotactile effect is produced on the input device 806.

The system may be manipulated based at least in part on the manipulation of the input
10 device. For example, if a knob is rotated to the right one full revolution, the volume of a stereo system may be doubled. In another example, if a circular touch pad is contacted in a counter-clockwise motion, a menu structure shown on a display may navigate up.

The vibrotactile effect 806 can be synchronized with the manipulation of the system
15 804. As a user navigates a menu shown on a display, a vibrotactile effect may be produced on a circular touch pad input device.

Examples of Virtual Detents

Figures 9A, 9B, 9C, 9D, 9E, 9F, 9G, and 9H are eight illustrations of virtual detent
profiles in various embodiments of the present invention. In Figures 9A-9H, the rotary knob
20 202 is shown on the right along with a representation of the virtual detent profile on the left corresponding with the rotary knob. The virtual detent profiles illustrated in Figures 9A-9H are exemplary embodiments of the invention. Other embodiments may be apparent to those skilled in the art. In some embodiments, various types of detents may be combined to produce a combination vibrotactile effect.

Figure 9A depicts a programmable virtual detent profile. Virtual detents are shown at
25 A, B, C, D, and E. For example, as a rotary knob is rotated through each point A-E, the rotary knob may be vibrated to generate the feeling of a real detent. The magnitude and width of the vibrotactile feedback applied to the input device at each virtual detent may simulate the magnitude and width of a mechanical detent.

Figure 9B depicts a hard stop virtual detent profile. A hard stop, or barrier virtual
30 detent, may simulate a mechanical hard stop or barrier. For example, a virtual hard stop may indicate that a system can no longer be manipulated. As an illustration, as a user turns a rotary knob, virtual detents may indicate each increasing fan level selected by a user. When

the fan level reaches its maximum, the processor 106 may send a detent signal to the actuator 108 comprising a barrier detent instruction.

Figure 9C depicts a hill virtual detent profile. A hill effect may simulate the approach to the end of a menu system, or a maximum or minimum threshold of a system. For example, as the user approaches the last item in a menu, the vibrotactile effect may gradually increase. As another example, when the user is approaching the end of a wrap-around menu structure, the intensity of the vibrotactile feedback may increase until the user reaches the beginning item, which may be accompanied by vibrotactile feedback with lower intensity.

Figure 9D depicts a compound virtual detent profile. In some embodiments, the magnitude and/or width of the vibrotactile feedback may be varied at each point. In such embodiments, a compound effect may include two or more effects such as barriers or detents. A compound effect may be related to the operational characteristics of a system. For example, a compound effect used in conjunction with a menu system may generate light intensity vibrotactile feedback while a menu is traversed within a subcategory, but generate heavier intensity vibrotactile feedback when larger categories of the menu are traversed. In one embodiment, a hill effect may be used as a user traverses contact names beginning with the same letter. When a new letter is reached, a hard stop effect may be used to indicate the new letter.

Figure 9E depicts a spring virtual detent profile. A spring virtual detent may indicate a preferred position of an input device. For example, as a user manipulates a rotary knob away from a home position, a spring effect virtual detent may increase in intensity as the knobs distance from the home position increases.

Figure 9F depicts a damper virtual detent profile. In a damper virtual detent, the vibrotactile force may increase or decrease based on the speed of the manipulation of an input device. For example, a light vibrotactile effect may accompany slow rotation of a rotary knob, while a heavier vibrotactile effect may accompany faster rotation of the rotary knob.

Figure 9G depicts a constant virtual detent profile. A constant force effect may be a continuous force independent of the position or manipulation of the input device. For example, as a rotary knob is rotated, the force of the vibrotactile effect may remain constant. A constant virtual detent profile may be used in combination with a null force profile, such that vibrotactile effects are generated at a constant intensity during part of a manipulation of an input device, and not generated at all at a later time. For example, a constant vibrotactile force may be produced on a rotary knob until a threshold is reached, upon which no vibrotactile force is generated in response to manipulation of the rotary knob. In another

example, a constant vibrotactile force may be output while a user has selected one item in a menu system, but not generated when a user selects a different item in a menu system.

Figure 9H depicts a periodic virtual detent profile. The periodic force effect profile may comprise a sine wave, square wave, or triangular wave profile. In one example of a
5 triangular virtual detent, the intensity of a virtual detent may increase and decrease linearly over time. A periodic virtual detent may last for a set period of time.

General

The foregoing description of embodiments of the invention has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit
10 the invention to the precise forms disclosed. Numerous modifications and adaptations thereof will be apparent to those skilled in the art without departing from the spirit and scope of the present invention.

CLAIMS

That which is claimed:

1. A method comprising:
receiving an input signal comprising information associated with a manipulation of an
5 input device, and
generating a vibrotactile signal configured to cause an actuator to produce a
vibrotactile effect to the input device, the vibrotactile effect comprising a virtual detent.
2. The method of claim 1, further comprising generating a system signal associated with
10 a system to be manipulated, the system signal based at least in part on the input signal, and
wherein generating a system signal and generating the vibrotactile signal occur substantially
simultaneously.
3. The method of claim 1, wherein the vibrotactile signal is based at least in part on the
15 input signal.
4. The method of claim 1, wherein the vibrotactile signal is further based in part on the
status of the input device.
- 20 5. The method of claim 1, further comprising determining whether to generate a signal.
6. The method of claim 5, wherein determining whether to generate a signal is based at
least in part on a status of the system to be manipulated.
- 25 7. The method of claim 1, further comprising determining one of a plurality of virtual
detents to generate.
8. The method of claim 1, wherein the information associated with the manipulation of
an input device comprises information associated with the rotation of a rotary knob or the
30 sliding of a fader.
9. A method comprising:
detecting a change in position of an input device; and

generating a detent signal based at least in part on the change in position, the detent signal configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a virtual detent, the vibrotactile effect based at least in part on the detent signal.

5

10. A computer-readable medium on which is encoded program code, the program code comprising:

program code for receiving an input signal comprising information associated with the manipulation of an input device; and

10 program code for generating a detent signal configured to cause an actuator to produce a vibrotactile effect to the input device, the vibrotactile effect comprising a virtual detent.

11. The computer-readable medium of claim 10, further comprising program code for
15 generating a system signal associated with a system to be manipulated, the system signal based at least in part on the input signal.

12. The computer-readable medium of claim 10, further comprising program code for
20 determining whether to generate a detent signal.

13. The computer-readable medium of claim 10, further comprising program code for
determining a virtual detent to generate.

14. A computer-readable medium on which is encoded program code, the program code
25 comprising:

program code for detecting a change in position of an input device, and

program code for generating a detent signal based at least in part on the change in
position, the detent signal configured to cause an actuator to produce a vibrotactile effect
to the input device, the vibrotactile effect comprising a virtual detent, the vibrotactile
30 effect based at least in part on the detent signal.

15. A system comprising:
an input device;

a processor in communication with the input device, the processor configured to receive an input signal, the processor further configured to generate a detent signal; and
at least one actuator coupled to the input device, the at least one actuator configured to receive the detent signal and produce a vibrotactile effect to the input device, the vibrotactile
5 effect comprising a virtual detent.

16. The system of claim 15, wherein the processor is further configured to control a system based at least in part on a manipulation of the input device.

10 17. The system of claim 15, wherein the processor is further configured to determine whether to generate a detent signal.

18. The system of claim 15, wherein the at least one actuator is coupled to a housing of the input device.

15

19. The system of claim 15, wherein the input device comprises a sensor.

1/10

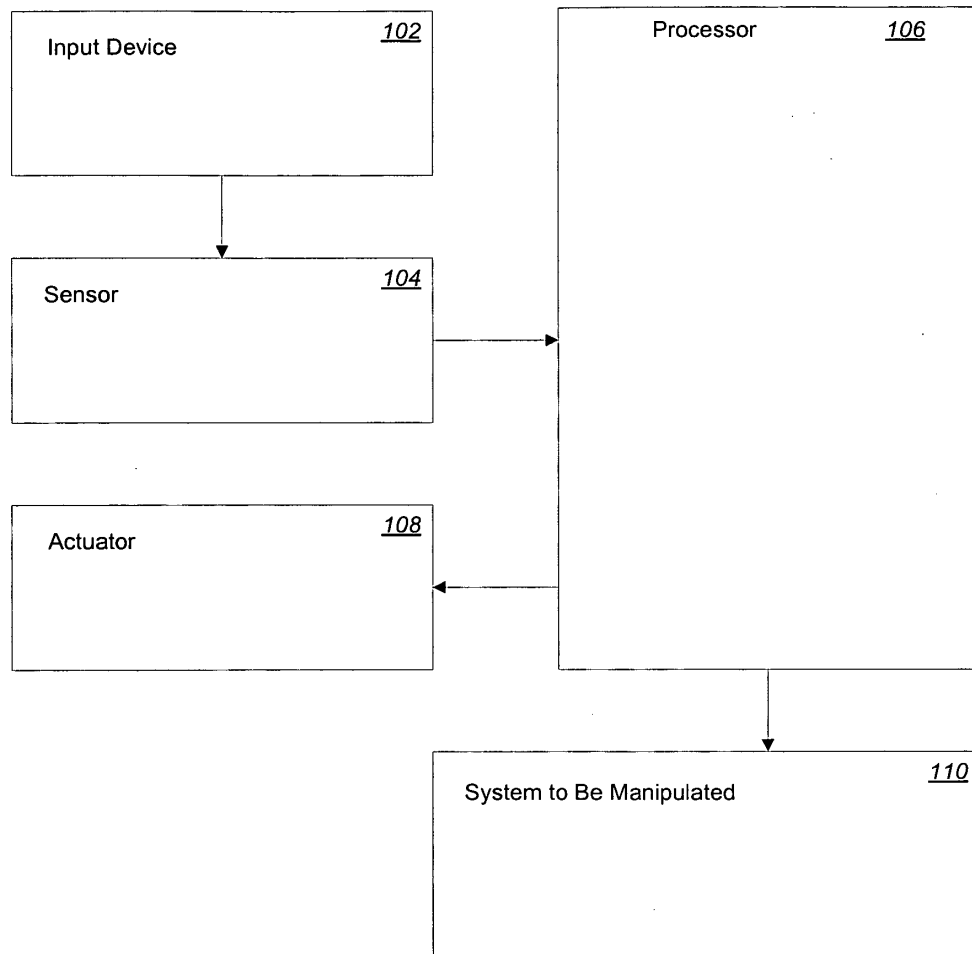


Figure 1

2/10

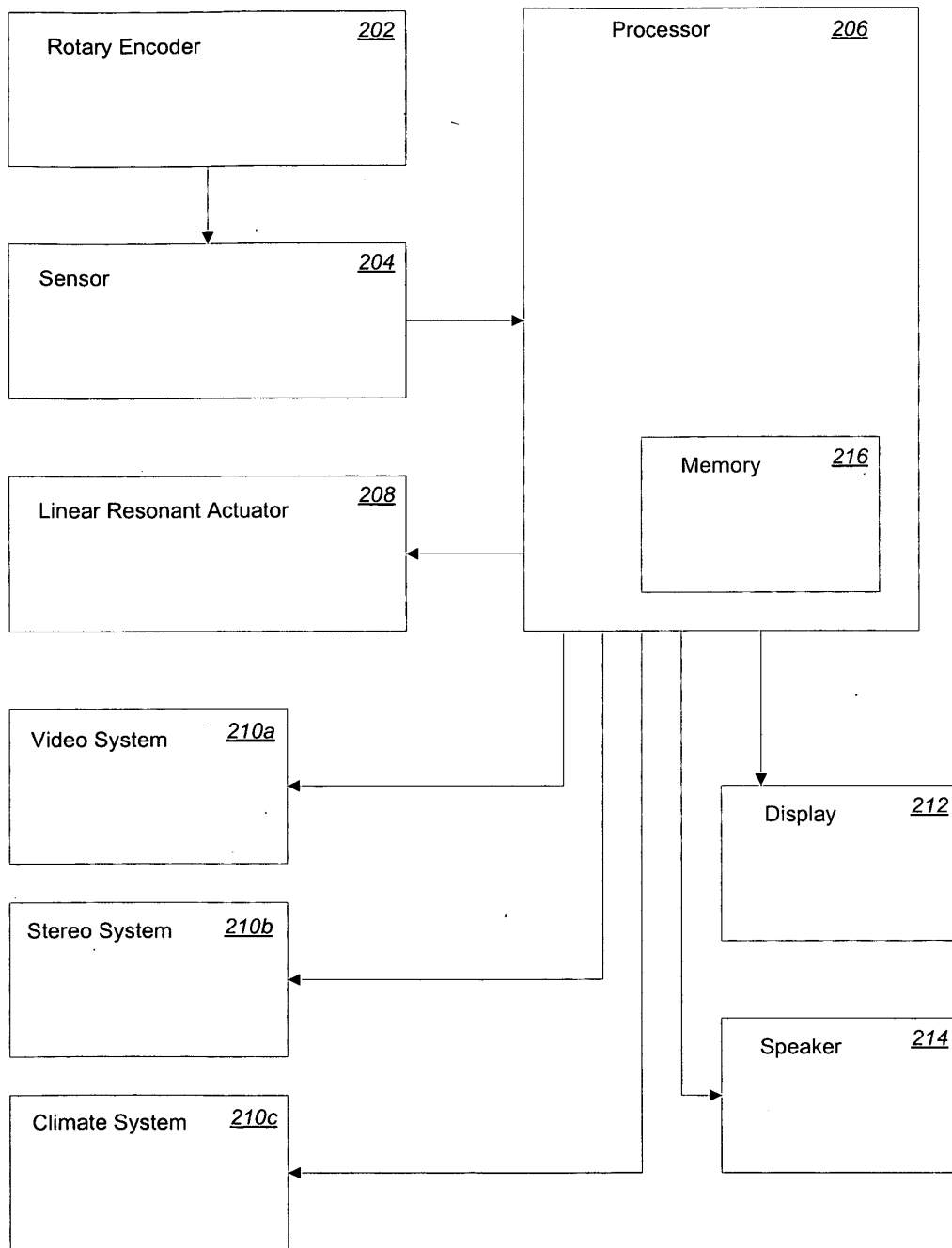


Figure 2

3/10

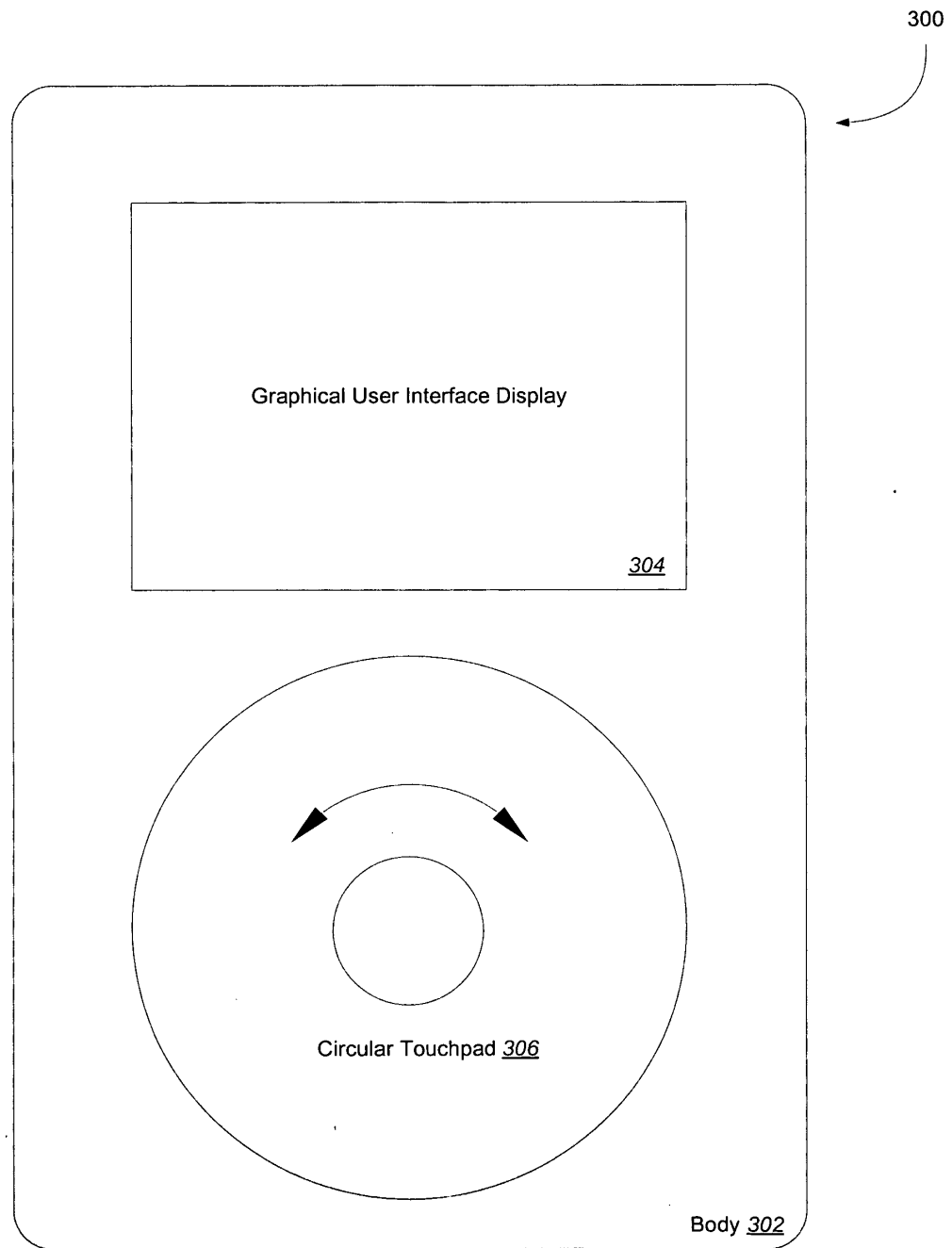


Figure 3

4/10

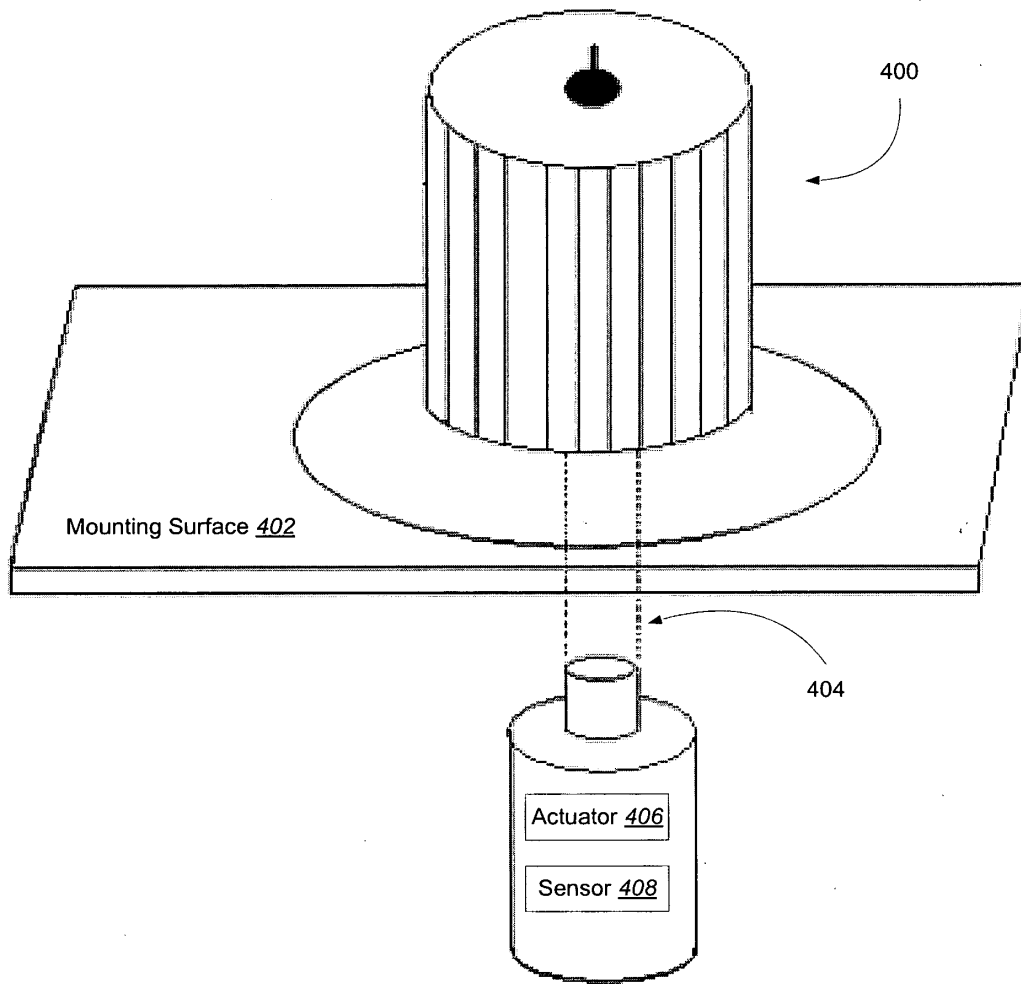


Figure 4

5/10

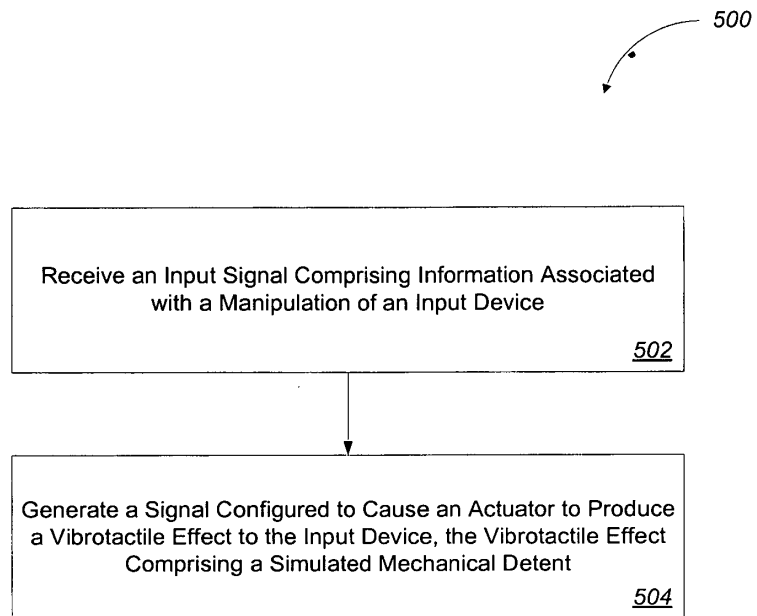


Figure 5

6/10

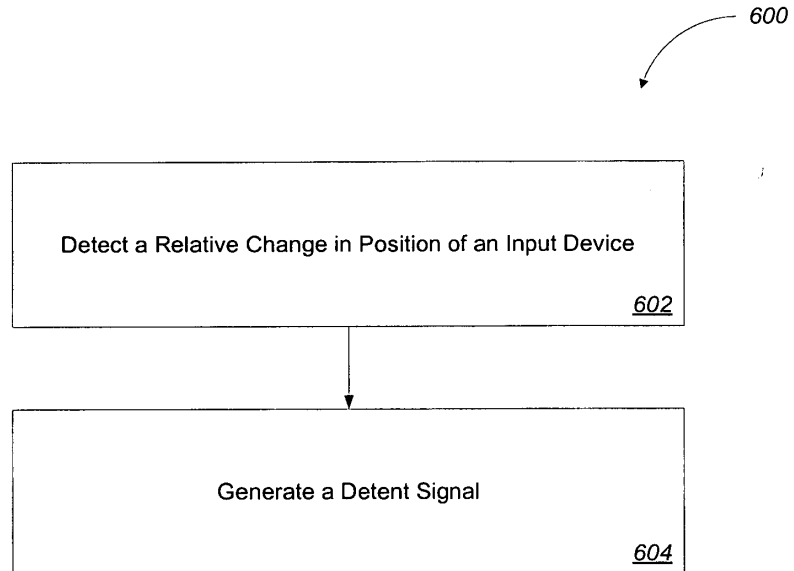


Figure 6

7/10

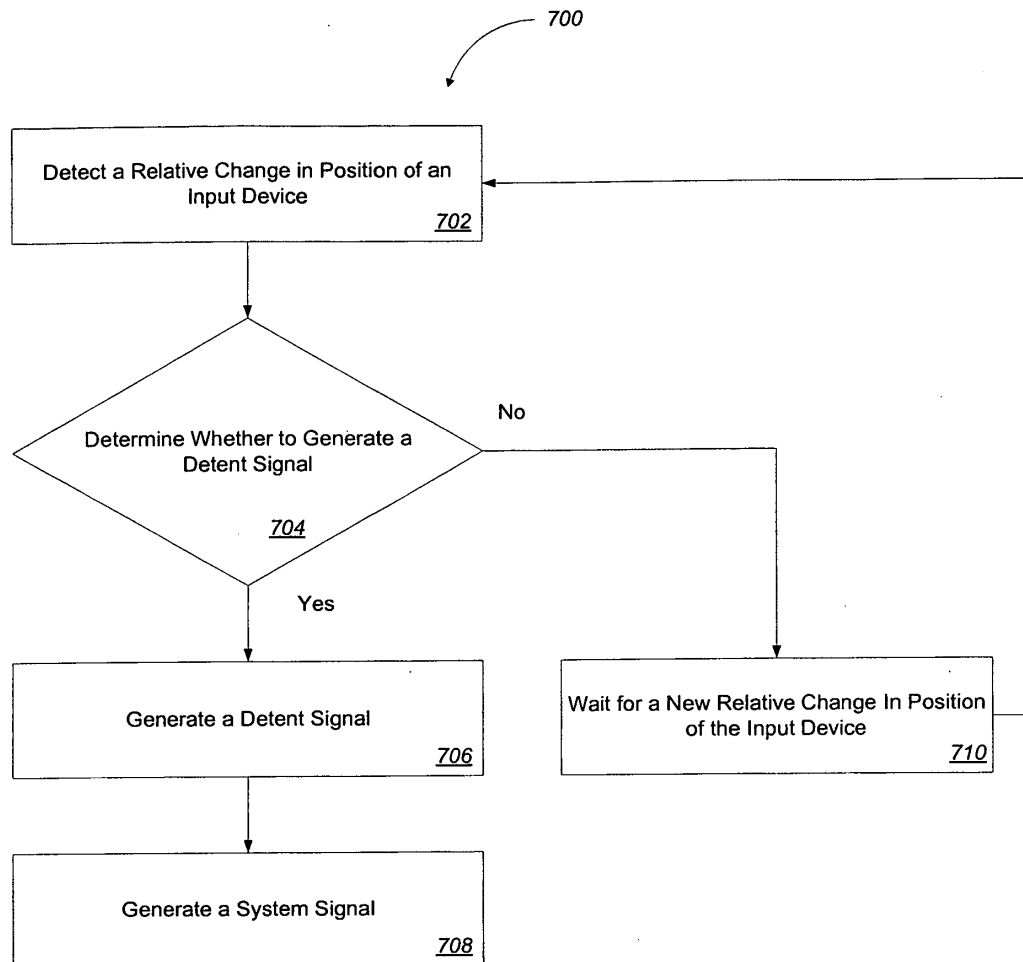


Figure 7

8/10

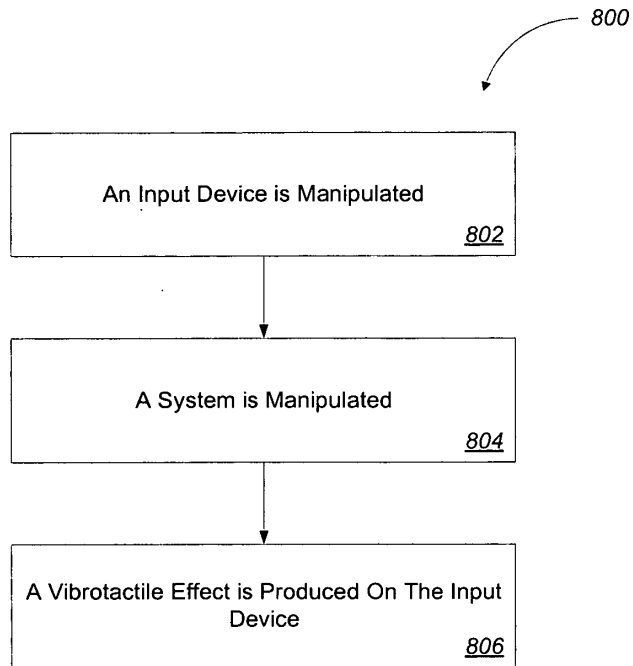


Figure 8

9/10

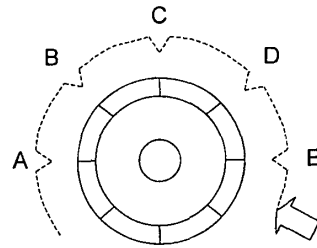
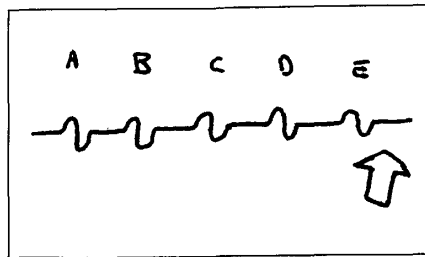


Figure 9A

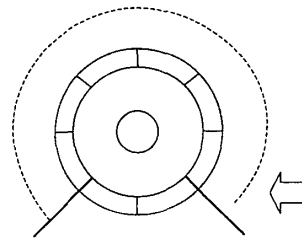
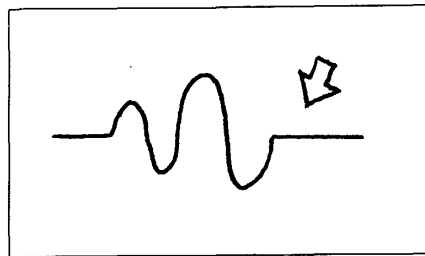


Figure 9B

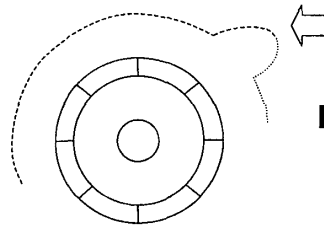
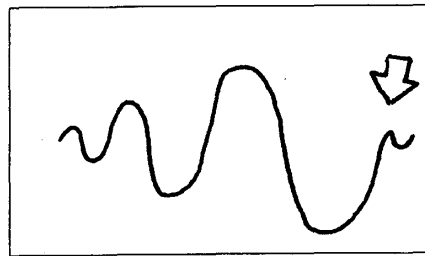


Figure 9C

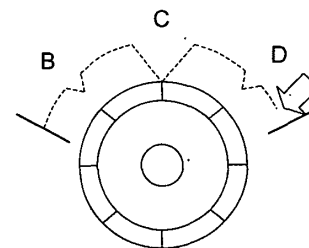
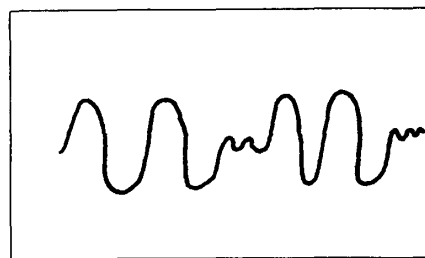


Figure 9D

10/10

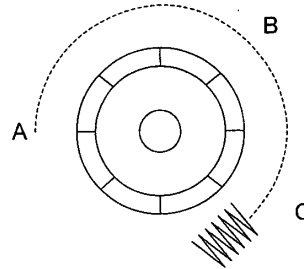
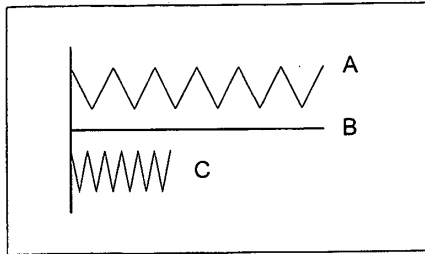


Figure 9E

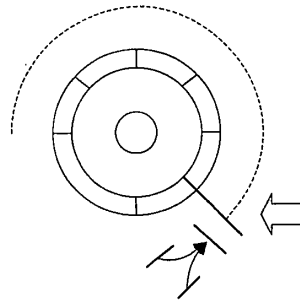
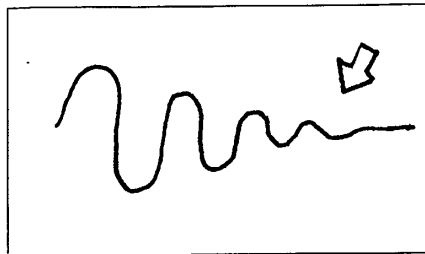


Figure 9F

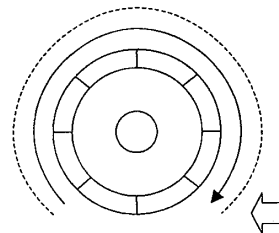
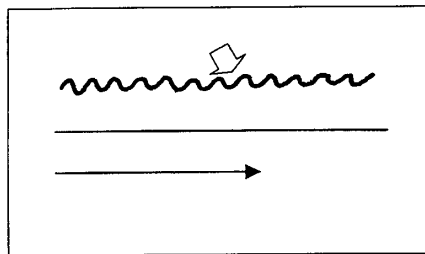


Figure 9G

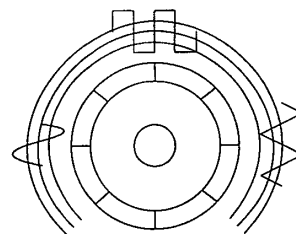
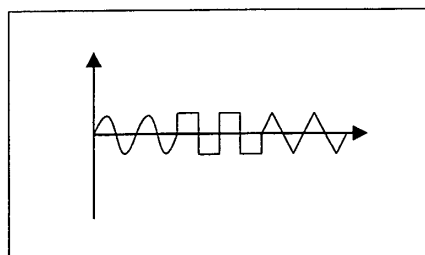


Figure 9H

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 07/26355

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06F 3/01 (2008.04)

USPC - 715/702

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)

IPC(8): G06F 3/01 (2008.04)

USPC: 715/702

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
715/701; 715/700; 345/156

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO WEST (PGPB, USPT, EPAB, JPAB); GOOGLE

Search Terms Used: vibro\$, haptic\$, virtual, detent, knob, fader, arrest, resist, move\$, signal\$, input\$, device

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2006/0119573 A1 (GRANT et al.) 08 June 2006 (08.05.2006), entire document, especially para [0006], [0016]-[0021] and Fig 1	1-19
Y	US 6,917,867 B2 (HUANG et al.) 12 July 2005 (12.07.2005), entire document, especially col 2, ln 51 to col 3, ln 4; col 3, ln 56 to col 4, ln 60	1-19
A	US 2006/0033703 A1 (OLIEN et al.) 16 February 2006 (16.02.2006)	1-19
A	US 7,119,789 B1 (SHAW et al.) 10 October 2006 (10.10.2006)	1-19

☐ Further documents are listed in the continuation of Box C.

* 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

21 April 2008 (21.04.2008)

Date of mailing of the international search report

22 MAY 2008

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents

P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2007)