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(54) **HAPTIC HEALTH FEEDBACK MONITORING**

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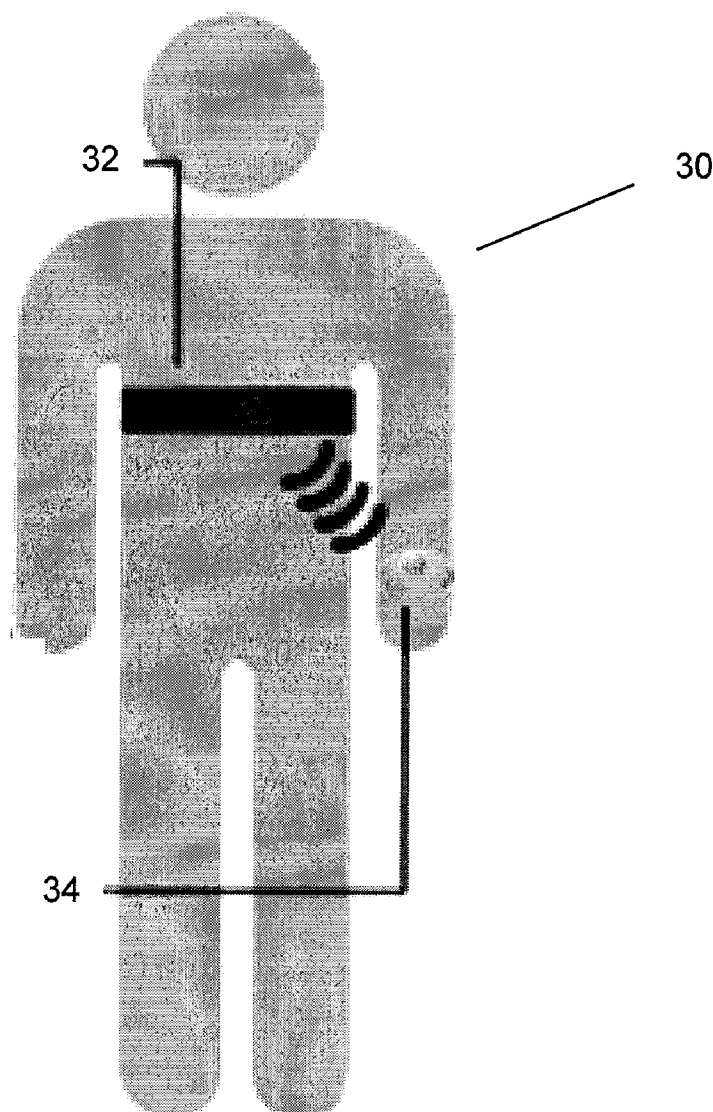
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(57) **ABSTRACT**

A haptic health feedback monitor includes a health parameter monitor that detects a health parameter. A haptic feedback generator receives the health parameter and compares it to a predetermined level. If the health parameter reaches or exceeds the level, a type of haptic feedback to generate is determined. The type of feedback may depend on which predetermined level is reached or exceeded. The haptic feedback generator then generates the determined type of haptic feedback.



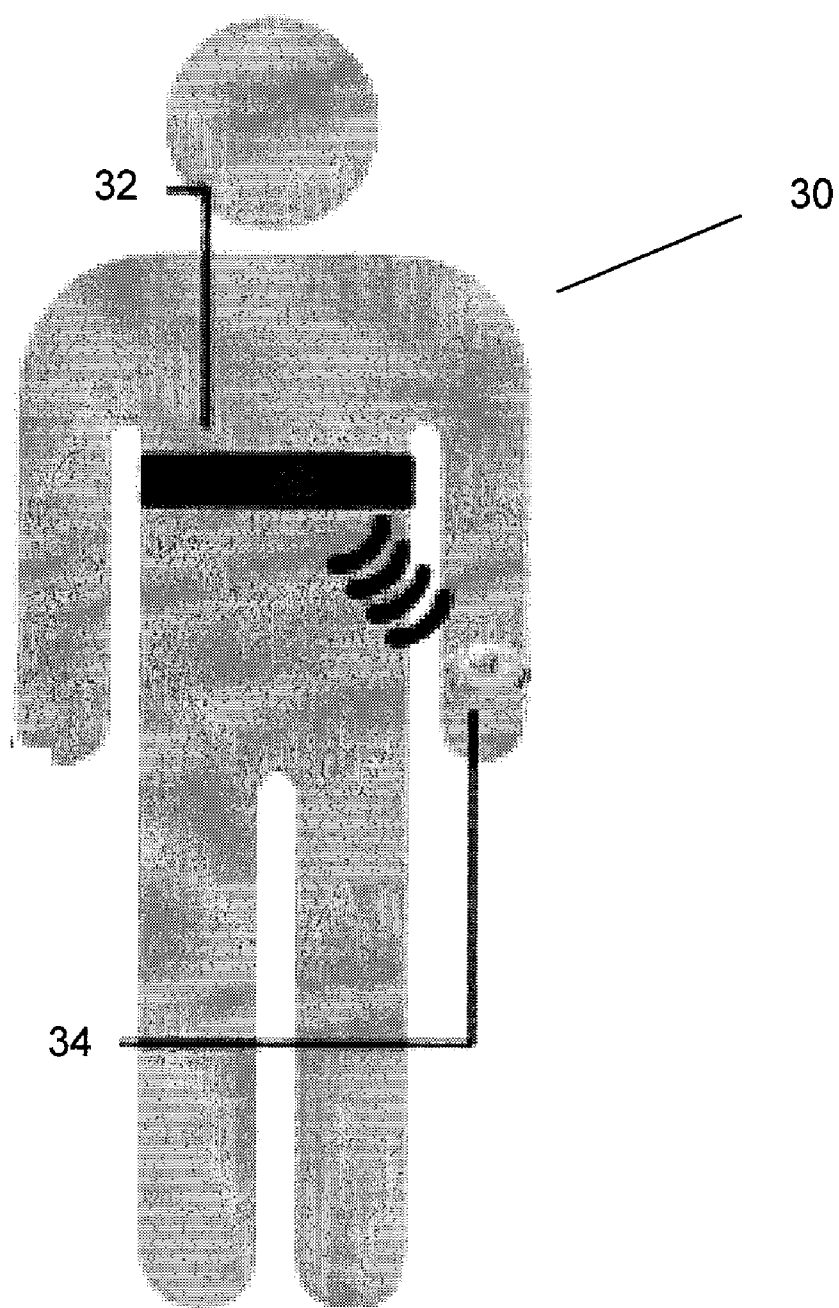


Fig. 1

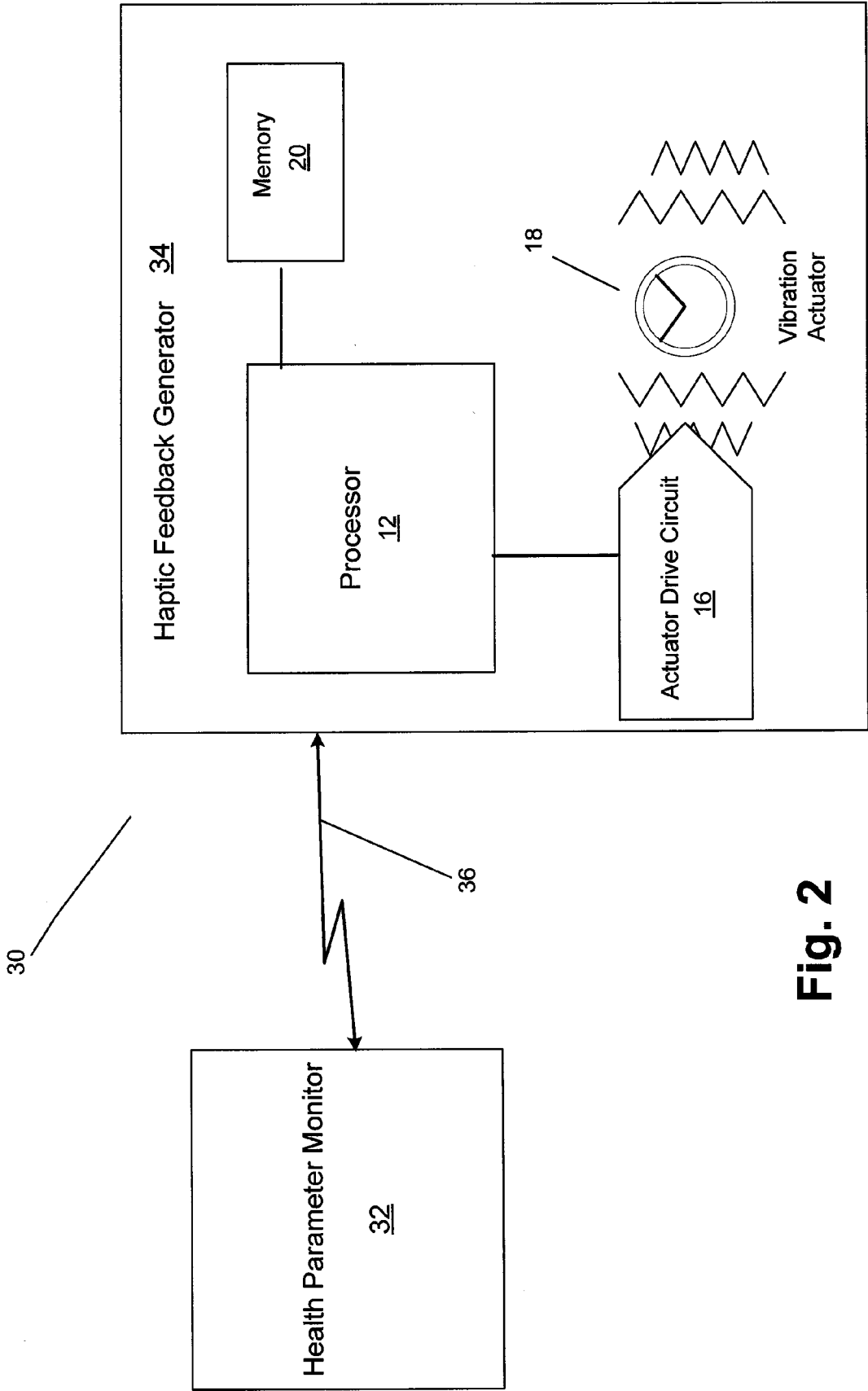
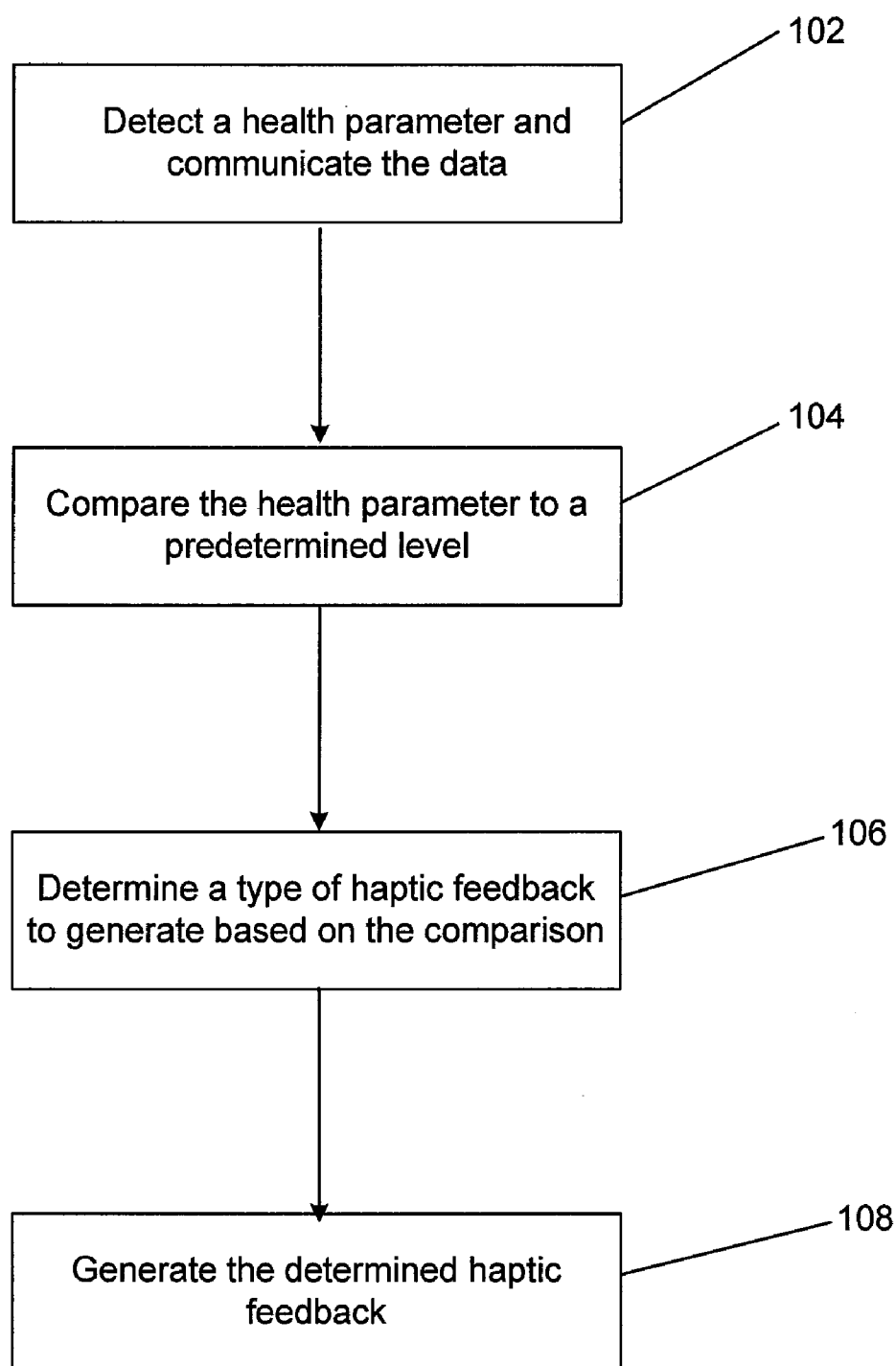


Fig. 2

**Fig. 3**

HAPTIC HEALTH FEEDBACK MONITORING

FIELD OF THE INVENTION

[0001] One embodiment of the present invention is directed to a haptic feedback system. More particularly, one embodiment of the present invention is directed to a system that generates haptic feedback based on monitored health parameters.

BACKGROUND INFORMATION

[0002] In the medical profession today, the advent of high technology has provided a myriad of impressive diagnostic tools. However the focus of this medical technology has been on diagnosis of acute conditions, rather than advanced warnings and preventive advice. Routine “checkups” are the recognized method of monitoring a person’s health. Such examinations provide a physician with information relating to the patient’s condition. However, unless a patient’s checkup is fortuitously scheduled for a time at which symptoms of an ensuing illness are just developing, the checkup may not be effective in helping to detect the onset of an adverse medical condition.

[0003] Portable health monitors have been developed in the past which monitor body/health parameters specific to a particular medical condition. In some cases these monitors record specific parameter data, while in others they provide an output to the patient which is indicative of the physical parameters they sense. Some monitors simply provide an alarm when the parameters reach a pre-set level of particular concern. Others such as portable heart rate monitors provide a digital display of heart rate to the patient. Still others record heart rate over time. Patients use such heart rate monitors to warn them of high heart rates. Athletes use them to ensure that their physical training includes periods of elevated heart rate thought to be sufficient to promote conditioning. Similar monitors also exist for measuring other parameters.

[0004] Known methods of alerting users of health parameters are fairly limited. In many instances, a user needs to be alerted or informed of parameters without having to look at a specific display or listen for a distinctive noise. Based on the foregoing, there is a need for an improved system and method for monitoring and alerting a user of health parameters.

SUMMARY OF THE INVENTION

[0005] One embodiment is a haptic health feedback monitor that includes a health parameter monitor that detects a health parameter. A haptic feedback generator receives the health parameter and compares it to a predetermined level. If the health parameter reaches or exceeds the level, a type of haptic feedback to generate is determined. The type of feedback may depend on which predetermined level is reached or exceeded. The haptic feedback generator then generates the determined type of haptic feedback.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a plan view of a health monitoring system in accordance with one embodiment that monitors health parameters of a user.

[0007] FIG. 2 is a block diagram of the health monitoring system in accordance with one embodiment.

[0008] FIG. 3 is a flow diagram of the functionality of the health monitoring system in accordance with one embodiment.

DETAILED DESCRIPTION

[0009] Embodiments of the present invention may include kinesthetic feedback (such as active and resistive force feedback) and/or tactile feedback (such as vibration, texture, and heat), more generally known collectively as “haptic feedback”, to provide health parameters to a user. Haptic feedback can provide cues that enhance and simplify the user interface. Specifically, vibration effects, or vibrotactile haptic effects, may be useful in providing cues to users of electronic devices to alert the user to specific events, or provide realistic feedback to create greater sensory immersion within a simulated or virtual environment. One embodiment is a health monitoring system in which haptic feedback is used to alert a user of health parameter levels.

[0010] FIG. 1 is a plan view of a health monitoring system 30 in accordance with one embodiment that monitors health parameters of a user. The system includes a health parameter monitor 32 coupled to a haptic feedback generator 34. Health parameter monitor 32 may be any type of device for monitoring health parameters. For example, embodiments that are used for disease management may monitor blood glucose, blood pressure, ambulatory ECG, respiratory, temperature, heart rate, blood salinity, blood electrolytes, hormones, blood iron, blood alcohol, etc. Embodiments that are used for healthy lifestyle management may include monitoring for temperature, heart rate, blood pressure, amount of work or rate of work performed, etc.

[0011] One embodiment of haptic parameter monitor 32 may be a chest strap, as shown in FIG. 1, that includes a variety of parametric sensors that can detect health parameters non-invasively. Other embodiments may detect health parameters in a more invasive method such as through sampling of blood or other body fluids. Health parameter monitor 32 may include a processor and memory.

[0012] In one embodiment, haptic feedback generator 34 is any type of device that is capable of communicating with health parameter monitor 32 to receive measured health parameters, and is capable of applying haptic feedback to a user in response to the health parameters. Haptic feedback generator 34 may be worn on the user’s wrist, as shown in FIG. 1, or on any other portion of the user’s body, including as a glove on a hand, a belt around the waist, a shoe or clothing or accessories such as a shirt, pants, undergarments, sunglasses, ear-pieces, rings, bracelets, necklaces, etc. Haptic feedback generator 34 may also be a device that is not “attached” to the user’s body but still is able to apply haptic feedback that can be detected by the user. For example, a cellular telephone that can be slipped in the user’s pocket may be used to apply a haptic feedback to the user. Further, haptic feedback generator 34 may be housed in the same physical device as health parameter monitor 32.

[0013] FIG. 2 is a block diagram of health monitoring system 30 in accordance with one embodiment. Health parameter monitor 32 is in communications with haptic feedback generator 34 via communication link 36. Communication link may be any type of interface for communicating data, including wired, wireless, radio, infra-red (“IR”), etc. Health parameter monitor 32 and haptic feedback generator 34 include communication modules (not shown) for facilitating data communications via communication link 36.

[0014] Processor 12 can decide what haptic effects are to be played and the order in which the effects are played based on high level parameters which are based on information from the monitor 32 regarding health parameter values falling outside of or reaching predefined levels. In general, the high level parameters that define a particular haptic effect include magnitude, frequency, duration, attack level, attack time, fade level and fade time. These high level parameters can also be dynamically changed. Individual haptic effects can also be grouped together to form more complex haptic effects or timelines.

[0015] Processor 12 outputs the control signals to drive circuit 16 which includes electronic components and circuitry used to supply actuator 18 with the required electrical current and voltage to cause the desired haptic effects. Actuator 18 is a haptic device that generates a vibration on the body of haptic feedback generator 34 or in some other area so that it can be felt by the user. Actuator 18 may be, for example, an electromagnetic actuator such as an Eccentric Rotating Mass ("ERM") in which an eccentric mass is moved by a motor, a Linear Resonant Actuator ("LRA") in which a mass attached to a spring is driven back and forth, or a "smart material" such as piezoelectric, electro-active polymers or shape memory alloys.

[0016] Memory 20 can be any type of storage device, such as random access memory ("RAM") or read-only memory ("ROM"). Memory 20 stores instructions executed by processor 12. Memory 20 may also be located internal to processor 12, or any combination of internal and external memory. Memory 20 further stores data of measured parameters from haptic parameter monitor 32 so that it can be used at a later time.

[0017] Haptic feedback generator 34 can generate multiple types of haptic effects to communicate different information to the user. For example, for vibration based haptic effects, high amplitude, high frequency vibration can communicate one type of information, while low amplitude, low frequency vibration can communicate another type of information. Similarly, for temperature based haptic effects, a cold temperature or hot temperature may communicate two or more types of information. Other examples of possible haptic effects that can be varied to communicate more than one type of information include humidity levels (e.g., wet or dry) or the rigidity of generator 34 (e.g., it can be changed from loose and floppy to tight/constricting and rigid). All permutations and combinations of the various types of haptic feedback can be combined in embodiments to create compelling haptic effects. The use of varying patterns of haptic effects can also be used to communicate different information to the user. A limitless number of haptic patterns could be used to communicate a plethora of health-related information by varying not only the individual haptic effect amplitude, frequency and duration parameters, but by varying the durations between these haptic effects and by combining the same or dissimilar haptic effects into unique patterns for the purpose of this communication. For example, in one embodiment the application of a series of short duration haptic effects repeated at a set interval can communicate one type of information and the application of a series of long duration haptic effects at a different interval can communicate another type of information.

[0018] Many health parameters monitored by health parameter monitor 32 have various levels that may be of interest to a user. For example, for a measured heart rate a user

might desire a haptic feedback when the heart rate exceeds a predetermined level (e.g., 180 beats per minute ("bpm")). However, some athletes attempt to get their heart rate within various "zones" such as Zone 1 (50-60% of maximum heart rate); Zone 2 (60-70% of maximum heart rate); Zone 3 (70-80% of maximum heart rate); Zone 4 (80-90% of maximum heart rate); Zone 5 (90-100% of maximum heart rate). For these users, it is beneficial to receive a different type of haptic effect when entering each zone. Similarly, one level of blood glucose may generate one type of haptic effect, while a second level, which may indicate that medication or other steps must be undertaken immediately, may generate another type of haptic effect.

[0019] FIG. 3 is a flow diagram of the functionality of health monitoring system 30 in accordance with one embodiment. In one embodiment, the functionality of the flow diagram of FIG. 3 is implemented by software stored in or loaded into memory and executed by a processor. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software. Further, any of the functionality may be performed by either monitor 32 or generator 34.

[0020] At 102, health parameter monitor 32 detects a health parameter and communicates that data to haptic feedback generator 34.

[0021] At 104, haptic feedback generator 34 compares the health parameter to a predetermined level, such as zone 2 heart rate, mildly high blood glucose level, etc.

[0022] At 106, based on the comparison, generator 34 determines a type of haptic feedback to generate.

[0023] At 108, the haptic feedback parameters are compiled and sent to the haptic device (e.g., actuator drive circuit 16 and vibration actuator 18) to create the haptic feedback. Therefore, the particular haptic feedback that is generated will depend on the type determined at 106. Similarly, different levels at 104 will result in a different type of haptic feedback being generated at 108.

[0024] In addition to generating haptic feedback at 108 to provide an alert to the user, in some embodiments the haptic feedback itself may counteract the health parameter. For example, if the type of haptic feedback is temperature based, a rising temperature can be counteracted by the application of a cold temperature haptic effect, or moisture released in response to the body suffering from arid conditions.

[0025] Further, the haptic feedback alert can be generated remotely from health parameter monitor 32 and can be applied to a user other than the user wearing health parameter monitor 32. For example, in combat situations, medics could be informed of a soldier's need for medical attention or more generally alerted to the need for medical attention for a group of soldiers based on an average of the group's vital stats readings. Further, those who care for the elderly or the physically disabled can be alerted for the need for medical attention or other type of assistance, or it can be used to remotely monitor children.

[0026] In one embodiment, health parameter monitor 32 further includes a Global Positioning System ("GPS") that generates information regarding the geographic location of the user. In one embodiment, the GPS information can be used after the alert has been triggered to assist in guiding medical or monitoring personnel to the person needing attention. In one embodiment, after triggering a haptic health alert and communicating vital health information to the monitoring staff, the system can enter a GPS mode that provides

guidance through a series of haptic effects of increasing amplitude, frequency, duration or patterns that assist in pinpointing the location of the person needing attention. In one embodiment, the haptic effects, in addition to being generated at a remote user, can also be used as a two-way communication system in sending one or more haptic effects to the injured person, letting them know a number of relevant facts such as: the alert has been sent; the alert has been received; help is on the way; GPS pinpointing has been activated; or the relative position or distance of medical assistance.

[0027] Several embodiments are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is:

1. A method of monitoring health comprising: detecting a first health parameter; comparing the first health parameter to a first predetermined level; determining a first type of haptic feedback to generate based on the comparison; and generating the determined first type of haptic feedback.
2. The method of claim 1, further comprising detecting a second health parameter; comparing the second health parameter to a second predetermined level; determining a second type of haptic feedback to generate based on the second comparison; and generating the determined second type of haptic feedback.
3. The method of claim 1, wherein the first type of haptic feedback is vibrotactile.
4. The method of claim 1, wherein the first type of haptic feedback is temperature.
5. The method of claim 1, wherein the first type of haptic feedback is humidity.
6. The method of claim 1, wherein the first type of haptic feedback is rigidity.
7. The method of claim 1, wherein the first health parameter is at least one of heart rate, blood pressure, blood glucose level, respiratory level, temperature, blood alcohol level, blood iron level, blood salinity, blood electrolyte level and hormone level.
8. The method of claim 1, wherein the first type of haptic feedback is applied to a user that has the first health parameter.
9. The method of claim 1, wherein the first type of haptic feedback is applied to a first user that is different from a second user that has the first health parameter.
10. The method of claim 1, further comprising transmitting a signal that indicates a location of a user that has the first health parameter.
11. A haptic health feedback monitor comprising: a health parameter monitor that detects a first health parameter; and a haptic feedback generator coupled to the monitor that receives the first health parameter and compares to a first predetermined level;

wherein the generator determines a first type of haptic feedback to generate based on the comparison and generates the determined first type of haptic feedback.

12. The monitor of claim 11, wherein the generator detects a second health parameter, compares the second health parameter to a second predetermined level, determines a second type of haptic feedback to generate based on the second comparison, and generates the determined second type of haptic feedback.

13. The monitor of claim 11, wherein the first type of haptic feedback is vibrotactile.

14. The monitor of claim 11, wherein the first type of haptic feedback is temperature.

15. The monitor of claim 11, wherein the first type of haptic feedback is humidity.

16. The monitor of claim 11, wherein the first type of haptic feedback is rigidity.

17. The monitor of claim 11, wherein the first health parameter is at least one of heart rate, blood pressure, blood glucose level, respiratory level, temperature, blood alcohol level, blood iron level, blood salinity, blood electrolyte level and hormone level.

18. The monitor of claim 11, further comprising a location determiner that determines a location of the parameter monitor.

19. An apparatus for monitoring health comprising: means for detecting a first health parameter; means for comparing the first health parameter to a first predetermined level; means for determining a first type of haptic feedback to generate based on the comparison; and means for generating the determined first type of haptic feedback.

20. The apparatus of claim 19, further comprising means for detecting a second health parameter; means for comparing the second health parameter to a second predetermined level; means for determining a second type of haptic feedback to generate based on the second comparison; and means for generating the determined second type of haptic feedback.

21. A computer readable medium having instructions stored thereon that, when executed by a processor, cause the processor to:

receive a first health parameter and compare to a first predetermined level; determine a first type of haptic feedback to generate based on the comparison; and generate the determined first type of haptic feedback.

22. The computer readable medium of claim 21, said processor further:

compare the second health parameter to a second predetermined level; determine a second type of haptic feedback to generate based on the second comparison; and generate the determined second type of haptic feedback.

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