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- (54) **Title:** VIBRATION SIGNATURES FOR INTELLIGENT ALERTS

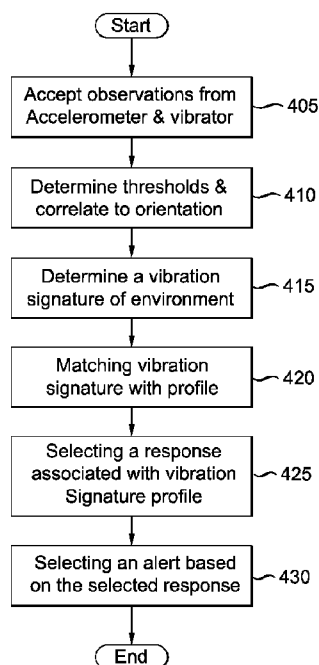


FIG. 4

(57) **Abstract:** A method and apparatus for determining an environment for a mobile device are described including determining a vibration signature of the environment of the mobile device, matching the vibration signature with a profile retrieved from a vibration signature database, selecting a response associated with the profile and selecting an alert based on the selected response. Also described are a method and apparatus for configuring a vibration signature database including actuating a vibrator, accepting observations from an accelerometer, the observations being generated in response to actuation of the vibrator, recording the accelerometer observation, clustering the accelerometer observations, recording the clustered accelerometer observations, creating vibration signature profiles of the clustered accelerometer profiles and recording the vibration signature profiles.

VIBRATION SIGNATURES FOR INTELLIGENT ALERTS

FIELD OF THE INVENTION

The present invention relates to mobile device alerts, and in particular, to using
5 accelerometer data to determine the environment that the mobile device is in and if a
vibrator of the mobile device is functional and what type of alert the mobile device
should use in the determined environment.

BACKGROUND OF THE INVENTION

10 This section is intended to introduce the reader to various aspects of art, which
may be related to the present embodiments that are described below. This discussion is
believed to be helpful in providing the reader with background information to facilitate a
better understanding of the various aspects of the present disclosure. Accordingly, it
should be understood that these statements are to be read in this light.

15 Alerts should be adjusted corresponding to changes in the environment of the
mobile device. Depending on a respective environment, certain types of alerts, e.g.
audible signals, optical signals or vibration alerts, may go unnoticed.

SUMMARY OF THE INVENTION

20 As used herein, a mobile device may be (but is not limited to) a cell phone, a
laptop, a notebook computer, a tablet computer, a portable media player, a smartphone or
any other like device.

The present invention uses vibration signatures to determine how to alert the user.
Some mobile devices, such as cell phones, are equipped with vibrators to perform a silent
25 notification, and accelerometers which can be used to determine the movement or
orientation of the mobile device. In a mobile device outfitted with both an accelerometer
and a vibration unit, the mobile device can monitor the vibration response and determine
a vibration signature of the mobile device to determine the environment that the mobile
device is in.

30 Mobile devices can sometimes substitute a vibration for an auditory alert or
notification. If the vibrator is no longer able to function the user may miss one or more

alerts before a vibrator failure is discovered. A mobile device in accordance with the present disclosure can take steps to ensure that the user is notified (alerted).

A method and apparatus for determining an environment for a mobile device are described including determining a vibration signature of the environment of the mobile device, matching the vibration signature with a profile in a vibration signature database, selecting a response associated with the vibration signature and selecting an alert based on the selected response. Also described are a method and apparatus for configuring a vibration signature database including actuating a vibrator, accepting observations from an accelerometer, the observations being in response to actuation of the vibrator, recording the accelerometer observation, clustering the accelerometer observations, recording the clustered accelerometer observations, creating vibration signature profiles of the clustered accelerometer profiles and recording the vibration signature profiles.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is best understood from the following detailed description when read in conjunction with the accompanying drawings. The drawings include the following figures briefly described below:

Fig. 1 shows examples of mobile devices such as a cell phone, a smartphone and a tablet.

Fig. 2 is a block diagram of an exemplary mobile device in accordance with the principles of the present invention.

Fig. 3 is a flowchart of the configuration of an exemplary mobile device in accordance with the principles of the present invention.

Fig. 4 is a flowchart of the operation of an exemplary mobile device in accordance with the principles of the present invention.

It should be understood that the drawing(s) are for purposes of illustrating the concepts of the disclosure and is not necessarily the only possible configuration for illustrating the disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present description illustrates the principles of the present disclosure. It will thus be appreciated that those skilled in the art will be able to devise various arrangements that, although not explicitly described or shown herein, embody the principles of the disclosure and are included within its scope.

All examples and conditional language recited herein are intended for educational purposes to aid the reader in understanding the principles of the disclosure and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions.

Moreover, all statements herein reciting principles, aspects, and embodiments of the disclosure, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any elements developed that perform the same function, regardless of structure.

Thus, for example, it will be appreciated by those skilled in the art that the block diagrams presented herein represent conceptual views of illustrative circuitry embodying the principles of the disclosure. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudocode, and the like represent various processes which may be substantially represented in computer readable media and so executed by a computer or processor, whether or not such computer or processor is explicitly shown.

The functions of the various elements shown in the figures may be provided through the use of dedicated hardware as well as hardware capable of executing software in association with appropriate software. When provided by a processor, the functions may be provided by a single dedicated processor, by a single shared processor, or by a plurality of individual processors, some of which may be shared. Moreover, explicit use of the term “processor” or “controller” should not be construed to refer exclusively to hardware capable of executing software, and may implicitly include, without limitation, digital signal processor (DSP) hardware, read only memory (ROM) for storing software, random access memory (RAM), and nonvolatile storage.

Other hardware, conventional and/or custom, may also be included. Similarly, any switches shown in the figures are conceptual only. Their function may be carried out through the operation of program logic, through dedicated logic, through the interaction of program control and dedicated logic, or even manually, the particular technique being
5 selectable by the implementer as more specifically understood from the context.

In the claims hereof, any element expressed as a means for performing a specified function is intended to encompass any way of performing that function including, for example, a) a combination of circuit elements that performs that function or b) software in any form, including, therefore, firmware, microcode or the like, combined with
10 appropriate circuitry for executing that software to perform the function. The disclosure as defined by such claims resides in the fact that the functionalities provided by the various recited means are combined and brought together in the manner which the claims call for. It is thus regarded that any means that can provide those functionalities are equivalent to those shown herein.

Mobile devices are stored in a variety of locations. Each location can present a unique degree of immobilization for the mobile device that changes the vibratory response of the mobile device. The most visually prominent example of mobile devices' reactivity is when placing the device on a desk or hard surface. Should the vibrator of the mobile device be actuated, the mobile device may appear to jump around. In a person's
15 pocket the vibrator makes the device move but the motion seems calm in comparison to the vibration when the mobile device is sitting on a desk. In a hand, fixed in location by the user's fingers, the mobile device is not that free to move around resulting in a calmer vibration signature. Inside a purse or satchel the mobile device will act (behave) as if it were in a vice and move very little. Should the vibrator fail, there will be no vibratory
20 signature. The movement of the mobile device induced by activating the vibrator may be referred to as vibration response.

By varying the degree of actuation of the vibrator and observing when there is a significant change in the measured response, the resilience of the environment can be characterized. This technique could be used whenever the vibrator is activated(an alert) or
25 under certain circumstances(training). For example, during a vibration-alert the vibrator is actuated at 100% for 1 s, then 75% for approximately 0.25 s, restored to 100% for 1 s,

then 50% for 0.25 s, restored to 100% for 1 s, then 25% for 0.25 s, and finally 100% for 1 s. Actual timings and power may vary for different reasons, but this technique allows the sampling to be hidden within a normal vibration alert. If two dissimilar environments are categorized as the same, this technique can be used to differentiate their profiles. Two similar environments can be distinguished by adjusting the degree of actuation of the vibrator and determining a threshold of increased response. For example, the technique could be used to distinguish a wooden surface (e.g., table or desktop) from a glass surface (table or desktop). The glass surface will reflect energy more readily while the wood will absorb more energy. This results in less energy being needed to make the device bounce around on a glass surface than a wood surface. By varying the degree of actuation of the vibrator, the amount of energy needed to make the device bounce or overcome the resilience aspect of the environment can be determined.

The vibration response for each of the above examples can be observed. The observations can then be clustered. The clusters can be used as profiles. A profile corresponds to a type of environment. A non-exclusive list of environments comprises 'Desk', 'Pocket', 'In a hand', and 'Purse or satchel'. Profiles can be preset at the factory or the user can generate profiles in a training-mode of the device. A combination of both factory and user observations/clusters/profiles is also conceivable.

Thresholds and correlation factors are used to match a particular event with a profile. Next each profile is associated with at least one response. The response's intent is to react more appropriately to the situation the device finds itself in. Reaction for the above list profiles can occur as follows:

Desk or, more generally, hard surface – In this case, the mobile device would lower vibrator power to prevent undesired movement or shifting of the device and to protect the device from falling off a surface.

Pocket – A shirt pocket may be considered loose suggesting a decrease the vibrator power. While a pants pocket might be considered restrictive requiring an increase in vibrator power.

In a hand – The mobile device would significantly decrease the vibrator power, since the hand is generally very sensitive, and the device may possibly be close to the user's ear.

Purse or satchel – The mobile device would revert to audible alarm so that the alert can be recognized.

No vibratory signature indicating a vibrator failure – In this case, the mobile device reverts to an audible alarm and posts a message to notify the user of a vibrator failure. The mobile device may also require/request the user to reconfigure alerts.

A further embodiment would involve passively monitoring the user's physical activity by the accelerometer and other components of the mobile device. In the case where the user is jogging or at the gym or involved in another physical activity, the user may configure the mobile device of such physical activity for other purposes such as monitoring calories, heart rate etc. and this configuration could also automatically adjust the alert notifications. The user may not explicitly configure the mobile device prior to such physical activity but the accelerometer's profile may indicate an event of strenuous activity such as exercise or even walking resulting in an adjustment in the type of alert notification. A jogging profile may require the device to be silent/non-vibrating until the jogging stops and then notifying (alerting) the user. This is so as to not distract the jogger and hopefully avoid accidents that would otherwise occur if the jogger were distracted.

In another embodiment, mobile devices may include built-in microphones that can measure the amount of ambient noise. Profiles of the ambient noise can then be used to determine if the audible alert would be likely to be heard. If it is unlikely the audible alert would be heard then the vibrator can be turned on by itself or in conjunction with the audible alert. In quiet environments, the alert volume can be lowered, or turned off substituting alerting the user with the vibrator.

Fig. 1 shows examples of mobile devices such as a cell phone, a smartphone and a tablet.

Fig. 2 is a block diagram of an exemplary mobile device 200 in accordance with the principles of the present invention. The exemplary mobile device includes an accelerometer 201. The accelerometer 201 is a three-axis accelerometer. That is, the accelerometer can detect movement in the x, y and z axes. In terms of motion, the three-axis accelerometer can determine (calculate) pitch, roll and yaw from the measured motion along the x, y and z axes. The accelerometer 200 is in communication with a record observations module 202 and a threshold module 203. The record observations

module 202 is in communication with a cluster observations module 204 and also with memory (storage) 206. The cluster observations module 204 is in communication with a profiles module 207 and also with memory (storage) 206. The profiles module 207 is in communication with memory (storage) 206 and also with a response selection module 208. The mobile device 200 also includes a vibrator 209 which is in communication with the threshold module 203. The threshold module 203 is in communication with the profiles module 207. The vibrator 209 is also in communication with the response selection module 208. The response selection module is in communication with an audio module 211. The audio module 211 and the vibrator 209 are used to alert the user to audio calls, text messages, emails and the like. The accelerometer 201 provides information (data, observations) to record observations module 202. The observations are clustered and from the clustered observations (information, data) a profile of a vibration signature is created by the profiles module 207. The accelerometer 201 and the vibrator 209 also provide observations (information, data, sensor data) to the threshold module in order to determine a vibration signature of the environment of the mobile device. The vibration signature is matched against vibration signatures retrieved from the memory 206 (storage) by the profiles module 207. The profiles module 207 then forwards the matched vibration signature to the response selection module 208 which selects an appropriate alert based on the matched vibration signature and forward the selected alert to either the audio module 211 or the vibrator 209 or both. In the event of a failure of the vibrator 209, the response selection module may also notify the user with a text message on a screen (not shown) of a failure of the vibrator 209 and request/require the user to reconfigure the alert notifications of the mobile device 200.

Fig. 3 is a flowchart of the configuration of an exemplary mobile device in accordance with the principles of the present invention. The mobile device (in training or configuration mode) accepts observations and records (stores) the observations (information, data, sensor data) at 305. The observations of a three-axis accelerometer are made in response to actuation of a vibrator. At 310 the mobile device clusters the observations (information, data, sensor data) and stores the clustered observations. At 315 the mobile device creates profiles of vibration signatures. The profiles are stored (recorded). It should be noted, for example, that not all surfaces on which the device may

be placed have the same characteristics. Glass surfaces will reflect more energy than laminated surfaces, which reflect more energy than solid wood surfaces. Glass, laminated and wood surfaces could all be clustered into a generic 'table top' vibration signature profile. K-means clustering can be used to analyze the observations to identify and cluster similar vibration signatures. Other cluster analysis methods may be chosen. The cluster profiles can be used to "learn" about new surfaces or new vibration signatures. The above method may be performed at the factory or by a user or a combination of both. A number of standard vibration profiles can be loaded at the factory and the user can then augment the standard vibration profiles by training or configuring the mobile device to recognize vibration profiles of environments in which the user typically finds him or herself. The augmentation of the configuration may also be performed automatically, e.g. when a user reduces or increases the vibrator amplitude after an event has been notified, without requiring the user to enter a dedicated 'learning mode'. The mobile device attempts to correlate a new observation against existing vibration signatures. While performing these correlations, a threshold is used to determine if the newly observed vibration signature is a match (within a threshold value) to an existing vibration profile. A threshold value may be a percentage or a probability.

If the mobile device is placed on a table top, or more generally a horizontal surface, there would be a great deal of freedom of motion in the x-direction (along the x-axis). In this case, assume that the mobile device is flat on its back. The motion would also be symmetrical since the device could move in both a positive and negative direction along the x-axis. However, downward motion (in the negative direction along the y-axis) is limited by the table top. Upward motion (in the positive direction along the y-axis) is amplified by the reflected downward inertia. Forward and backward motion (motion along the z-axis), similar to motion along the x-axis is fairly large and symmetrical. In another example, if the mobile device is placed upright in a bag (bottom of the mobile device is toward the bottom of the bag), for example between two books, then motion along the x-axis is severely restricted (limited), while motion along the y-axis may be limited by the frictional forces but may move to some extent. If the mobile device is further at the bottom of the bag then motion along the y-axis would more likely be in the positive (upward) direction. Motion along the z-axis may also be limited by frictional

forces. In yet another example, if the mobile device is held in the user's hand, then motion along the x-axis may be more than if the mobile device is in a bag but less motion along the x-axis than if the mobile device is on a table top. Frictional forces limit the motion of the mobile device along the y-axis but what motion there is along the y-axis is likely to be symmetrical. Similarly, frictional forces would limit motion along the z-axis but not as much as motion is limited by frictional forces along the y-axis.

The mobile device, by operation of the method described above has a database of profiles created based on accelerometer observations and/or pre-loaded from the factory. If the mobile device detects itself to be in an environment unknown to the mobile device based on querying the database with the current accelerometer observations then the mobile device may initiate a dialog with the user to determine the environment in order to associate an environment name with the observations in order to create a new profile for storage in the database. If the current environment is not an environment that the user expects will be encountered again, the user may decline to engage in the dialog with the mobile device.

Fig. 4 is a flowchart of the operation of an exemplary mobile device in accordance with the principles of the present invention. At 405 the mobile device accepts observations (information, data, sensor data) from an accelerometer in response to the operation of a vibrator. The accelerometer measures motion in the x, y and z axes and determines (calculates) pitch, roll and yaw using the measured motion along the x, y and z axes. The accelerometer observations are made in response to actuation of the vibrator. The accelerometer observations are stored (recorded) in a memory. At 410 the mobile device determines thresholds and correlates the observations to orientation of the mobile device. At 415 the mobile device also determines a vibration signature of the environment of the mobile device. At 420 the mobile device matches the vibration signature with a profile. At 425 the mobile device selects a response associated with the profile. At 430 the mobile device selects an alert associated with the selected response.

It is to be understood that the present invention may be implemented in various forms of hardware, software, firmware, special purpose processors, or a combination thereof. Special purpose processors may include application specific integrated circuits (ASICs), reduced instruction set computers (RISCs) and/or field programmable gate

arrays (FPGAs). Preferably, the present invention is implemented as a combination of hardware and software. Moreover, the software is preferably implemented as an application program tangibly embodied on a program storage device. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units (CPU), a random access memory (RAM), and input/output (I/O) interface(s). The computer platform also includes an operating system and microinstruction code. The various processes and functions described herein may either be part of the microinstruction code or part of the application program (or a combination thereof), which is executed via the operating system. In addition, various other peripheral devices may be connected to the computer platform such as an additional data storage device and a printing device.

It should be understood that the elements shown in the figures may be implemented in various forms of hardware, software or combinations thereof. Preferably, these elements are implemented in a combination of hardware and software on one or more appropriately programmed general-purpose devices, which may include a processor, memory and input/output interfaces. Herein, the phrase "coupled" is defined to mean directly connected to or indirectly connected with through one or more intermediate components. Such intermediate components may include both hardware and software based components.

It is to be further understood that, because some of the constituent system components and method steps depicted in the accompanying figures are preferably implemented in software, the actual connections between the system components (or the process steps) may differ depending upon the manner in which the present invention is programmed. Given the teachings herein, one of ordinary skill in the related art will be able to contemplate these and similar implementations or configurations of the present invention.

CLAIMS:

1. A method for determining an environment for a mobile device, said method comprising:
 - determining a vibration signature of said environment of said mobile device;
 - 5 matching said vibration signature with a profile retrieved from a vibration signature database;
 - selecting a response associated with said profile; and
 - selecting an alert based on said selected response.
- 10 2. The method according to claim 1, further comprising:
 - actuating a vibrator; and
 - accepting observations from an accelerometer, said observations being generated in response to actuation of said vibrator.
- 15 3. The method according to claim 2, wherein said accelerometer measures motion along x, y and z axes.
4. The method according to claim 2, wherein said accelerometer determines pitch, roll and yaw using said measured motion along said x, y and z axes.
- 20 5. The method according to claim 2, further comprising storing said accelerometer observations.
- 25 6. The method according to claim 2, wherein said matching further comprises comparing said accelerometer observations against stored vibration signatures.
7. The method according to claim 1 wherein said matching is made within a threshold value.
- 30 8. The method according to claim 1, wherein if said alert is an audio alert, a volume of said audio alert is adjusted responsive to ambient noise sensed by a microphone.

9. An apparatus for determining an environment for a mobile device, comprising:

a profiles module, said profiles module determining a vibration signature of said environment of said mobile device;

5 said profile module matching said vibration signature with a profile in a vibration signature database;

a response selection module, said response selection module selecting a response associated with said profile, said response selection module being in communication with said profiles module; and

said response selection module selecting an alert based on said selected response.

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10. The apparatus according to claim 9, further comprising:

a vibrator, said vibrator actuated by said mobile device; and

a record observations module, said record observations module accepting observations from an accelerometer, said observations being generated in response to actuation of said vibrator.

15

11. The apparatus according to claim 10, wherein said accelerometer measures motion along x, y and z axes.

20 12. The apparatus according to claim 10, wherein said accelerometer determines pitch, roll and yaw using said measured motion along said x, y and z axes.

13. The apparatus according to claim 10, further comprising a memory module, said memory module storing said accelerometer observations.

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14. The apparatus according to claim 10, wherein said profiles module further compares said accelerometer observations against stored vibration signatures.

15. The apparatus according to claim 9, further comprises a threshold module, said threshold module matching said vibration signature against a profile in a vibration signature stored in memory within a threshold value.
- 5 16. The apparatus according to claim 10, wherein if said alert is an audio alert, a volume of said audio alert is adjusted responsive to ambient noise sensed by a microphone.
17. A method for configuring a vibration signature database, said method comprising:
- 10 actuating a vibrator;
- accepting observations from an accelerometer, said observations being generated in response to actuation of said vibrator;
- recording said accelerometer observation;
- clustering said accelerometer observations;
- recording said clustered accelerometer observations;
- 15 creating vibration signature profiles of said clustered accelerometer observations; and
- recording said vibration signature profiles.
18. An apparatus for configuring a vibration signature database of a mobile device, said
- 20 method comprising:
- a vibrator, said vibrator actuated by said mobile device;
- a record observations module, said record observations module accepting observations from an accelerometer, said observations being generated in response to actuation of said vibrator;
- 25 a memory module, said memory module recording said accelerometer observation, said record observations module being in communication with said memory module;
- a cluster observations module, said cluster observations module clustering said accelerometer observations, said cluster observations module being in
- 30 communication with said memory module;
- said memory module recording said clustered accelerometer observations;

a profiles module, said profiles module creating vibration signature profiles of said clustered accelerometer observations, said profiles module being in communication with said cluster observations module, said profiles module being in communication with said memory module; and

5 said memory module recording said vibration signature profiles.

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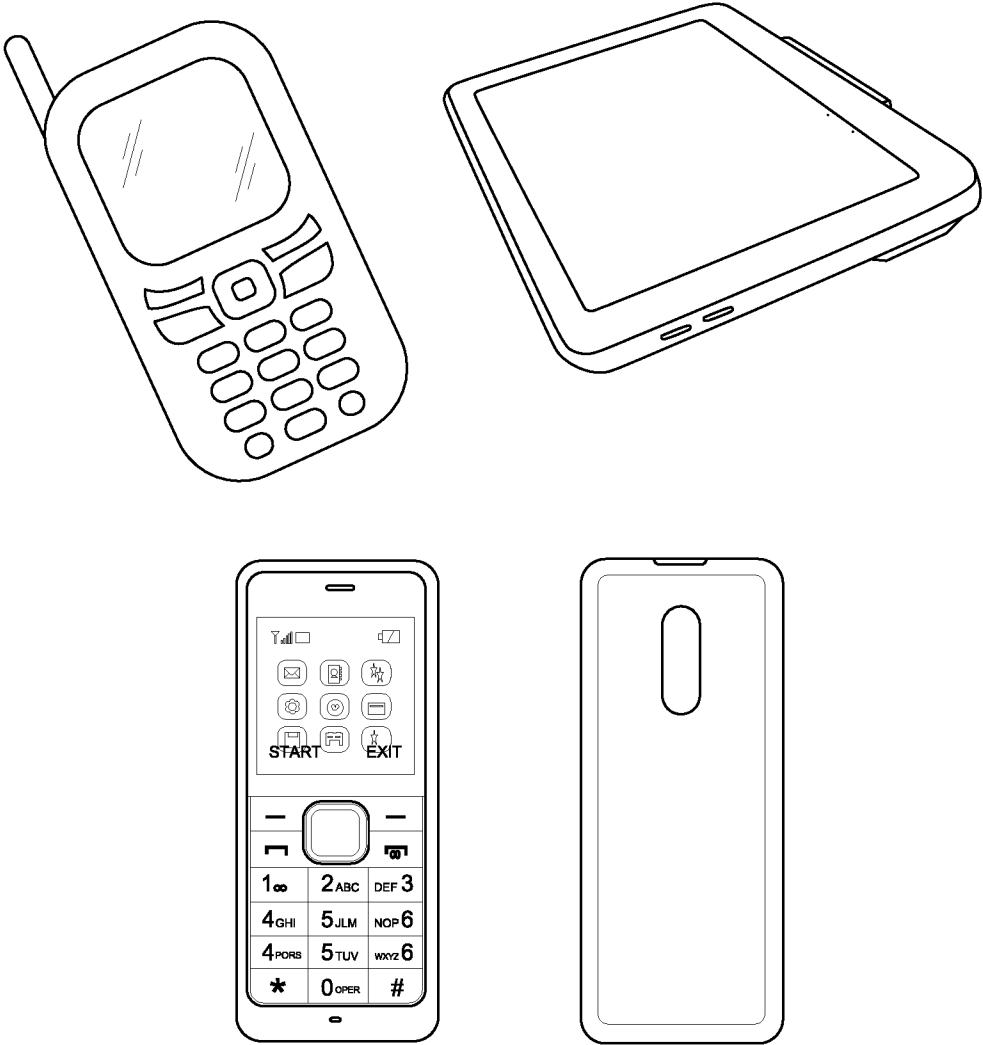
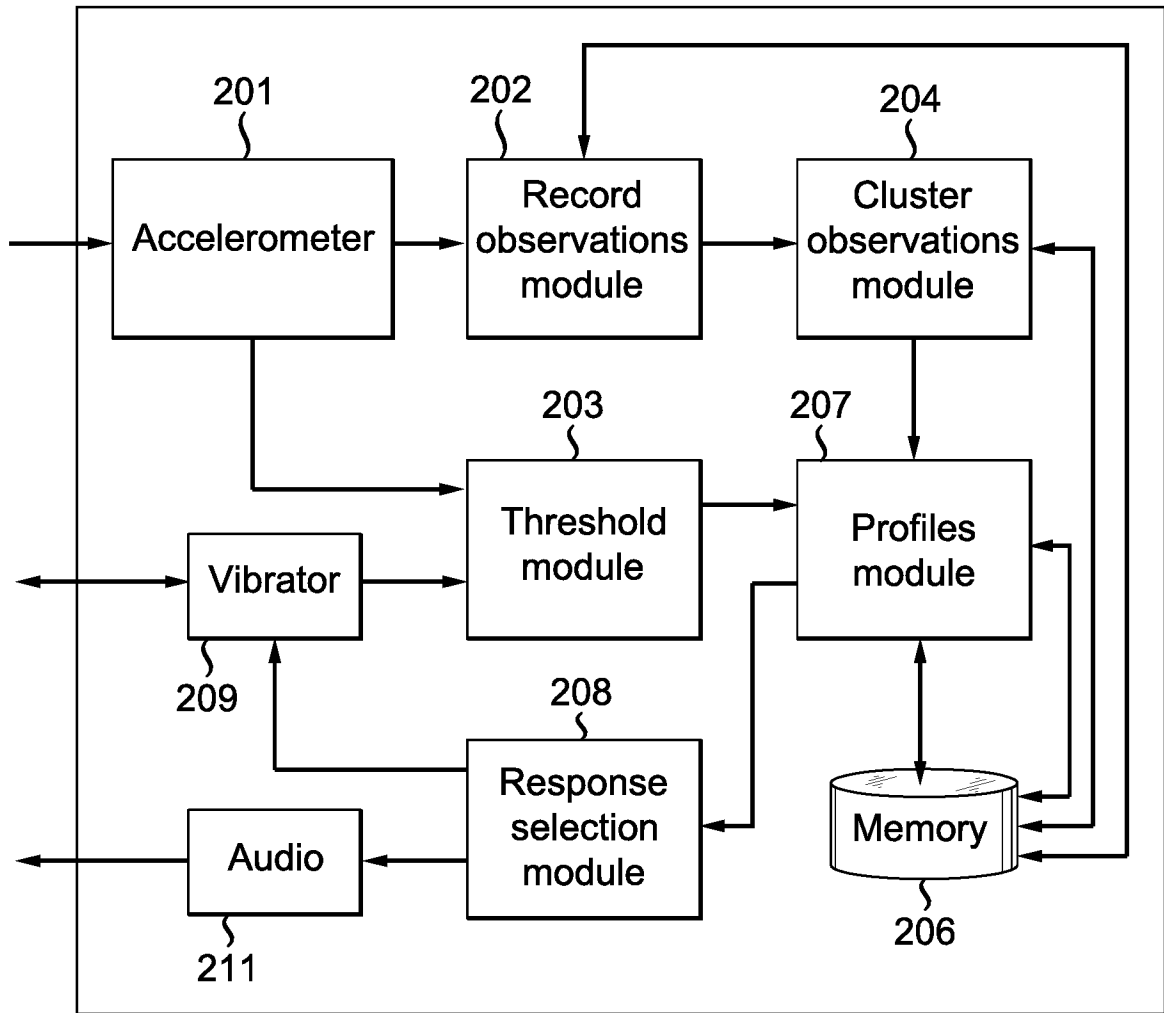
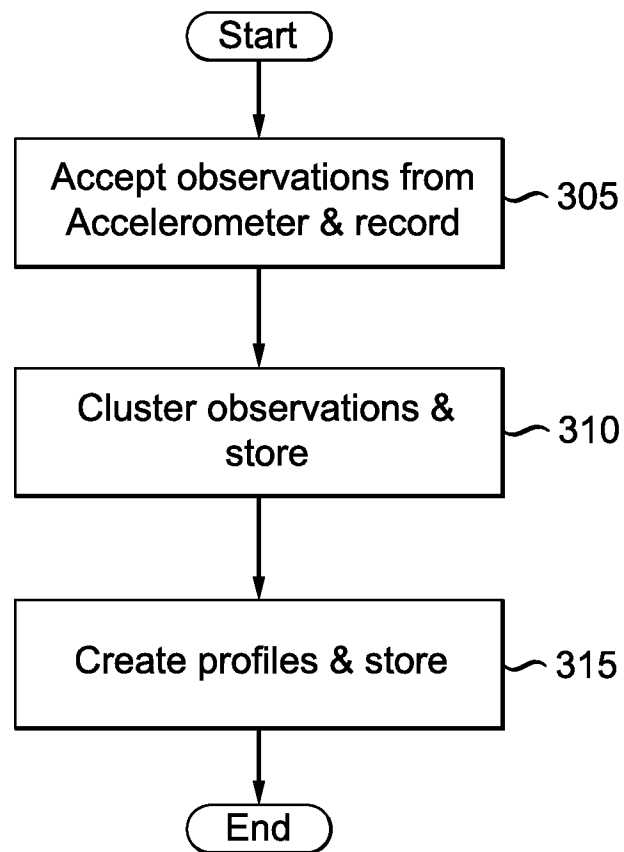


FIG. 1

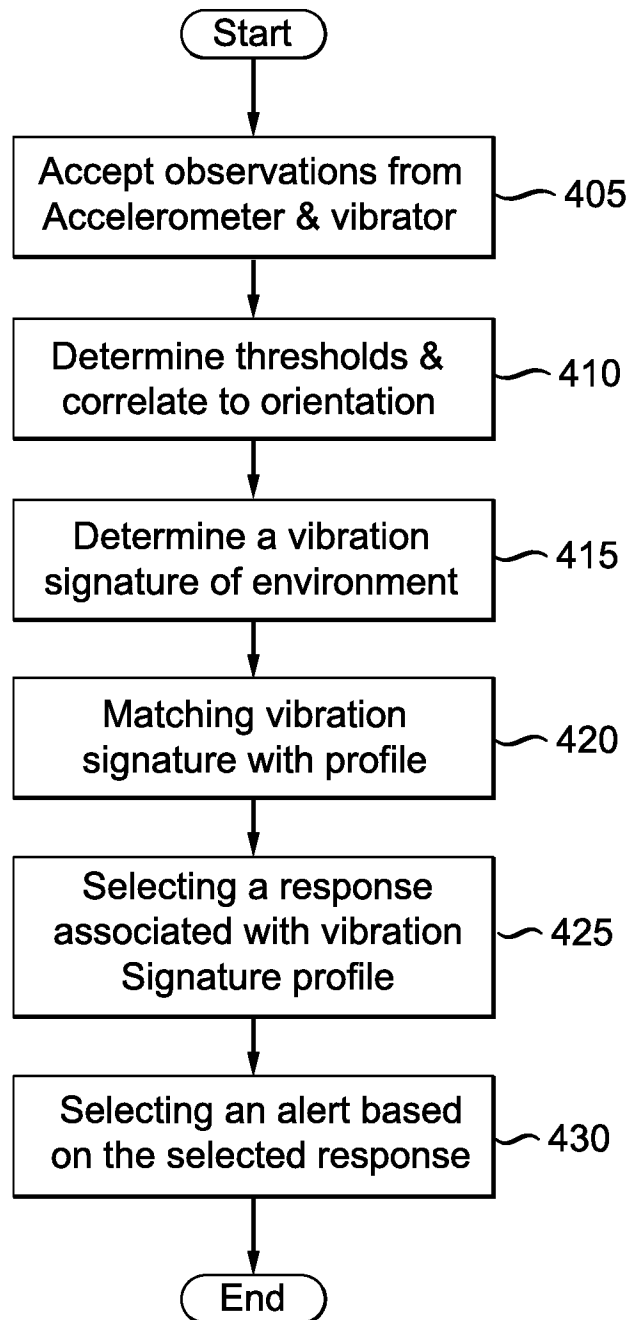
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200*FIG. 2*

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*FIG. 3*

4/4

*FIG. 4*

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/024611

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F3/01
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, INSPEC, COMPENDEX, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/227486 A1 (LIU YINONG [CN]) 13 September 2012 (2012-09-13) abstract paragraphs [0003], [0004], [0095] - [0192] -----	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012227486 A1	13-09-2012	CN 102680736 A	19-09-2012
		EP 2684344 A1	15-01-2014
		US 2012227486 A1	13-09-2012
		WO 2012120346 A1	13-09-2012
