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(54) **A SYSTEM AND A COMPUTER PROGRAM FOR IMPROVING A PERSON'S SLEEP**

SYSTEM UND COMPUTERPROGRAMM ZUR VERBESSERUNG DES SCHLAFS

SYSTÈME ET PROGRAMME INFORMATIQUE POUR AMÉLIORER LE SOMMEIL D'UNE PERSONNE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to temperature adjustable bedding layers.

BACKGROUND OF THE INVENTION

[0002] Scientific studies have proven that a higher skin temperature in bed has a positive effect on the sleep of a person sleeping said bed. Scientific research has shown that warming the bed to get a small increase in skin temperature results in falling asleep faster, less awakenings during the night, longer sleeping time and more deep sleep.

[0003] Many people suffer from bad sleep. A survey in the USA in 2008 revealed that 65% of the adults experience bad sleep, stating that they have more than 2 nights a week not sleeping well. When these persons were asked for the reasons, they mentioned among other reasons that they have cold feet and/or feel either too warm or too cold during night.

[0004] Electrical blankets for raising the temperature in bed are well known and already exist for decades. However, the major disadvantage of conventional electric blankets is the fact that their temperature is not controlled. A constant power input is applied, and for some blankets the power setting can be changed in a few discrete steps. However, such a change of power setting does not take into account other conditions such as, for example, the presence of additional blankets on top of the bed, different metabolism of users in the bed or the room temperature. Thus, users of electric blankets often complain that the bed was heated too much during the night.

[0005] US 4,433,062 describes a system that can detect the presence of a human body in the bed by a human body detection means for detecting retiring or rising of a user. The human body detection means is either pressure sensitive, or it may be a system using temperature signals in accordance with the presence or absence of a living human body. The preset temperature is automatically raised when the user rises so that the user is allowed to fall asleep again. The higher temperature preset is automatically decreased when the user goes to bed, and the presence of the user's body in the bed is detected.

[0006] US patent application publication US 2009/0099631 A1 discloses a multi-zone electric heating blanket which may be shaped to cover the outstretched arms or other body parts of a patient. The blanket includes two body part portions and a connecting bridge. A power controller may supply power to heating elements in both body part portions based on a temperature sensor in one of the body part portions. The temperature sensor is positioned such that it is always in direct contact with the patient's skin. The blanket comprises two temperatures sensors at maximum, and the temperature regulation is to prevent overheating.

[0007] Document WO 03/022190 A2 discloses an apparatus for regulating a temperature of a body support structure including at least one bladder. A temperature modulator is coupled to the at least one bladder for varying the temperature of fluid within the bladder.

[0008] Document WO 2006/023479 A2 discloses a person support surface comprising a multitude of inflatable cells. The cells are inflated and deflated to adjust an interface pressure between the person support surface and a person supported by the surface.

[0009] Document WO 2012/160502 A1 teaches a system for adjusting the microclimate of a bed environment. The system comprises a multi-zone mattress-style support including a plurality of individual heating zones, means for heating the individual heating zones, means for cooling the multi-zone mattress-style support, and a plurality of temperature sensors, wherein the means for cooling the multi-zone mattress-style support comprises at least one air duct within the multi-zone mattress-style support for transporting ambient air through the multi-zone mattress-style support.

[0010] European patent application EP 2 269 547 A1 describes an occupant support including a mattress, a detector and an energy management system comprising thermally conductive pathways and a controller. The controller activates one or more selected pathways in response to information from the detector to regulate energy transfer at a detected region of risk on the mattress.

[0011] Document US 2009/0099631 A1 teaches a multi-zone electric heating blanket. The blanket may be shaped to cover the outstretched arms or other body parts of a patient. The blanket includes first and second body part portions and a connecting bridge. The interconnection via the bridge leaves an open gap between the first and second body part portions for unblocked access to a patient. A power controller may supply power to heating elements in both body part portions based on a temperature sensor in one of the body part portions.

[0012] Document US 2009/0064411 A1 discloses a climate controlled seat, bed or other assembly configured to receive a person. The device includes a blower and two or more thermoelectric devices or other conditioning fluid modules. According to one embodiment of an operational scheme, a control system for the seat or bed is configured to continuously discharge air from the blower through the thermoelectric devices. In one arrangement, the thermoelectric devices are sequenced between an activated and a deactivated position.

[0013] Document US 2001/020303 A1 describes a mattress suitable for medical application in hospitals etc., the mattress including a cushion body having air permeability, an air discharger provided below the cushion body for discharging air into the cushion body, and a heat source provided below the cushion body for performing far infrared radiation into the cushion body.

[0014] Document WO 2010/129803 A1 concerns a climate-conditioned bed including an upper portion having

at least a first climate zone and at least one fluid module associated with such a first climate zone. The fluid module comprises a fluid transfer device for selectively moving a fluid and a thermoelectric device for selectively heating or cooling a fluid. The bed additionally includes one or more control modules configured to regulate the operation of the fluid module, at least one input device configured to allow an occupant to select a setting of mode associated with the first climate zone and at least a first temperature sensor configured to detect a temperature associated with the first climate zone of the thermally conditioned bed.

[0015] Document US 2009/0177257 A1 discloses an apparatus and a method for performing warming therapy. In one exemplary embodiment, the apparatus includes a warming platform, a heating source, a controller, and a plurality sensors. The heating source comprises a plurality of heating elements forming a matrix, wherein each heating element is operable to heat a corresponding region of the warming platform. The controller is operatively coupled to the heating source for controlling the temperature in each region of the warming platform. The plurality of sensors are operatively coupled to the controller for sensing a physiological parameter of a patient (e.g., body temperature) residing on the warming platform, and providing one or more control signals to the controller for selectively controlling the heating elements.

[0016] US patent No. 5,948,303 teaches a temperature control apparatus for a bed including at least one heating element, mounted in a resting surface on a mattress of the bed for warming at least a first area of the resting area. A temperature sensor is located to detect the temperature of the first area of the resting area, and transmits the information to a central control unit. The central control unit includes a central processing unit which is interconnected with both the heating element and the temperature sensor to adjust the temperature in the first, area of the resting area as desired. The central control unit is also connected to a timer to permit programming of temperature changes as desired. An occupant sensor in the resting surface of the mattress will detect the presence and absence of an occupant, and transmit this information to the central control unit for processing.

[0017] US patent No. 6,646,556 provides a sensor for use in patient monitoring situations, wherein the level of patient motion activity is tracked for purposes of determining whether or not that patient has exhibited sufficient activity to merit eliminating a scheduled assisted relocation to a new position. The device broadly operates to sense the length of time since a patient has last moved from a previous sitting or lying position. If the patient has not moved during some predetermined time interval, it is preferred that the nursing staff be notified that it is time to manually reposition the patient. On the other hand, if the patient has changed position within the specified time period, the device will note that fact and inform the attending nurse or other caregiver that the patient need not be moved at the next scheduled relocation, thereby eliminating the need in some cases to rouse the patient from an otherwise sound sleep.

[0018] US patent No. 5,800,480 discloses an apparatus for supporting a human or animal body, while selectively cooling weight-bearing areas of the body in order to prevent or reduce damage from ischemia. The apparatus includes a cooling layer that is partitioned into a plurality of zones, and a surface disposed over the cooling layer to support the body. Each zone of the cooling layer is disposed for cooling a respective portion of the surface. A mechanism is provided to selectively operate one or more zones of the plurality of the zones to cool a portion of the surface that receives pressure from a weight-bearing surface of the body being supported.

[0019] Document WO 2009/129306 A1 teaches a microclimate management system comprising a mattress, a topper, and a control system. The topper is coupled to the mattress and is supported thereon. The topper defines an interior region and a person containing surface. The control system is configured to maintain at least one of a surface temperature, a relative surface humidity, and a heat withdrawal capacity of at least a portion of the person contacting surface within a predetermined operating.

[0020] Document US 2011/0263950 A1 discloses a system for monitoring medical conditions including pressure ulcers, pressure-induced ischemia and related medical conditions. The system comprises at least one sensor adapted to detect one or more patient characteristic including at least position, orientation, temperature, acceleration, moisture, resistance, stress, heart rate, respiration rate, and blood oxygenation, a host for processing the data received from the sensors together with historical patient data to develop an assessment of patient condition and suggested course of treatment. In some embodiments, the system can further include a support surface having one or more sensors incorporated therein either in addition to sensors affixed to the patient or as an alternative thereof. The support surface is, in some embodiments, capable of responding to commands from the host for assisting in implementing a course of action for patient treatment. The sensor can include bi-axial or triaxial accelerometers, as well as resistive, inductive, capacitive, magnetic and other sensing devices, depending on whether the sensor is located on the patient or the support surface, and for what purpose.

[0021] Furthermore, in electric blankets, heat is supplied uniformly to the whole bed instead of being supplied to those areas only which in fact require heating. Blankets having a separate heating zone for the feet of a sleeping person exist, but again have a fixed heating power only rather than a temperature control.

[0022] There is a need for a bedding layer for improving a person's sleep, which bedding layer provides a better adjustment of the temperature within a bed.

[0023] More specifically, it is desirable to tune the temperature control of individual zones of the bedding sep-

arately accounting to the fact of whether a part of the sleeping person's body is lying on top or underneath an individual heating zone Therefore, it would be advantageous to detect the position of a body lying on a bed, without the need for direct contact between sensor and body. A solution could be to use pressure sensing mats that are commercially available. Such a pressure sensitive mat is placed underneath the body of a lying person, and the mat is capable of detecting a two-dimensional pressure distribution.

[0024] However, such mats are expensive, and not comfortable to lie as they are made of plastic-like material having limited flexibility and no moisture transmission.

SUMMARY OF THE INVENTION

[0025] The present invention is defined in independent claims 1 and 10; preferred embodiments are disclosed in the dependent claims. The present invention utilizes temperature sensors within a bedding layer to detect the presence of a person in a bed, and/or the position of the person's body within the bed when a said person is present in the bed.

[0026] In a first aspect it is an objective to provide a method for improving a person's sleep. The method comprises

- detecting the presence and or the position of the body of the person on or underneath a bedding layer, the bedding layer comprising a plurality of individually thermally adjustable zones and a plurality of temperature sensors, wherein at least one temperature sensor per thermally adjustable zone is dispersed throughout the bedding layer, wherein any one of the group consisting of the temperature, the heating rate and the cooling rate of each thermally adjustable zone can be controlled separately,
- controlling any one of the group consisting of the temperature, the heating rate and the cooling rate of each individual thermally adjustable zone of the bedding layer such that the temperature of the thermally adjustable zones are adjusted to a preset temperature, and
- adjusting the temperature of each individual thermally adjustable zone of the bedding layer such that the temperature of each individual thermally adjustable zone in which areas a part of the person's body is present is maintained at a preset temperature.

[0027] In a second aspect it is an object to provide a system for improving a person's sleep, wherein the system can detect the presence and/or position of the person's body on or underneath the bedding layer and controls the temperature of individual thermally adjustable zones that are present in the bedding layer, accounting for the presence or absence of a part of the person's body in the area of each of the individual thermally adjustable zones. Thereby, it is possible to have a variation in temperature control of different parts of the bed environment, depending on the presence or absence of a part of the person's body. Temperature adjustment, e.g. heating or cooling of individual thermally adjustable zones can be turned off or on during night as the person moves in the bed and changes its body's position.

[0028] The system comprises a bedding layer comprising a plurality of thermally adjustable zones, a plurality of temperature sensors, wherein at least one temperature sensor per thermally adjustable zone is dispersed throughout the bedding layer. The thermally adjustable zones can be controlled separately, and means for controlling the heating power of each of said thermally adjustable zones depending on whether or not a part of the person's body is present in the area of said thermally adjustable zone.

[0029] It is another aspect of the invention to provide a computer program product for improving a person's sleep, wherein the computer program includes a dedicated algorithm for detecting the position of a person's body on or underneath a bedding layer.

DETAILED DESCRIPTION OF EMBODIMENTS

[0030] The present invention will be described with respect to particular embodiments and with reference to the figures, but the invention is not limited thereto, but only to the claims. The drawings described are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes.

[0031] Where an indefinite or definite article is used when referring to a singular noun, e.g. "a", "an", "the", this includes a plural of that noun unless something else is specifically stated. Furthermore, the terms first, second, third and the like in the description and in the claims are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein. Moreover, the terms top, bottom, over, under, beyond and the like in the description and in the claims are used for descriptive purposes and not necessarily for describing relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other orientations than described or illustrated herein. It is to be noticed that the term "comprising", used in the present description and claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant compo-

nents of the device are A and B.

[0032] The method according to the first aspect comprises:

- detecting the position of the body of the person on or underneath a bedding layer, the bedding layer comprising a plurality of individually thermally adjustable zones and a plurality of temperature sensors, wherein at least one temperature sensor per thermally adjustable zone is dispersed throughout the bedding layer, wherein any one of the group consisting of the temperature, the heating rate and the cooling rate of each thermally adjustable zone can be controlled separately,
- controlling any one of the group consisting of the temperature, the heating rate and the cooling rate of each individual thermally adjustable zone of the bedding layer such that the temperature of the thermally adjustable zones are adjusted to a preset temperature, and
- adjusting the temperature of each individual thermally adjustable zone of the bedding layer such that the temperature of each individual thermally adjustable zone in which areas a part of the person's body is present is maintained at a preset temperature.

[0033] The term "thermally adjustable" comprises being capable of cooling, heating and maintaining a temperature. "Thermally adjustable" or "thermally adjusted" further comprises influencing the heat loss to the environment.

[0034] In a non-limiting embodiment of the method, the bedding layer is a bedding layer according to one of the embodiments described in more detail for the first aspect of the invention.

[0035] In another or additional non-limiting embodiment, the method for detecting the position of the body of the person on or underneath the bedding layer comprises recording the temperature increase and/or the power required to maintain a set temperature.

[0036] The set temperature to be maintained in the method can preferably be set to a temperature between approximately 28°C and 35°C. The temperature increases much faster in those areas of the bedding layer where the body of the person is in contact with the bedding layer, compared to those areas where the body is not in contact with the bedding layer. Also, in those areas of the bedding layer where the body of the person is in contact with the bedding layer, compared to those areas where the body is not in contact with the bedding layer, much less power is required to maintain the set temperature. Detecting the faster temperature increase to set temperature and/or the reduced need for maintaining the set temperature for each of the thermally adjustable zones is used to determine the zones in contact with the person's body, and hence is used to determine the position of the person's body on or underneath the bedding layer.

[0037] It is even possible that the actual temperature in close vicinity of the bedding layer, as determined by one or more of the temperature sensors, raises above the set temperature as the temperature of human skin is about 35.5°C, at least in some portions of the body. Thus, detecting that the actual temperature is above the set temperature of between approximately 28°C to 35°C is used to determine the position of the person's body on or underneath the bedding layer.

[0038] According to another or additional non-limiting embodiment of the method, the position of the body of the person on or underneath the bedding layer is determined in that the plurality of temperature sensors are used for identifying those thermally adjustable zones, where the temperature increases faster than in the other zones, where the power needed for maintaining a set temperature is less, compared to other thermally adjustable zones of the bedding layer, and where the actual temperature is above the set temperature.

[0039] In another or additional non-limiting embodiment of the method, the power for adjusting the temperature, e.g. the heating or cooling power, is adjusted to reach any one selected from the group consisting of rapid heating, rapid cooling, no over shooting of the temperature beyond or below the set temperature, no overheating, and no overcooling.

[0040] In another or additional non-limiting embodiment of the method, the protocol for thermal adjusting is different for those thermally adjustable zones where the presence of the person's body is not detected, and for those thermally adjustable zones where the person's body is detected. For example, the set temperature may be lower for the former thermally adjustable zones, but still within the comfortable temperature range, in particular for person's moving around during sleep, and higher for the latter thermally adjustable zones. As a person moves around in the bed during sleep or at night, these movements can also be detected in a preferred embodiment of the method. This information can be used for determining the sleep quality and can be given as feedback to the user of the system.

[0041] According to another or additional non-limiting embodiment of the method, the bedding layer is selected from the group consisting of bed sheets, blankets, and mattresses.

[0042] According to another or additional non-limiting embodiment of the method, the bedding layer comprises heating wires, and said temperature sensors are located between the electric heating wires.

[0043] According to another or additional non-limiting embodiment of the method, the bedding layer comprises tubes or channels, and said temperature sensors are located between these tubes or channels. Preferably, each thermally adjustable zone of the bedding layer comprises at least one tube or channel. Said at least one tube or channel constitutes of flow path for a cooling and/or heating medium. Said cooling medium is preferably selected from the group consisting of air and water.

[0044] According to another or additional non-limiting

embodiment of the method, the bedding layer comprises at least one coolable zone, preferably a plurality of individually controllable coolable zones.

[0045] According to the the invention, a system is provided which comprises a bedding layer comprising a plurality of thermally adjustable zones, a plurality of temperature sensors, wherein at least one temperature sensor per thermally adjustable zone is dispersed throughout the bedding layer, the temperature of each thermally adjustable zone can be controlled separately, and the system comprises means for controlling the heating or cooling power of each of said thermally adjustable zones, wherein the system is configured such that the position of the body of the person on or underneath the bedding layer can be detected, any one of the temperature, the heating rate and the cooling rate of each individual thermally adjustable zone can be controlled.

[0046] The system is configured that the means for controlling the heating or cooling power of the thermally adjustable zones can control the heating or cooling power of each of the thermally adjustable zones depending on whether or not a part of the person's body is present in the area of said thermally adjustable zone.

[0047] In a non-limiting embodiment of the system, the bedding layer is selected from the group consisting of bed sheets, blankets, and mattresses. The bedding layer may be a bed sheet that is used by the person to cover his/her body while lying in bed. This embodiment has the advantage that the person can take the bedding layer wherever he or she wants to sleep. The bedding layer of this embodiment is not restricted to a specific bed, but can be transferred to any other bed, sofa or the like said person wants to rest or sleep.

[0048] In preferred embodiments, the bedding layer is a blanket or mattress. In these embodiments, the bedding layer is a bedding layer that is intended for a person to lie on while resting or sleeping. Being configured as blanket or mattress, the bedding layer according to this embodiment provides the advantage of a more accurate detection of the person's body position in bed.

[0049] In another or additional non-limiting embodiment of the system, the bedding layer comprises heating means, preferably electric heating wires, and the temperature sensors are located between the electric heating wires. Using electric heating wires for heatable blankets is known in the art. Using multiple electric heating wires for the bedding layer allows providing each individual heatable zone with an individual electric heating wire such that each individual heatable zone can be heated individually. Thus, the bedding layer of this embodiment comprises multiple individual heatable zones, and multiple individual electric heating wires, wherein each individual heatable zone includes at least one electric heating wire. Thereby, each of the individual heatable zones can be heated separately in that electric power is applied to the electric heating wire of said individual heatable zone.

[0050] In another or additional non-limiting embodiment, the bedding layer comprises combined cooling and heating means. Said cooling and heating means are preferably selected from the group consisting of tubes and channels. A heat transferring medium such as water or air can be forced to flow through the tubes or channels. The temperature sensors are located between the heating and cooling means. Using multiple tubes or channels allows separation of the bedding layer in multiple individually thermally adjustable zones. By addressing each channel with an individual fluid flow that is heated or cooled, the temperature of each zone can be controlled independently.

[0051] The bedding layer of this embodiment further includes multiple temperature sensors, at least one temperature sensor for each individual thermally adjustable zone, wherein each of the temperature sensors is located in between, but not in direct contact with the heating/cooling means. This arrangement provides the most accurate opportunity of sensing the temperature in the area of the thermally adjustable zone where said temperature sensor is located, and at the same time sense the heat coming from or the temperature of the person's body. In addition, this arrangement permits an accurate determination of whether a part of the person's body is present in the area of a specific individual thermally adjustable zone or not. Hence, this arrangement permits a good spatial resolution of the person's body position in bed.

[0052] In a non-limiting embodiment of the system, the bedding layer can be heated and/or cooled. Preferably, the bedding layer comprises a plurality of thermally adjustable zones. Providing the bedding layer with one or more thermally adjustable zones, the microclimate of the bed can be adjusted more individually and/or over a broader range. This embodiment has the advantage of decreasing the amount of energy needed for cooling, as the coolable zone is only cooled when the presence of a person or a body part is detected. This embodiment also permits the use of the system in case the environmental temperature is such that heating the bed would be considered uncomfortable by a given person. In a preferred embodiment, the plurality of coolable zones can be individually controlled. The embodiment provides the advantage that the bedding layer allows spatially distinct cooling of the bedding layer, preferably depending on whether or not a part of the person's body is present in the area of a coolable zone or not.

[0053] In an embodiment of the system, each individual thermally adjustable zone is an individually controllable coolable zone too. This embodiment provides that the temperature of each of these individual zones can be controlled at the best possible extent, i.e. the range of temperatures the desired temperature can be adjusted to is larger, the speed of raising or lowering the temperature in the zone is faster, the likelihood of overheating is reduced, because it can be prevented by active means, and the like.

[0054] In a further or additional non-limiting embodiment, the system is configured to trigger an alarm when

a person gets out of it bed. The system can detect the presence or absence of a living person in a bed by means of the temperature sensors the bedding layer is provided with.

[0055] When all or at least more than a predetermined number of the temperature sensors detects a decreasing temperature or a temperature below the temperature caused by a living person in the bed and/or a temperature within the range of the ambient temperature in the bedroom, the system may trigger an alarm. In an embodiment, the alarm may be given to a caretaker who takes care of the person supposed to be in bed. This embodiment is particularly useful in facilities where persons live which need to be taken care of such as disabled, mentally disabled or imprisoned persons, or persons suffering from senile dementia. Any caretaker can be notified promptly if one of the persons to be taken care of has left the bed, purposely or not, and can look after that person.

[0056] In a further or additional non-limiting embodiment, the system is configured for detecting the time a person is out of the bed. In this embodiment, the system can not only detect the presence or absence of a living person in a bed by means of the temperature sensors the bedding layer is provided with, but also records the time a person is out of its bed. This configuration permits delaying an alarm to be triggered such that not every short-term leaving of the bed will cause an alarm which may classify as a false alarm. This embodiment may further assist in switching-off the system in case that the heating is no longer needed. For example, recording the time a person is out of its bed may be utilized to determine whether said person got up and started his daily routine. During the daily routine, the heating of/by the bedding layer is not required, and the system can be shut-off to save energy and for safety reasons as well.

[0057] Also for the realization of the sleep benefit it is important to know that the user is temporarily out of the bed. Otherwise the loss of body heat input in the bed might result in compensation by the system resulting in possible overshoot once the user returns.

[0058] The system is configured to automatically switch-off the heating after a preset period of time after the person got out of the bed. In the embodiments which automatically switch-off the system, no manual switching-off each day is required, and switching-off cannot be forgotten.

[0059] In a further or additional non-limiting embodiment, the system is configured to record the movements of the person during night. The information of the person's movement at night can be used to provide a feedback to the person about the duration, intensity, depth and quality of sleep, and may hence be used by the person to further improve the quality of his sleep, for example in adjusting the preset temperature of the system to a more comfortable temperature.

[0060] In a further or additional non-limiting embodiment, the system is configured to adjust local bed properties other than temperature. The adjustment of other properties than the temperature, in addition to controlling the temperature, can help improving the sleep quality of a person. An examples of other properties than temperature that can be adjusted by the system according to this embodiment is the stiffness of the mattress. Other properties may for example be the position of the upper end of the mattress, the position of the lower end of the mattress, for example in height of the feet and/ or knees, the illumination of the bedroom, the positioning of shades in front of the bedroom windows, the presence and/or loudness of background music, the environmental temperature in the bedroom, the intensity of ventilation of the bedroom, the insulation properties of the bedding material, and the like.

[0061] Figure 1 illustrates an embodiment of the system 100. The system 1oo comprises a mattress 10, wherein said mattress 10 comprises three sections 123, 456, and 789. A first section 123 constitutes the head end of the mattress, a second section 456 constitutes the midsection of the mattress, and a third section 789 constitutes the foot end of the mattress. Each of the three sections 123, 456, and 789 comprises three zones, wherein section 123 comprises zones 1, 2 and 3, section 456 comprises zones 4, 5 and 6, and section 789 comprises zones 7, 8 and 9. Each zone N, wherein N represents an integer from 1 to 9, comprises a temperature sensor N' and a means N" for adjusting the temperature of the zone N' said means N" is located in. Said means N" for adjusting the temperature of a zone N' may for example be an electric heating wire and/or a tube filled with a heating/cooling medium such as air or water. For example, section 123 includes zone 1. Said zone 1 comprises a temperature sensor 1' for detecting the temperature in zone 1, and a means 1" for adjusting the temperature in zone 1. The system 100 allows adjusting the temperature of each zone N for a person 11 lying on the mattress.

[0062] Figure 2 is a diagram illustrating the body position in a bed based on maximum temperatures in individual zones N of a mattress. The signals were measured in a sleep laboratory test and indicate the position of a sleeping person's body. The left axis indicates where parts of the person's body were positioned as a function of time during one night. As can be seen from the solid line, the persons' feet moved between zones 1, 2 and 3 (see sketch above the graphs), but were most of the time in zone 2. The person's hips were mainly in zone 5 (dashed line). The shoulders of said person were mainly in zones 8 and 9 (dotted line).

[0063] The graphics in Fig. 2 also shows the maximum temperatures that were measured in zones 1, 2, 3 (solid line), in zones 4, 5, 6 (dashed line), and in zones 7, 8, and 9 (dotted line), wherein the right axis indicates the temperatures.

[0064] In the third aspect, the invention provides a computer program product to execute a method for improving a person's sleep, wherein the computer program includes an algorithm for detecting the position of a body

on or underneath a bedding layer. The algorithm detects the position of a body by identifying thermally adjustable zones selected from the group of zones, where the temperature increases faster than in other zones, where the power needed for maintaining a set temperature is less, and where the actual temperature is above the set temperature by using the plurality of temperature sensors. The algorithm uses this information in controlling the heating or cooling power applied to each of the individual thermally adjustable zones. The algorithm switches off the heating automatically after a preset period of time after the person got out of the bed.

[0065] In an embodiment, the algorithm of the computer program further controls the cooling power applied to each of the individual cooling zones.

Claims

1. A system for improving a person's sleep, the system comprises a bedding layer comprising a plurality of thermally adjustable zones, a plurality of temperature sensors, wherein at least one temperature sensor per thermally adjustable zone is dispersed throughout the bedding layer, the temperature of each thermally adjustable zone can be controlled separately, and the system comprises means for controlling the heating or cooling power of each of said thermally adjustable zone, wherein the system is configured such that the position of the body of the person on or underneath the bedding layer can be detected by using the plurality of temperature sensors for identifying those thermally adjustable zones selected from the group of zones, where the temperature increases faster than in other zones, where the power needed for maintaining a set temperature is less, and where the actual temperature is above the set temperature, any one of the temperature, the heating rate and the cooling rate of each individual thermally adjustable zone can be controlled, and wherein the system is configured to automatically switch-off the heating after a preset period of time after the person got out of the bed.

2. The system according to claim 1, wherein said bedding layer is selected from the group consisting of bed sheets, blankets, and mattresses.

3. The system according to claim 1 or 2, wherein said bedding layer comprises heating means, said heating means are preferably electric heating wires, and said temperature sensors are located between the heating means.

4. The system according to any one of claims 1 to 3, wherein said bedding layer comprises cooling or heating means, said cooling or heating means are preferably selected from the group consisting of tubes and channels, and said temperature sensors are located between the cooling means.

5. The system according to claim 1, wherein the system is configured such that the means for controlling the heating power and cooling power of the thermally adjustable zones can control the cooling power of the thermally adjustable zones.

6. The system according to any one of claims 1 to 5, wherein the system is configured to trigger an alarm when the person gets out of the bed.

7. The system according to any one of claims 1 to 6, wherein the system is configured for recording the time a person is out of the bed.

8. The system according to any one of claims 1 to 7, wherein the system is configured to record the movements of the person during the night.

9. The system according to any one of claims 1 to 8, wherein the system is configured to adjust at least one local bed environmental properties other than temperature of the bedding layer, said local bed environmental property other than temperature is preferably selected from the group consisting of mattress stiffness, illumination of the bedroom, positioning of shades, loudness of background music, environmental temperature, intensity of ventilation, and insulation properties of bedding material.

10. A computer program product to execute a method on the system of claim 1, for improving a person's sleep, the method comprising:

    - detecting the position of the body of the person on or underneath a bedding layer, the bedding layer comprising a plurality of individually thermally adjustable zones and a plurality of temperature sensors, wherein at least one temperature sensor per thermally adjustable zone is dispersed throughout the bedding layer, wherein any one of the group consisting of the temperature, the heating rate and the cooling rate of each thermally adjustable zone can be controlled separately,
    - controlling any one of the group consisting of the temperature, the heating rate and the cooling rate of each individual thermally adjustable zone of the bedding layer such that the temperature of the thermally adjustable zones are adjusted to a preset temperature, and
    - adjusting the temperature of each individual thermally adjustable zone of the bedding layer such that the temperature of each individual thermally adjustable zone in which areas a part of the person's body is present is maintained at

a preset temperature,
- switching-off the heating automatically after a preset period of time after the person got out of the bed,
wherein the computer program includes an algorithm for detecting the position of a body on or underneath a bedding layer, the algorithm identifies those thermally adjustable zones selected from the group of zones, where the temperature increases faster than in other zones, where the power needed for maintaining a set temperature is less, and where the actual temperature is above the set temperature by using the plurality of temperature sensors.

Patentansprüche

1. System zur Verbesserung des Schlafes einer Person, wobei das System eine Bettzeugschicht mit einer Vielzahl von thermisch einstellbaren Zonen, eine Vielzahl von Temperatursensoren umfasst, wobei mindestens ein Temperatursensor pro thermisch einstellbarer Zone in der gesamten Bettzeugschicht verteilt ist, wobei die Temperatur jeder thermisch einstellbaren Zone separat gesteuert werden kann, und wobei das System Mittel zum Steuern der Erwärmungs- oder Kühlungsleistung jeder der thermisch einstellbaren Zone umfasst, wobei das System dazu konfiguriert ist, um die Position des Körpers der Person auf oder unter der Bettzeugschicht unter Verwendung der Vielzahl von Temperatursensoren zum Identifizieren jener thermisch einstellbaren Zonen erkennen zu können, die ausgewählt sind aus der Gruppe aus Zonen, in denen die Leistung, die zum Beibehalten einer gesetzten Temperatur benötigt wird, geringer ist, und wobei die derzeitige Temperatur oberhalb der gesetzten Temperatur ist, wobei jede von der Temperatur, der Erwärmungsrate und der Kühlungsrate jeder einzelnen thermisch einstellbaren Zone gesteuert werden kann und wobei das System dazu konfiguriert ist, um die Erwärmung nach einem voreingestellten Zeitraum, nachdem die Person das Bett verlassen hat, automatisch auszuschalten.

2. System nach Anspruch 1, wobei die Bettzeugschicht ausgewählt ist aus der Gruppe bestehend aus Bettlaken, Decken und Matratzen.

3. System nach Anspruch 1 oder 2, wobei die Bettzeugschicht ein Erwärmungsmittel aufweist, wobei die Erwärmungsmittel vorzugsweise elektrische Heizdrähte sind und die Temperatursensoren zwischen dem Erwärmungsmittel angeordnet sind.

4. System nach einem der Ansprüche 1 bis 3, wobei die Bettzeugschicht Kühlungs- oder Erwärmungsmittel aufweist, wobei die Kühlungs- oder Erwärmungsmittel vorzugsweise ausgewählt sind aus der Gruppe bestehend aus Rohren und Kanälen, und wobei die Temperatursensoren zwischen dem Kühlungsmittel angeordnet sind.

5. System nach Anspruch 1, wobei das System konfiguriert ist, damit die Mittel zum Steuern der Erwärmungsleistung und der Kühlungsleistung der thermisch einstellbaren Zonen die Kühlungsleistung der thermisch einstellbaren Zonen steuern können.

6. System nach einem der Ansprüche 1 bis 5, wobei das System konfiguriert ist, um einen Alarm auszulösen, wenn die Person aus dem Bett steigt.

7. System nach einem der Ansprüche 1 bis 6, wobei das System konfiguriert ist, um die Zeit aufzuzeichnen, die eine Person aus dem Bett ist.

8. System nach einem der Ansprüche 1 bis 7, wobei das System konfiguriert ist, um die Bewegungen der Person während der Nacht aufzuzeichnen.

9. System nach einem der Ansprüche 1 bis 8, wobei das System konfiguriert ist, um mindestens eine von örtlichen Bettumgebungseigenschaften einzustellen, die von der Temperatur der Bettzeugschicht verschieden sind, wobei die örtliche Bettumgebungseigenschaft, die von der Temperatur verschieden, ist, vorzugsweise ausgewählt ist aus der Gruppe bestehend aus Matratzenhärte, Schlafzimmerbeleuchtung, Schattenposition, Lautstärke der Hintergrundmusik, Umgebungstemperatur, Belüftungsintensität und Isolationseigenschaften des Bettzeugmaterials.

10. Computerprogrammprodukt zum Ausführen eines Verfahrens auf dem System nach Anspruch 1 zum Verbessern des Schlafes einer Person, wobei das Verfahren umfasst:

- Erfassen der Position des Körpers der Person auf oder unter einer Bettzeugschicht, wobei die Bettzeugschicht eine Vielzahl von einzeln thermisch einstellbaren Zonen und eine Vielzahl von Temperatursensoren umfasst, wobei mindestens ein Temperatursensor pro thermisch einstellbarer Zone in der gesamten Bettzeugschicht verteilt ist, wobei jede aus der Gruppe bestehend aus der Temperatur, der Erwärmungsrate und der Kühlungsrate jeder thermisch einstellbaren Zone separat gesteuert werden kann,
- Steuern einer beliebigen der Gruppen bestehend aus der Temperatur, der Erwärmungsrate und der Kühlungsrate jeder einzeln thermisch einstellbaren Zone der Bettzeugschicht derart, dass die Temperatur der thermisch einstellba-

ren Zonen auf eine voreingestellte Temperatur eingestellt wird, und
- Einstellen der Temperatur jeder einzeln thermisch einstellbaren Zone der Bettzeugschicht derart, dass die Temperatur jeder einzelnen thermisch einstellbaren Zone, in der sich ein Körperteil der Person befindet, auf einer voreingestellten Temperatur gehalten wird,
- automatisches Ausschalten der Erwärmung nach einem voreingestellten Zeitraum, nachdem die Person das Bett verlassen hat,
wobei das Computerprogramm einen Algorithmus zum Erkennen der Position eines Körpers auf oder unter einer Bettzeugschicht einschließt, der Algorithmus jene thermisch einstellbaren Zonen identifiziert, die ausgewählt sind aus der Gruppe von Zonen, in denen die Temperatur schneller ansteigt als in anderen Zonen, wobei die Leistung, die zur Beibehaltung einer gesetzten Temperatur benötigt wird, geringer ist, und wobei die derzeitige Temperatur unter Verwendung der Vielzahl von Temperatursensoren über der gesetzten Temperatur ist.

Revendications

1. Système destiné à améliorer le sommeil d'une personne, le système comprend une couche de literie comprenant une pluralité de zones thermiquement réglables, une pluralité de capteurs de température, dans laquelle au moins un capteur de température par zone thermiquement réglable est dispersé dans la couche de literie, la température de chaque zone thermiquement réglable peut être commandée séparément, et le système comprend des moyens permettant de commander la puissance de chauffage ou de refroidissement de chacune desdites zones thermiquement réglables, dans lequel le système est configuré de sorte que la position du corps de la personne sur ou en-dessous de la couche de literie peut être détectée à l'aide de la pluralité de capteurs de température pour identifier ces zones thermiquement réglables choisies parmi le groupe de zones, où la puissance augmente plus vite que dans d'autres zones, où la puissance nécessaire au maintien d'une température d'une température fixée est inférieure, et où la température réelle est supérieure à la température fixée, l'une quelconque de la température, la vitesse de chauffage et la vitesse de refroidissement de chaque zone individuelle thermiquement réglable peut être commandée, et dans lequel le système est configuré pour désactiver automatiquement le système de chauffage après une période de temps prédéfinie dès la sortie du lit de la personne.

2. Système selon la revendication 1, dans lequel ladite couche de literie est choisie parmi le groupe se composant de draps de lit, couvertures et matelas.

3. Système selon la revendication 1 ou 2, dans lequel ladite couche de literie comprend des moyens de chauffage, lesdits moyens de chauffage sont de préférence des fils électriques chauffants, et lesdits capteurs de température sont situés entre les moyens de chauffage.

4. Système selon l'une quelconque des revendications 1 à 3, dans lequel ladite couche de literie comprend des moyens de refroidissement ou de chauffage, lesdits moyens de refroidissement ou de chauffage sont de préférence choisis parmi le groupe se composant de tubes et de canaux, et lesdits capteurs de température sont situés entre les moyens de refroidissement.

5. Système selon la revendication 1, dans lequel le système est configuré de sorte que les moyens permettant de commander la puissance de chauffage et la puissance de refroidissement des zones thermiquement réglables peuvent commander la puissance de refroidissement des zones thermiquement réglables.

6. Système selon l'une quelconque des revendications 1 à 5, dans lequel le système est configuré pour déclencher une alarme dès la sortie du lit de la personne.

7. Système selon l'une quelconque des revendications 1 à 6, dans lequel le système est configuré pour enregistrer l'heure à laquelle une personne est sortie du lit.

8. Système selon l'une quelconque des revendications 1 à 7, dans lequel le système est configuré pour enregistrer les mouvements de la personne pendant la nuit.

9. Système selon l'une quelconque des revendications 1 à 8, dans lequel le système est configuré pour régler au moins l'une des propriétés environnementales locales relatives aux lits différentes de la température de la couche de literie, ladite propriété environnementale locale relative aux lits différente de la température est choisie de préférence parmi le groupe se composant de la dureté du matelas, l'éclairage de la chambre, le positionnement des stores, le volume sonore de la musique d'ambiance, la température ambiante, l'intensité du système de ventilation, et les propriétés isolantes des matériaux de literie.

10. Produit de programme informatique destiné à exécuter un procédé sur le système selon la revendica-

tion 1, pour améliorer le sommeil d'une personne, le procédé comprenant :

- la détection de la position du corps de la personne sur ou en-dessous d'une couche de literie, la couche de literie comprenant une pluralité de zones individuelles thermiquement réglables et une pluralité de capteurs de température, dans laquelle au moins un capteur de température par zone thermiquement réglable est dispersé dans la couche de literie, dans laquelle l'une quelconque du groupe se composant de la température, la vitesse de chauffage et la vitesse de refroidissement de chaque zone thermiquement réglable peut être commandée séparément,
- la commande de l'une quelconque du groupe se composant de la température, la vitesse de chauffage et la vitesse de refroidissement de chaque zone individuelle thermiquement réglable de la couche de literie de sorte que la température des zones thermiquement réglables est réglée sur une température prédéfinie, et
- le réglage de la température de chaque zone individuelle thermiquement réglable de la couche de literie de sorte que la température de chaque zone individuelle thermiquement réglable dans lesquelles zones une partie présente du corps de la personne est maintenue à une température prédéfinie,
- la désactivation automatique du système de chauffage après une période de temps prédéfinie dès la sortie du lit de la personne,

dans lequel le programme informatique inclut un algorithme permettant de détecter la position d'un corps sur ou en-dessous d'une couche de literie, l'algorithme identifie ces zones thermiquement réglables choisies parmi le groupe de zones, où la température augmente plus vite que dans d'autres zones, où la puissance nécessaire au maintien d'une température fixée est inférieure, et où la température réelle est supérieure à la température fixée à l'aide de la pluralité de capteurs de température.

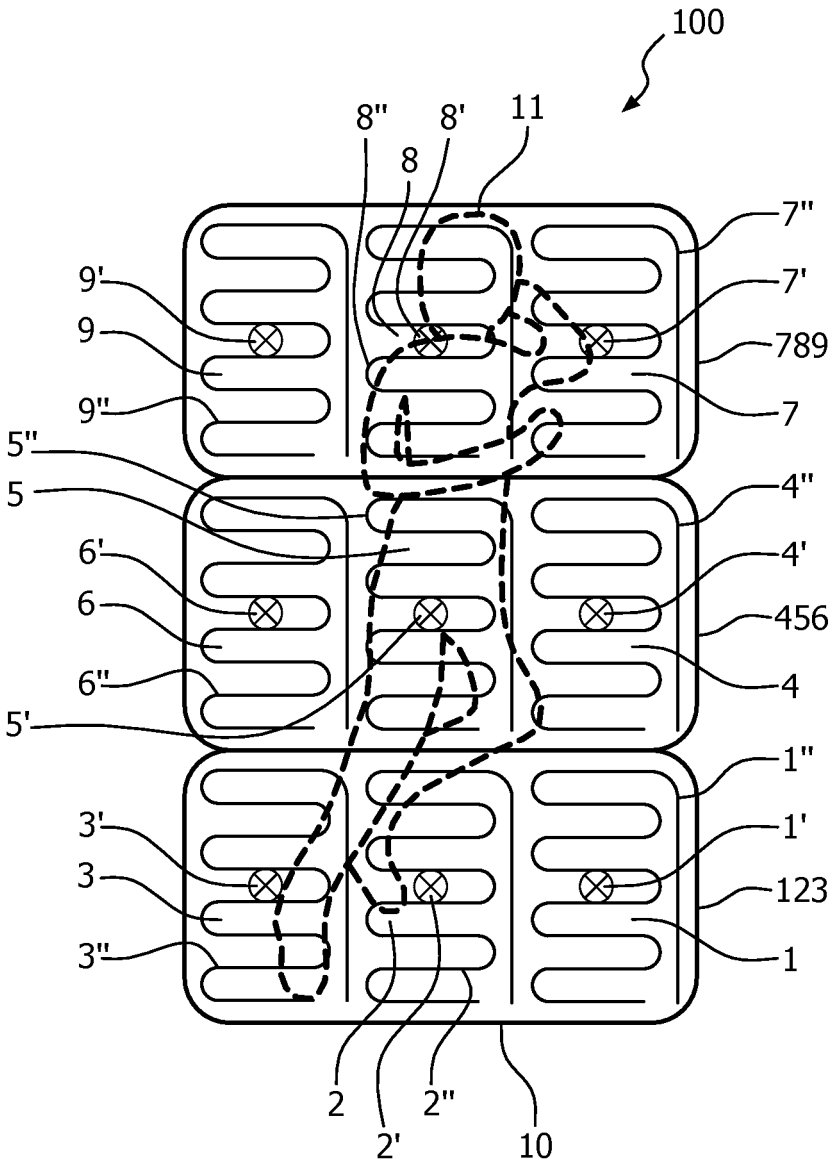

FIG. 1

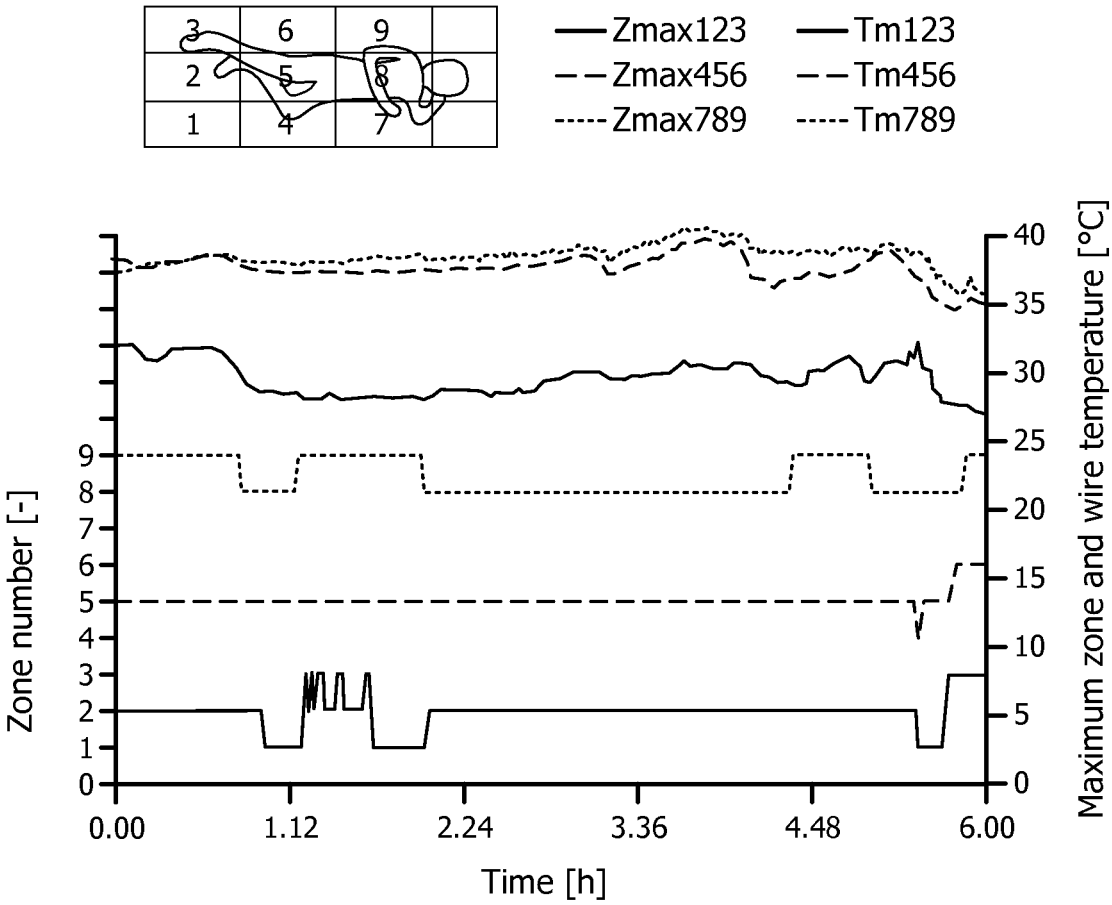
3
6
9
2
5
8
1
4
7
Zmax123
Tm123
Zmax456
Tm456
Zmax789
Tm789
Zone number [-]
Maximum zone and wire temperature [°C]
Time [h]
0.00
1.12
2.24
3.36
4.48
6.00

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	系统和用于改善睡眠的计算机程序		
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代理机构(译)	kroeze antonius，约翰		
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摘要(译)

一种用于改善人的睡眠的系统，包括具有多个可单独控制的热调节区域的床上用品层，多个温度传感器，其中每个热调节区域至少一个温度传感器分散在整个床上用品层中。 此外，控制器被配置为控制每个热可调区域的加热功率，并检测其中检测到身体存在的位置。

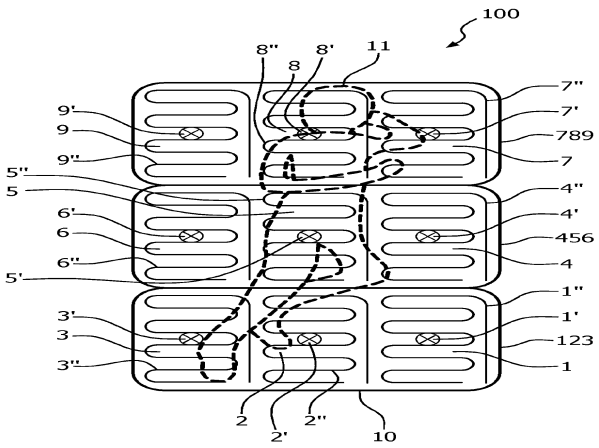

FIG. 1