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Loree, IV

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(54) **EASY WAKE WRIST WATCH**

(76) Inventor: **Leonor F. Loree, IV**, 3055 E. Pine Valley Rd., Atlanta, GA (US) 30305

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Related U.S. Application Data

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(51) **Int. Cl.**
A61B 5/103 (2006.01)

(52) **U.S. Cl.** **600/595**; 600/587

(58) **Field of Classification Search** 600/587, 600/595, 300, 301, 544–546, 529, 481–483, 600/532, 538
See application file for complete search history.

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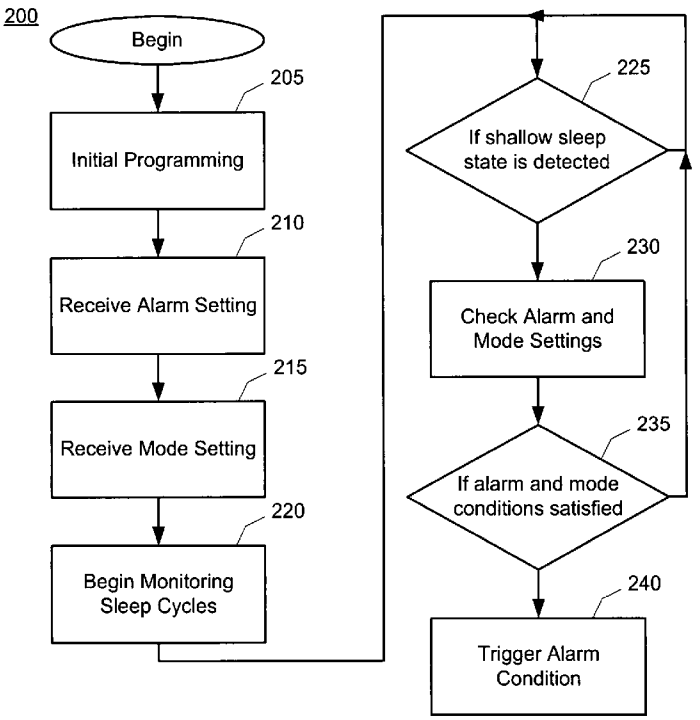
Primary Examiner—Max F. Hindenburg
Assistant Examiner—H. Q. Nguyen
(74) *Attorney, Agent, or Firm*—Smith Frohwein Tempel Greenlee Blaha, LLC; Gregory Scott Smith

(57) **ABSTRACT**

A device that monitors a user's sleep cycles and operates to sound an alarm to awaken the user at an optimal point within a sleep cycle. Once an alarm time is set and the alarm is activated, the device begins to monitor a wearer's sleep cycles by identifying the points in time at which the wearer moves his or her body limbs. As the alarm time is approached, the device can trigger the alarm earlier if the wearer is at an optimal point in the sleep cycle or, even retard the triggering of the alarm if the optimal point in the sleep cycle is expected to occur shortly.

11 Claims, 3 Drawing Sheets



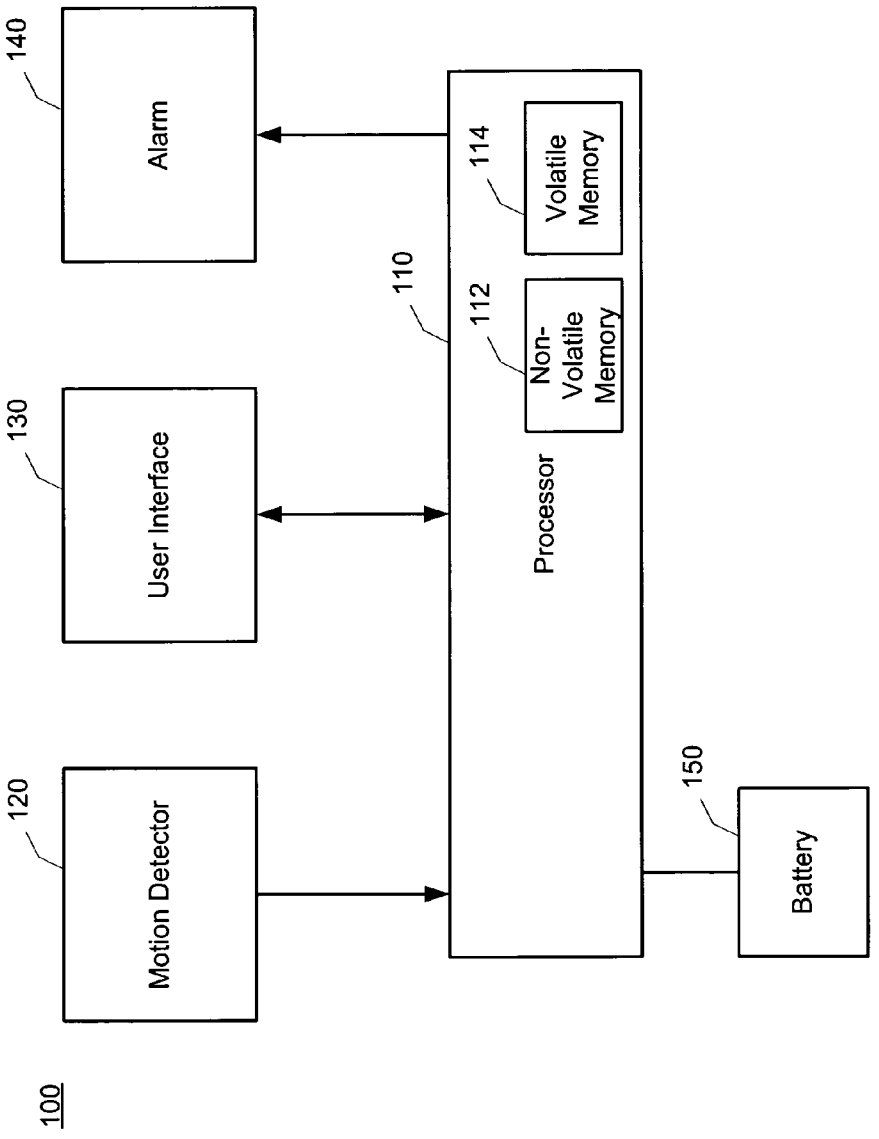

100
120
Motion Detector
130
User Interface
140
Alarm
110
Processor
112
Non-Volatile Memory
114
Volatile Memory
150
Battery

Fig. 1

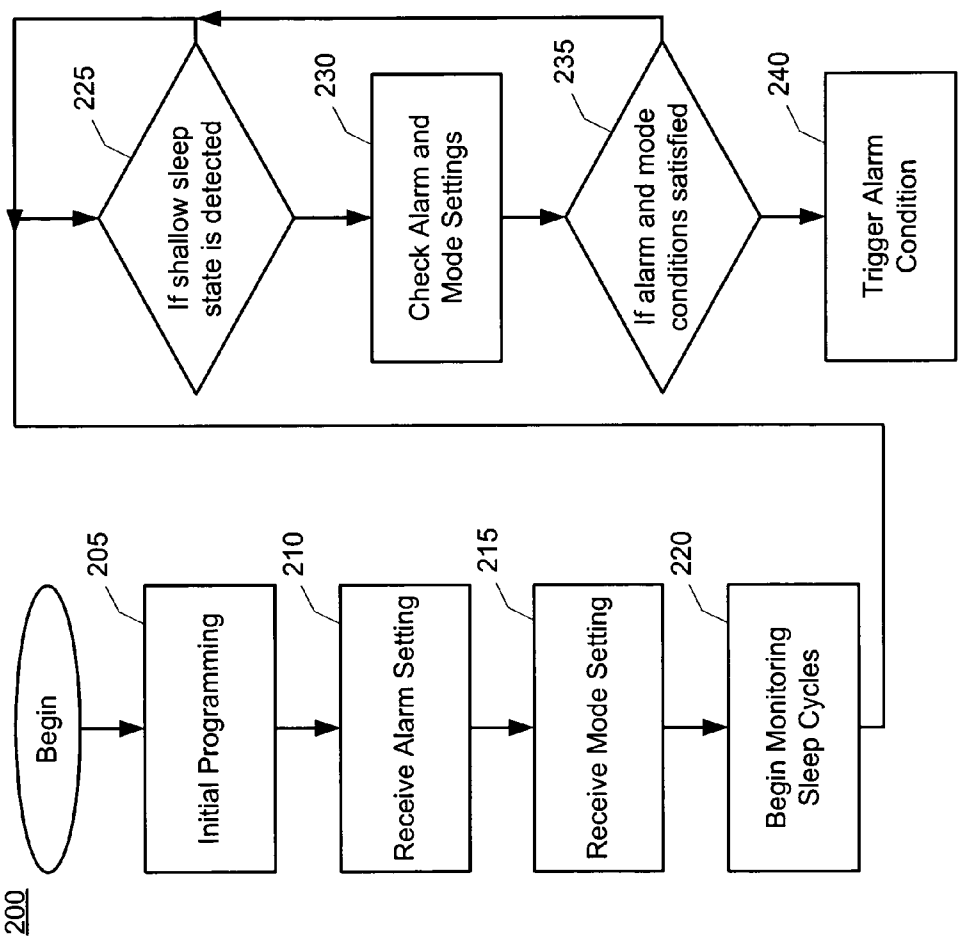

200
Begin
205
Initial Programming
210
Receive Alarm Setting
215
Receive Mode Setting
220
Begin Monitoring Sleep Cycles
225
If shallow sleep state is detected
230
Check Alarm and Mode Settings
235
If alarm and mode conditions satisfied
240
Trigger Alarm Condition

Fig. 2

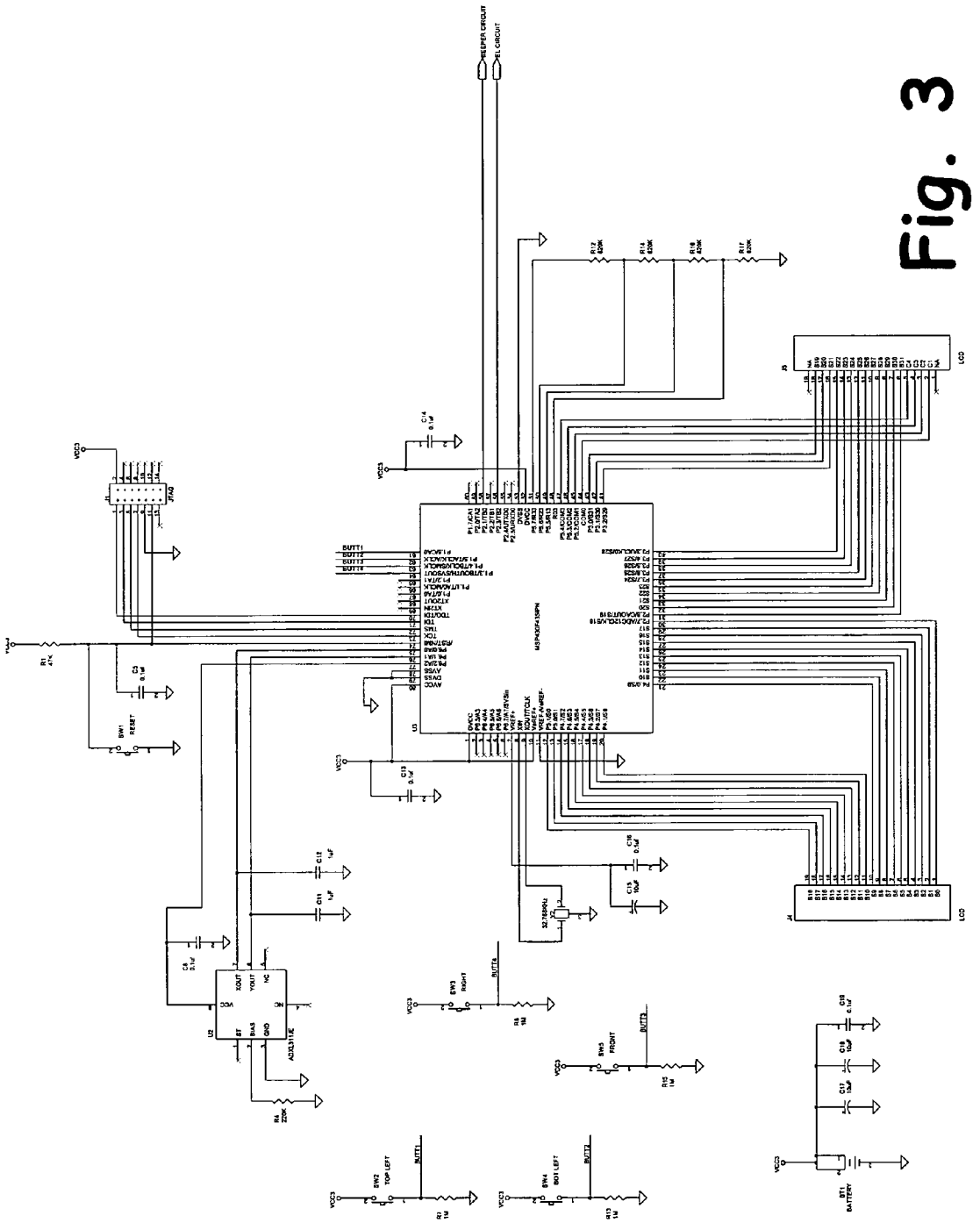


Fig. 3

EASY WAKE WRIST WATCH

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the filing date of U.S. Provisional Application for Patent filed on Jan. 9, 2004, having a title of EASY WAKE WRIST WATCH and having been assigned Ser. No. 60/535,247.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISK APPENDIX

Not applicable.

BACKGROUND OF THE INVENTION

The present invention is directed towards an apparatus and method for determining the optimal moments to awaken a user during the sleep cycle and, more specifically, it relates to an apparatus and method that detects motion of a sleeping user to determine the user's sleep cycle and may alter the triggering of an alarm condition based on the detection of the motion.

The human body is an amazingly complex electrical, chemical and physiological machine. In a world where technologists are all seeking "wireless" solutions, the human body has been operating in that mode since its earliest inception. Utilizing fuel ranging from BIG MACS with fries to pot roasts to SNICKERS bars, the human body is able to generate its own source of energy. Another extremely important requirement of the human body is down time. Although the amount of down time necessary for the human body can vary from person to person, everyone needs and requires some amount of down time, otherwise known as sleep.

Many studies have been performed around the concept of "sleep". From these studies it is well known that a period of sleep consists of several sleep cycles. Each sleep cycle spans a period of time that starts with a light or shallow state of unconsciousness, progresses to a deep state of unconsciousness, and then returns to the shallow state. It is also well known through empirical evidence that the human body is much more adept to recovering from a period of sleep when the individual is aroused out of the unconscious sleep state while in the shallow state. Being aroused from a deep state not only requires a longer recovery time, but can also adversely affect the individual's alertness and energy state throughout the day. Thus, there is a need in the art for a technique to arouse an individual from his or her sleep when the individual is within a shallow state of sleep.

It is also well known that when an individual is residing in a shallow state of sleep, there is a higher tendency for the individual to move parts of their body, such as their arms or legs. Thus, there is a need in the art for a technique to determine when an individual is in a shallow state of sleep and attempt to arouse the individual during this period of time.

SUMMARY OF THE INVENTION

The present invention combines a wrist watch and an accelerometer, or other motion detection device, into a single closed loop device for personal operation. The present invention operates to distinguish between the deep and shallow sleep cycles of an individual based on the individual's movements. During a shallow sleep cycle, individuals will have a tendency to move their limbs. The accelerometer detects such movements and identifies the user as being in a shallow sleep cycle. The user can set the wrist watch for a particular alarm time. If a shallow sleep cycle is detected during a particular window surrounding the set alarm time, the alarm may either be sounded early, or retarded to allow the user to be awakened at an optimal time.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a block diagram illustrating the functional components of an exemplary embodiment of the present invention.

FIG. **2** is a flow diagram illustrating the steps involved in an exemplary embodiment of the present invention.

FIG. **3** is a circuit diagram illustrating on technique of implementing the hardware aspect of the present invention.

DETAILED DESCRIPTION OF THE VARIOUS ASPECTS OF THE INVENTION

The present invention is directed towards a wrist watch type apparatus that includes an alarm mechanism. The alarm can be set to go off (a) at a particular time ("the programmed alarm"), (b) after a particular number of sleep cycles, or (c) a combination of the two.

When the device is set to go off at a particular time, the actual triggering of the alarm will depend upon motion detected by a motion detection apparatus. The operation of the invention is based on a correlation between body movement and a shallow portion of a person's sleep cycle. Thus, in a window of time around the programmed alarm, the present invention monitors the activity of the motion detector. If motion is detected within a certain period of time prior to the programmed alarm time, the alarm will trigger at an earlier time. If motion is not detected by the programmed alarm time, the triggering of the alarm will be delayed until either motion is detected or a threshold delay is reached.

In the preferred embodiment of the invention, the motion detection mechanism is an accelerometer. However, other methods of motion detection can also be used such as motion sensors embedded within a mattress or covering, optical movement detection devices, or the like. In addition, in the preferred embodiment, the device is in the form of a wrist watch; however, other embodiments may also be utilized such as, but not limited to, a finger device, ankle device, leg device, a head band, and arm device.

Example of operation. As an example, the user sets the watch for a 7:00 am wake up time and a 6:40 am window. The window could be any of a variety of setting such as +/−10 minutes, +/−20 minutes, +10 minutes −20 minutes, −15 minutes, or the like. In the present example, if between the times of 6:40-7:00 am the watch senses a particular type of movement, the alarm will be triggered early and the user will be awakened with almost no effort. The user will awake refreshed and feeling like they were hardly asleep. If in that 20-minute window the movement criteria are not met, the alarm will default to the 7:00 am alarm and wake the user like a normal alarm clock.

In one embodiment of the invention, motion is only detected in a particular plane. However, it should be understood that all planes of movement could be detected in three dimensional planes.

The present invention may also employ the use of hysterisis. For instance, a particular amount of movement may be required to trigger an early alarm. If some movement is detected, the device may enter a "look for more movement" mode of operation. If a particular amount of movement is detected in this mode, then the alarm may be triggered. However, if no additional movement is detected for a particular period of time, the device may exit the "look for more movement" mode of operation and revert back to the normal mode in which any movement is monitored.

The present invention may also be used to track sleep cycles during the night and obtain and average time for a user's sleep cycles. Using this information, the present invention may be able to detect anomalies in the person's sleep cycle. In addition, the device can utilize the sleep cycle information to conduct predictive analysis of when the users next shallow sleep cycle will occur.

The device may also include a snooze capability, similar to standard alarm devices that allow a user to delay the alarm for a fixed period of time. In addition, the device can include a snooze capability that request the alarm to be delayed for an incremental number of sleep cycles. Using this aspect of the present invention, a user can set the device to alarm after a particular number of sleep cycles. Thus, the user can take a short nap of just one sleep cycle, or a longer number of sleep cycles.

The present invention can also operate to distinguish between movement occurring while the user is attempting to go to sleep and movement occurring as a part of a sleep cycle. For instance, if the user selects a particular number of sleep cycles before the alarm will sound, the device can require a threshold amount of time to occur in which no movement is detected prior to beginning the sleep cycle count. Advantageously, this aspect of the present invention allows a user to set the device for his or her optimal number of sleep cycles and, the device will wait until the sleep cycle process begins before counting, and then sound an alarm during the shallow sleep cycle of the desired sleep cycle.

As another example, a user may not have any particular time in mind that he or she wants to be awakened but knows that he or she functions better if he or she has slept for 6 sleep cycles. Thus, the user sets the device for 6 sleep cycles and retires for the night. Once the device determines that the user has entered into sleep cycles, it begins to count the sleep cycles. After 6 sleep cycles, the device will detect motion during the shallow portion of the cycle and then sound an alarm. As previously described the device can keep a running average of the user's sleep cycles. Thus, if for some reason a user goes through a shallow sleep cycle without any movement, the device can apply heuristics to determine such a condition. For example, if a person's sleep cycle typically lasts for 45 minutes and the device does not detect motion for 90 minutes, the device can determine that one shallow sleep state had been missed and adjust the sleep cycle count accordingly. In addition, if the device does not detect movement at the end of the selected number of sleep cycles, the device can conclude that the end of the sleep cycle has been reached and after a threshold period of time, trigger the alarm. For example, if the user programs the device for **6** sleep cycles and the device has determined the user's typical sleep cycle is 45 minutes, then after a particular number of minutes (i.e., 20 minutes) after the 6th sleep cycle was to be completed, the device may trigger the alarm.

The device may utilize a variety of alarm mechanisms and the present invention is not limited to any particular mechanism. Some exemplary mechanisms include an audible alarm, a vibrator or a blinking light In addition, a wireless transmitter can be included in the device. The wireless transmitter can be used to trigger other alarm mechanisms that are equipped with a wireless receiver. For instance, the user may wish to be awakened by a radio or a television. If the radio or television is equipped with an appropriate wireless receiver, when the device triggers the alarm, a turn on signal will be sent to the wireless receiver. A typical wireless transmitter and receiver solution could include BlueTooth technology or I.E.E.E. 802.11.

Another aspect of the present invention is that it is self-contained in a single unit that can be worn on the body. It is not necessary to have wires extending from the body to another device that performs any of the functions such as monitoring or calculating sleep cycles.

In other embodiments, the technology of the present invention can be incorporated into other objects that can also detect movement of the user. For instance, in one embodiment, the invention can be incorporated into a sleeping mattress or a pad that is placed over the top of a mattress. In this embodiment, accelerometers or pressure detection devices could be used. In another embodiment, the invention can be incorporated in a blanket or comforter under which the user sleeps. Yet in another embodiment, the invention can be incorporated into the user's sleepwear, such as pajamas or a night gown.

FIG. **1** is a block diagram illustrating the functional components of an exemplary embodiment of the present invention. The device **100** could be embodied within a wrist watch or some similar apparatus that can be worn on the body. The device **100** includes a processor **110** that is powered through a battery **150**. The processor **110** interfaces to a motion detector **120**, a user interface **130** and an alarm **140**. As previously described, the motion detector can be an accelerometer or other motion sensing device embedded into the device **100**, or may be an external device that is wirelessly coupled to the processor **110**. The user interface can include a variety of mechanisms but, in general, includes a mechanism for a user to provide input to the processor and for the processor to display status, prompts and results to the user. In a wrist watch embodiment, the user interface may include a series of buttons and an LCD, LED or electroluminescence display. However, it should be appreciated that the present invention is not limited to any particular user interface mechanisms and other technologies can be employed without departing from the spirit and scope of the invention. Such technologies can include voice activations, touch sensitive screens, text to audio conversions and speakers, etc.

The processor **110** includes volatile memory **114** and non-volatile memory **112**. The volatile memory **114** may include RAM, EEPROM, bubble memory or other similar technologies and the non-volatile memory may include ROM, EPROM, PROM, Gate Arrays or other similar technologies. The non-volatile memory houses a program including instructions that are executed by the processor. Such instructions provide the intelligence for the processor in responding to inputs from the motion detector **120**, the user interface **130** and for controlling the outputs to the user interface **130** and the alarm **140**. The volatile memory **114** is used for storing configuration parameters such as the current time, alarm settings, modes of operation or the like.

FIG. **2** is a flow diagram illustrating the steps involved in an exemplary embodiment of the present invention. The

illustrated process **200** begins by conducting an initial programming **205** of the device **100**. The initial programming, among other things, may include a user entering the present local time and date as well as any user configurable parameters such as alarm notifications, text configurations or the like. The user can then program the device **100** with alarm settings **210**. As previously described, the alarm settings can include identifying a preferred time to be awakened, a window or threshold period of time, a number of desired sleep cycles or the like. The user can also program the device with mode settings **215**. As previously described, the mode settings can include setting the device to wake the user after a predetermined number of sleep cycles, threshold times, or the like. In some embodiments, the alarm settings and the mode settings can be accomplished simultaneously. Once the device **100** is programmed, the device enters into monitoring mode. The monitoring mode **220** can be automatically triggered in accordance with the alarm and mode settings or can be manually triggered by the user when the user retires.

In the monitoring mode, if the processor detects that the user is in a shallow state of sleep **225**, such as by receiving an input from the motion detector, the processor checks the alarm and mode settings **230** to determine if the alarm should be sounded. Otherwise, the monitoring mode is continued. If the alarm and mode settings are satisfied **235** (i.e., shallow sleep cycle is detected within the threshold time of the alarm setting or a specified number of sleep cycles is reached), then an alarm is triggered **240**. Otherwise, the monitoring mode continues.

FIG. **3** is a circuit diagram illustrating on technique of implementing the hardware aspect of the present invention. This circuit diagram is provided for informational purposes only and the particular components illustrated and the particular circuitry used in no way limits the present invention. In this example, the MSP430F435IPN device is used to provide the processor and memory elements of the device.

The present invention has been described using detailed descriptions of embodiments thereof that are provided by way of example and are not intended to limit the scope of the invention. The described embodiments comprise different features, not all of which are required in all embodiments of the invention. Some embodiments of the present invention utilize only some of the features or possible combinations of the features. Variations of embodiments of the present invention that are described and embodiments of the present invention comprising different combinations of features noted in the described embodiments will occur to persons of the art.

What is claimed is:

1. A portable alarm system that can be worn on a user's limb, the portable alarm system comprising:

a single housing that contains an accelerometer, a user interface, a display for rendering the user interface and a processing unit;

the accelerometer operating to detect motion on at least one plane;

the user interface enabling a user to program various alarm parameters and settings for the portable alarm system;

a strap that enables the housing to be attached to a user's limb; and

a processing unit, the processing unit being communicatively coupled to the accelerometer and the user interface, and in response to inputs from the accelerometer and the user interface, in cooperation with programming instructions, is operative to:

receive a user selected alarm setting via the user interface, the alarm setting including an alarm time, a threshold, and a sleep cycle count;

monitor the accelerometer for data indicating a positive movement of the user's limb to which the single housing is attached by means of the strap;

analyzing the accelerometer data to establish the timing of sleep cycles and to identify shallow sleep periods of the sleep cycles;

applying heuristics to estimate the conclusion of a sleep cycle based on sleep cycle data for the user, wherein the step of applying heuristics to estimate the conclusion of a sleep cycle based on sleep cycle data for the user further comprises the steps of:

identifying a typical sleep cycle for the user;

if a sleep cycle that is substantially longer than the typical sleep cycle for a user is detected, compare the duration of the long sleep cycle to the typical sleep cycle;

if the long sleep cycle is approximately a multiple of the typical sleep cycle, concluding that the detection of one or more sleep cycles was missed; and

incrementing the sleep cycle count in accordance with the estimated number of missed sleep cycles; and

receiving a user selected mode setting via the user interface that can enable alarm modes selected from a group of alarm modes including modes for:

triggering an alarm condition when a shallow sleep period of a sleep cycle occurs within a threshold prior to the alarm time;

triggering an alarm condition when a shallow sleep period of a sleep cycle occurs in conjunction with the number of sleep cycles reaching the sleep cycle count; and

triggering an alarm condition within a threshold after the alarm time.

2. The portable alarm system of claim **1**, wherein the accelerometer detects motion in two planes.

3. The portable alarm system of claim **1**, wherein the processing unit is further operative to:

maintain a running average of sleep cycles;

applying heuristics based on the running average of sleep cycles to identify a probable time for a next sleep cycle to occur.

4. The portable alarm system of claim **3**, wherein the heuristics includes identifying an average length of the sleep cycles and adding the average length to the time of the last detected shallow sleep cycle.

5. The portable alarm system of claim **1**, wherein in conjunction with the mode of triggering an alarm condition when a shallow sleep period of a sleep cycle occurs in conjunction with the number of sleep cycles reaching the sleep cycle count, the processing unit is further operative to delay a threshold period of time prior to beginning a sleep cycle count thereby alleviating false counts that may occur prior to going to sleep.

6. A portable alarm system that can be worn on a user's limb similar to a wrist watch, the portable alarm system comprising:

a motion detector including an accelerometer;

a user interface; and

a processing unit, the processing unit being communicatively coupled to the motion detector and the user interface, and in response to inputs from the motion detector and the user interface, in cooperation with programming instructions, is operative to:

receive an alarm time setting including an alarm time, a threshold value and a sleep cycle count;

monitor the motion detector for positive movement data indication of the user's limb;

if the positive movement data indication occurs within a threshold period of time prior to the alarm time or at or after the alarm time and after the number of sleep cycles counted is equal to or greater than the sleep cycle count, trigger an alarm condition; and

if no positive movement is detected within a threshold after the alarm time, applying heuristics based on previously received positive movement data to estimate the conclusion of a sleep cycle.

7. A portable alarm system comprising:

a single housing that contains a user interface, a display for rendering the user interface and a processing unit;

an accelerometer operating to detect motion on at least one plane and providing information regarding such detections to the processing unit;

a user interface enabling a user to program various alarm parameters and settings for the portable alarm system; and

the processing unit, the processing unit being communicatively coupled to the accelerometer and the user interface, and in response to inputs from the accelerometer and the user interface, in cooperation with programming instructions, is operative to:

receive a user selected alarm setting via the user interface, the alarm setting including a sleep cycle count value;

monitor the accelerometer for data indicating a positive movement;

analyzing the accelerometer data to establish the timing of sleep cycles and to identify shallow sleep periods of the sleep cycles;

identifying a typical sleep cycle for the user;

increment a sleep cycle counter for each detected sleep cycle;

if a sleep cycle is detected that is substantially longer than the typical sleep cycle for a user, compare the duration of the long sleep cycle to the typical sleep cycle;

if the long sleep cycle is approximately a multiple of the typical sleep cycle, concluding that the detection of one or more sleep cycles was missed;

incrementing a sleep cycle counter in accordance with the estimated number of missed sleep cycles; and

when the sleep cycle counter reaches the sleep cycle count value, triggering an alarm.

8. The portable alarm system of claim **7**, wherein the accelerometer is incorporated into the single housing.

9. The portable alarm system of claim **7**, wherein the accelerometer is incorporated into a mattress.

10. The portable alarm system of claim **9**, further comprising pressure detection devices.

11. The portable alarm system of claim **7**, further comprising a BlueTooth technology interface to transmit an alarm signal to turn on a remote device to sound an alarm.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

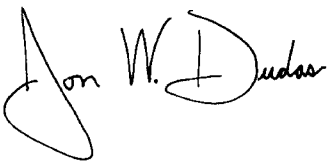
PATENT NO. : 7,306,567 B2
APPLICATION NO. : 11/032404
DATED : December 11, 2007
INVENTOR(S) : Leonor F. Loree, IV and Eric A. Toops

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page, item (76) should read as follows: Inventor: Leonor F. Loree, IV, 3055 E. Pine Valley Rd., Atlanta, GA (US) 30305 and Eric A. Toops, 565 Collins Road, Hoschton, Georgia 30548

Signed and Sealed this

First Day of July, 2008



JON W. DUDAS
Director of the United States Patent and Trademark Office