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AND SYSTEM AND METHOD FOR
MANAGING HEAT STRESS USING THE
SAME**(30) **Foreign Application Priority Data**

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(2), (4) Date: **Jun. 5, 2008**(57) **ABSTRACT**

A highly precise clock synchronization apparatus in a real-time locating system (RTLS), includes an optical transmitting/receiving unit for receiving a clock information frame from a clock synchronization server, converting the received clock information frame in series-parallel, and transmitting/receiving the clock information data and the clock information; an offset estimation unit for detecting a preamble signal and a clock information signal from the series-parallel converted clock information frame, calculating a phase difference value by comparing the detected preamble signal with the detected clock information signal, and outputting an offset value based on the calculated phase difference value; and a clock synchronization unit for updating a local clock value to a time of the clock synchronization server based on the offset value and the clock information frame.

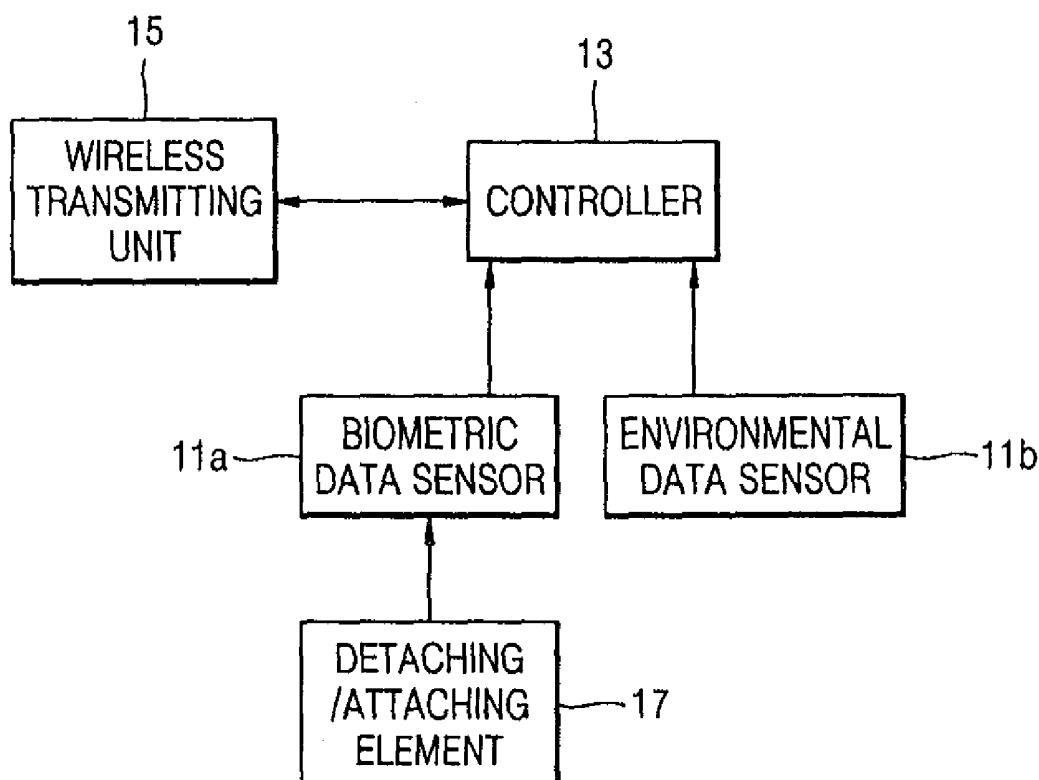
10

FIG. 1

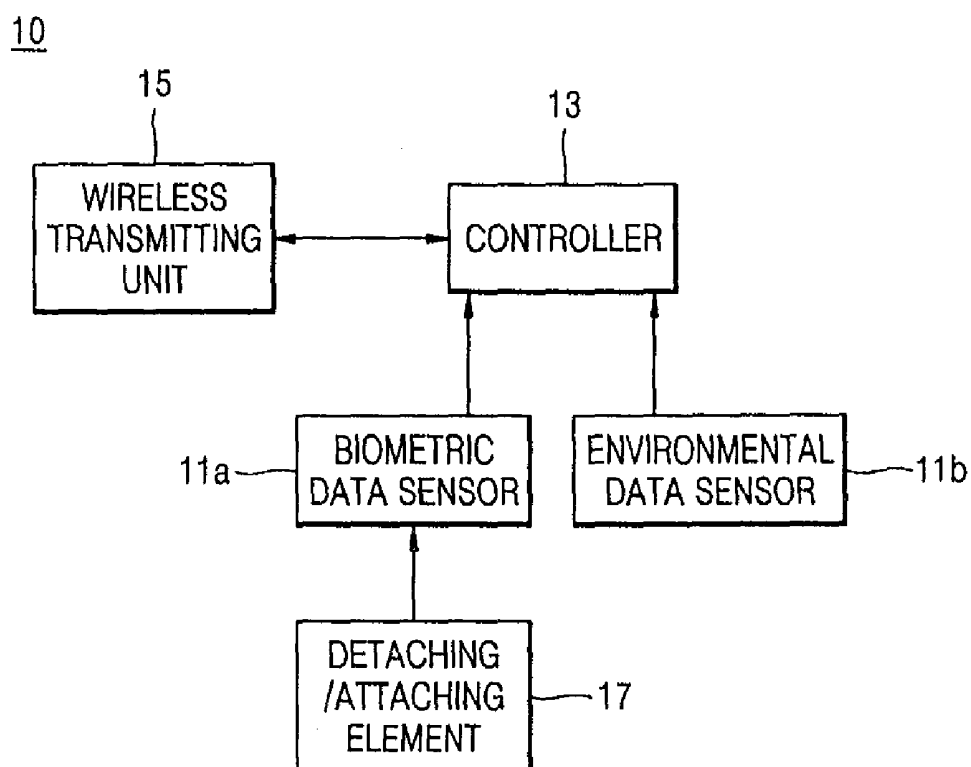


FIG. 2

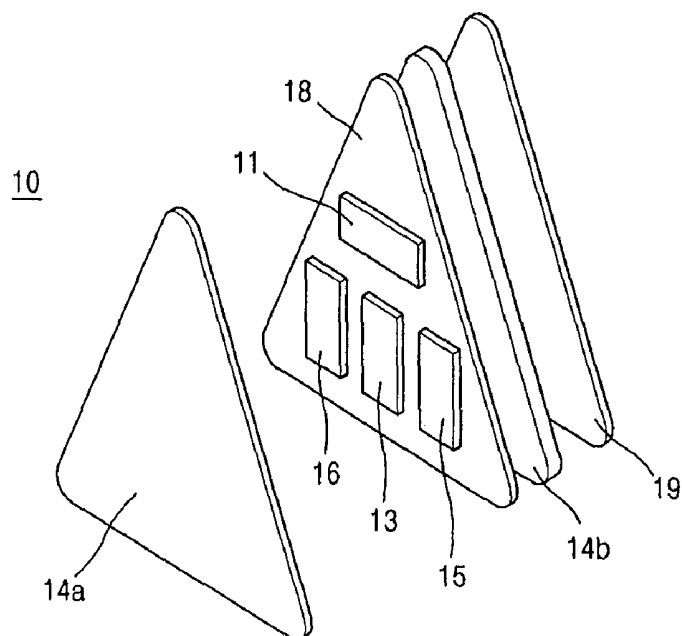


FIG. 3

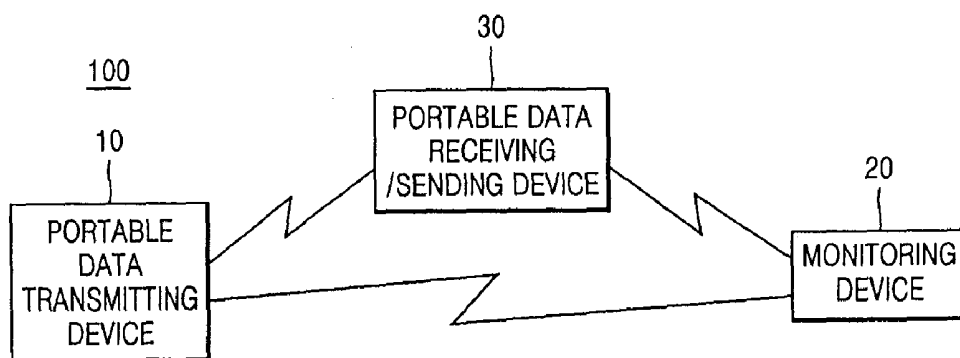


FIG. 4A

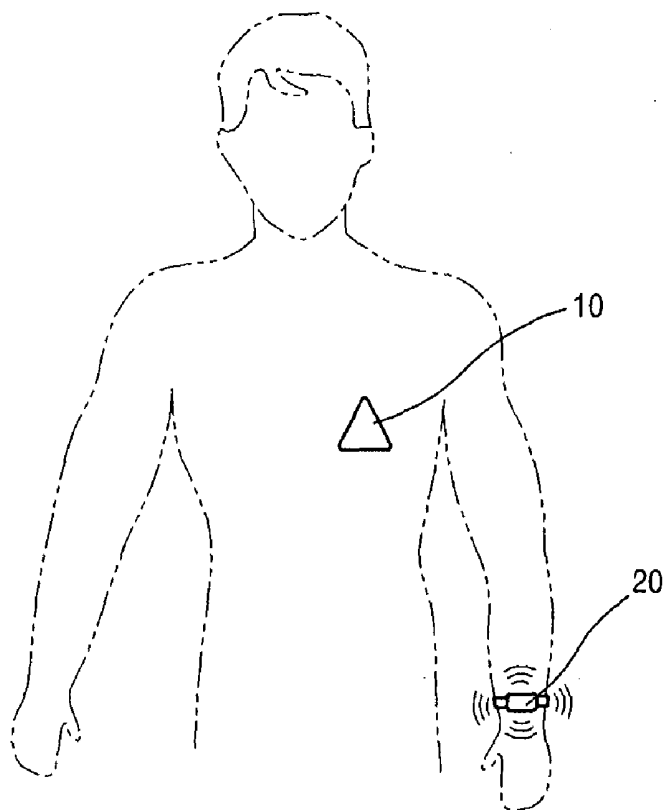


FIG. 4B

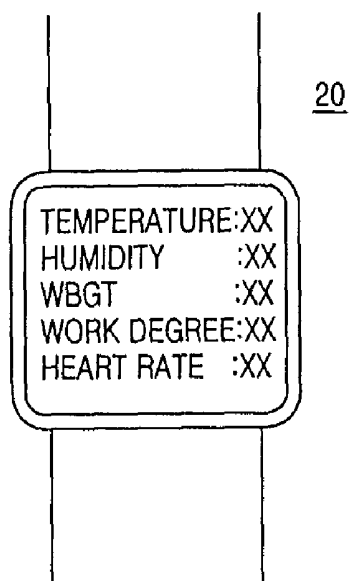
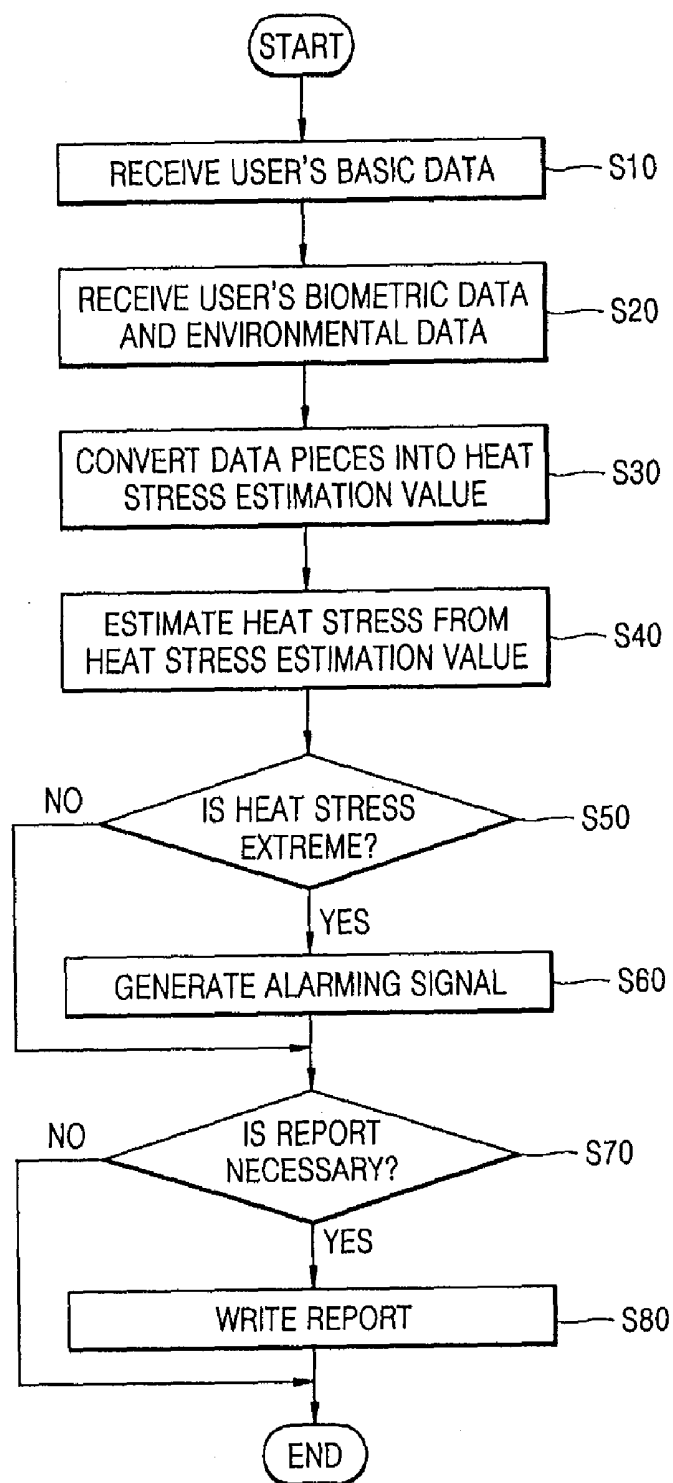


FIG. 5



**PORTABLE DATA TRANSMITTING DEVICE,
AND SYSTEM AND METHOD FOR
MANAGING HEAT STRESS USING THE
SAME**

TECHNICAL FIELD

[0001] The present invention relates to a portable data transmission device which monitors extreme heat stress imposed on a user's body, so as to prevent an extremely dangerous situation caused by the extreme heat stress occurring and prepare for an emergency situation, and a system and method of management heat stress.

BACKGROUND ART

[0002] In general, it has been found that heat stress is influenced by temperature, humidity, motion load, and climate acclimatization. In temperatures over 25° C., a human body tries to balance its body temperature by sweating so that the body temperature can be lowered due to vaporization of sweat. This mechanism is influenced by humidity. Thus, in a high humidity conditions, the mechanism becomes less effective. Furthermore, the mechanism is closely influenced by clothing, since air flow is restricted according to the kind of clothing worn.

[0003] Both short and long term heat stress is harmful to a human body. Examples of short term impacts include heat stroke, exhaustion, spasmodic motion, and confusion. On the other hand, examples of long term impacts include thermal weakening, high blood pressure, cardiac tissue damage, lack of sexual desire, and impotence.

[0004] Representative examples of dangerous occupations in terms of heat stress include police, military personnel, farmers, construction workers, and blast furnace workers.

[0005] In addition, firefighters may lose their lives while extinguishing fires such as a forest fire. In some cases, athletes may also lose their lives in the course of training due to heat stress, or due to environmental reasons such as exposure to intense sunlight. Thus, in order to prevent such occupational heat stress and various dangerous heat stress related situations, a method in which the heat stress is measured so that a user can be warned in advance is required.

[0006] In particular, heat stress needs to be detected on a regular basis if a workplace is exposed to heat stress, or if the user performs an operation which induces high heat stress.

[0007] The conventional wet bulb globe temperature (WBGT) measuring instrument is useful when heat stress has to be directly measured. The WBGT measuring instrument measures four environmentally important key factors, that is, temperature, relative humidity, insolation, and air flow, by comparing a temperature of a freely circulating wet ball with a temperature of a dry ball. A WBGT index is a standard for work in hot environments, ISO7243, and is used as a reference for measuring heat stress.

[0008] Conventional heat stress monitoring methods generally use a WBGT system installed in a workplace. Although the WBGT system can measure environmental influence, individual work load and climate acclimatization which are different for each individual cannot be easily taken into account using the WBGT system. In the WBGT system which basically measures environmental influence, the measured heat stress is not actual heat stress imposed on firefighters or blast furnace workers who usually wear protection equipment.

[0009] In addition, when a monitoring device is placed in a single position, measuring is not properly performed since thermal exposure is different according to where the monitoring device is located even within the same workplace. In reality, a supervisor has to maintain work stability by relying on a subjective decision by taking the numerous factors mentioned above into account. Thus, only a small number of workers can be supervised by one supervisor. Furthermore, effective preparation and prevention become difficult.

DETAILED DESCRIPTION OF THE INVENTION

Technical Problem

[0010] The present invention provides a portable data transmission device which wirelessly transmits individual's biometric data and environmental data.

[0011] The present invention also provides a heat stress management system which provides an optimum safety guideline in real time by remotely measuring heat stress in real time for each individual.

[0012] The present invention also provides a heat stress management method which provides an optimum safety guideline in real time by remotely measuring heat stress in real time for each individual.

Technical Solution

[0013] According to an aspect of the present invention, there is provided a portable data transmission device comprising: a detachable element which is detached from and attached to a user; a biometric data sensor which is connected to the detachable element, and measures user's biometric data; an environmental data sensor which measures data of an environment surrounding the user; and a wireless transmission unit which wirelessly transmits the measured data.

[0014] In the aforementioned aspect of the present invention, the portable data transmission device may further comprise: an A/D converter which converts the analog data measured by the sensors to digital signal; and a controller which controls the operation of the wireless transmission unit.

[0015] In addition, the sensors and the wireless transmission unit may be disposed on a flexible substrate, and the detachable element may comprise: flexible waterproof cases which encompass the flexible substrate; and an adhesive layer which is coated on one of the outer surfaces of the cases and is detachable from and attachable to a user's skin.

[0016] In addition, the cases may be made of a silicon rubber.

[0017] In addition, the biometric data may comprise heart rate and motion acceleration, and the environmental data may comprise a temperature and humidity.

[0018] According to another aspect of the present invention, there is provided a heat stress management system comprising: a portable data transmission device comprising a detachable element which is detached from and attached to a user; a biometric data sensor which is connected to the detachable element, and measures user's biometric data, an environmental data sensor which measures data of an environment surrounding the user, and a wireless transmission unit which wirelessly transmits the measured data; and a monitoring device which wirelessly receives the biometric data and the environmental data from the wireless transmission unit of the portable data transmission device, and converts the received biometric data, the environmental data, and user's basic data

that is input in advance, into a heat stress estimation value, thereby remotely monitoring the user's heat stress.

[0019] In the aforementioned aspect of the present invention, the biometric data may comprise heart rate and motion acceleration, the environmental data may comprise temperature and humidity, and the basic data may comprise weight and recent work record.

[0020] In addition, the heat stress estimation value may be a work load converted from the heart rate, a WBGT (wet bulb globe temperature) index converted from the temperature and humidity, a climate acclimatization converted from the recent work record, or a physical work degree converted from the weight and motion acceleration.

[0021] In addition, the monitoring device may convert the biometric data and the environmental data, which are wirelessly received from the portable data transmission device, and the input basic data into the heat stress estimation value, and may estimate a user's heat stress therefrom, and if the user's heat stress is determined to be extreme, an alarm signal may be automatically generated.

[0022] In addition, the monitoring device may be portable.

[0023] In addition, the heat stress management system may further comprise a portable data receiving/sending device which wirelessly receives the biometric data and the environmental data from the portable data transmission device, and wirelessly sends the received data to the monitoring device.

[0024] In addition, the portable data transmission device, the monitoring device, and the portable data receiving/sending device may communicate with one another wirelessly by using Bluetooth, Zig Bee, a high frequency RF signal, a wireless LAN, a CDMA mobile phone network, a GSM mobile phone network, or a Terrestrial Trunked Radio (TETRA).

[0025] According to another aspect of the present invention, there is provided a heat stress management method comprising reviewing user's basic data; wirelessly receiving user's biometric data and environmental data; converting the received data into a heat stress estimation value; estimating a user's heat stress from the heat stress estimation value; and generating an alarm signal if the user's heat stress is extreme.

[0026] In the aforementioned aspect of the present invention, the basic data may comprise weight and recent work record, the biometric data may comprise heart rate and motion acceleration, and the environmental data may comprise temperature and humidity.

[0027] In addition, the heat stress estimation value may be a work load converted from the heart rate, a WBGT (wet bulb globe temperature) index converted from the temperature and humidity, a climate acclimatization converted from the recent work record, or a physical work degree converted from the weight and motion acceleration.

[0028] In addition, the heat stress management method may further comprise automatically writing a report regarding the user's heat stress, if requested.

[0029] In addition, the report may comprise the basic data, the biometric data, the environmental data, and the heat stress estimation value.

ADVANTAGEOUS EFFECTS

[0030] According to the present invention, an optimized safety guideline can be provided in real time by remotely measuring heat stress in real time for each individual. Thus, an extremely dangerous situation caused by extreme heat stress imposed on a user's body can be prevented, and an

emergency situation can be prepared for. In addition, management efficiency can be maximized since manpower can be effectively managed due to automatic management and reporting.

DESCRIPTION OF THE DRAWINGS

[0031] The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

[0032] FIG. 1 is a block diagram of a portable data transmission device according to an embodiment of the present invention;

[0033] FIG. 2 is an exploded perspective view illustrating a portable data transmission device according to an embodiment of the present invention;

[0034] FIG. 3 is a block diagram of a heat stress management system according to an embodiment of the present invention;

[0035] FIG. 4A illustrates a user wearing a heat stress management system according to an embodiment of the present invention;

[0036] FIG. 4B is an enlarged view of monitoring device of the heat stress management system of FIG. 4A; and

[0037] FIG. 5 is a flowchart illustrating a heat stress management method according to an embodiment of the present invention.

BEST MODE

[0038] Hereinafter, the present invention will be described in detail by explaining exemplary embodiments of the invention with reference to the attached drawings.

[0039] FIG. 1 is a block diagram of a portable data transmission device according to an embodiment of the present invention.

[0040] Referring to FIG. 1, a portable data transmission device 10 includes a detachable element 17 which may be detached from and attached to a user, a biometric data sensor 11a which is connected to the detachable element 17 to measure the user's biometric data, an environmental data sensor 11b which measures data of an environment surrounding the user, and a wireless transmission unit 15 which wirelessly transmits the measured biometric data and the environmental data.

[0041] Furthermore, the portable data transmission device 10 may include an A/D converter (not shown) which converts the analog data obtained by the sensors 11a and 11b into a digital signal, and a controller 13 which controls the operation of the wireless transmission unit 15. Furthermore, the portable data transmission device 10 may include a memory (not shown) which stores the biometric data and the environmental data, and a power supply unit (not shown) such as a battery.

[0042] The biometric data sensor 11a may be formed of one or more sensors provided to measure the biometric data. The biometric data may include heart rate and motion acceleration.

[0043] The biometric data sensor 11a may be a well-known sensor for measuring the biometric data, such as heart rate or motion acceleration. For example, an electrocardiogram sensor may be used to measure the heart rate. A two-axis accelerometer (Analog Device, USA) may be used to measure motion acceleration.

[0044] The environmental data sensor **11b** may be formed of one or more sensors provided to measure environmental data. The environmental data may include temperature and humidity. The environmental data sensor **11b** may be a well-known sensor for measuring environmental data, such as temperature or humidity. For example, an on-chip sensor (Sensirion, Swiss), in which a relative humidity sensor is integrated with a temperature sensor, may be used to measure temperature and humidity. When the on-chip sensor is used, a distance between sensors shortens to 0.1 μm .

[0045] FIG. 2 is an exploded perspective view illustrating a portable data transmission device according to an embodiment of the present invention. In FIG. 2, a sensor **11**, a controller **13**, a wireless transmission unit **15**, and a battery **16** are shown.

[0046] Referring to FIG. 2, the sensor **11** and the wireless transmission unit **15** are disposed on a flexible substrate **18**. The detachable element **17** of FIG. 1 includes flexible waterproof cases **14a** and **14b** which encompass the flexible substrate **18**, and an adhesive layer **19** which is coated on one of the outer surfaces of the cases **14a** and **14b** and is detachable from and attachable to a user's skin.

[0047] A wearable heat stress sensor that is practically used in a specialized workplace needs to cause minimum restriction, have waterproof properties, be of low weight, be rapid and easy to install, be of low cost, and be applicable to various body shapes.

[0048] The portable data transmission device **10** according to an embodiment of the present invention meets all the requirements mentioned above. Specifically, the flexible substrate **18** may be a flexible printed circuit board (FPCB). The flexible waterproof cases **14a** and **14b** may be made of silicon rubber. The adhesive layer **19** may be a silicon rubber adhesive. By using the FPCB and the silicon rubber packaging, the portable data transmission device **10** can be bent in a flexible manner in order to be attached to a user's chest. In addition, by using the rubber adhesive, the portable data transmission device **10** can be washed by water, and then be reattached to the user's skin.

[0049] FIG. 3 is a block diagram of a heat stress management system according to an embodiment of the present invention.

[0050] Referring to FIG. 3, a heat stress management system **100** includes a portable data transmission device **10** which is attachable to a user's body, and a monitoring device **20** which wirelessly receives data from the portable data transmission device **10**.

[0051] The portable data transmission device **10** measures a user's biometric data and environmental data and wirelessly transmits the measured data. Detailed descriptions of the portable data transmission device **10** are the same as described above.

[0052] The monitoring device **20** wirelessly receives the biometric data and the environmental data from the wireless transmission unit **15** of the portable data transmission device **10**, and converts the received biometric data, the environmental data, and user's basic data that is input in advance, into a heat stress estimation value, thereby remotely monitoring the user's heat stress.

[0053] The monitoring device **20** may convert the biometric data and the environmental data, which are wirelessly received from the portable data transmission device **10**, and the input basic data into the heat stress estimation value, and

may estimate a user's heat stress therefrom. If the user's heat stress is determined to be extreme, an alarm signal may be automatically generated.

[0054] The monitoring device **20** may be a computer system existing in a supervisor's domain. Preferably, the monitoring device **20** is portable and carried by the user. For example, the monitoring device **20** may be provided in the form of a wristwatch, a mobile phone, a personal digital assistant (PDA), or a wireless telegraph set. If the user's heat stress is determined to be extreme, the alarm signal may be sent directly to the user.

[0055] The biometric data may be the heart rate or motion acceleration of the user. The environmental data may be the temperature or humidity of an environment surrounding the user. The basic data may be a recent weight or recent work record of the user.

[0056] The heat stress estimation value may be a work load converted from the heart rate, a wet bulb globe temperature (WBGT) index converted from the temperature and humidity, a climate acclimatization converted from the recent work record, or a physical work degree converted from the weight and motion acceleration.

[0057] FIG. 4A illustrates a user wearing a heat stress management system according to an embodiment of the present invention. FIG. 4B is an enlarged view of monitoring device of the heat stress management system of FIG. 4A.

[0058] Referring to FIG. 4A, a portable data transmission device **10** is placed on a user's chest, measures the user's biometric data and environmental data, and wirelessly transmits the measured data. A monitoring device **20** is placed on a user's wrist in the form of a wristwatch, wirelessly receives the biometric data and the environmental data from the portable data transmission device **10**, provides the user with information regarding the biometric data, the environmental data, and the heat stress estimation value, and sends the alarm signal to the user when the user's heat stress is determined to be extreme. Referring to FIG. 4B, the monitoring device **20** has the shape of a wristwatch, and provides information regarding temperature, humidity, WBGT index, work degree, and heart rate.

[0059] Referring back to FIG. 3, the heat stress management system **100** may further include a portable data receiving/sending device **30** which relays transmitted data. The portable data receiving/sending device **30** wirelessly receives the biometric data and the environmental data from the portable data transmission device **10**, and wirelessly sends the received data to the monitoring device **20**. The portable data receiving/sending device **30** may be provided in the form of a wristwatch, a mobile phone, a PDA, or a wireless telegraph set.

[0060] The portable data transmission device **10**, the monitoring device **20**, and the portable data receiving/sending device **30** may wirelessly communicate with one another by using Bluetooth, Zig Bee, a high frequency RF signal, a wireless LAN, a CDMA mobile phone network, a GSM mobile phone network, or a Terrestrial Trunked Radio (TETRA).

[0061] The above methods may vary according to an environment of the heat stress management system. For example, the portable data transmission device **10** may include a Bluetooth or Zig Bee module so as to transmit data to a main server via a user's wireless telegraph set or a mobile phone. In

addition, the portable data transmission device 10 may include a CDMA module so as to transmit the data directly to the main server.

[0062] FIG. 5 is a flowchart illustrating a heat stress management method according to an embodiment of the present invention.

[0063] Referring to FIG. 5, a heat stress management method includes receiving user's basic data (operation S10), wirelessly receiving user's biometric data and the environmental data (operation S20), converting the data into a heat stress estimation value (operation S30), estimating a user's heat stress from the heat stress estimation value (operation S40), and determining whether the user's heat stress is extreme (operation S50). If the user's heat stress is determined to be extreme, an alarm signal is generated (operation S60).

[0064] The basic data may be a recent weight or recent work record of the user. The user's biometric data may be a heart rate or motion acceleration of the user. The environmental data may be a temperature or humidity of an environment surrounding the user.

[0065] The heat stress estimation value may be a work load, a WBGT index, a climate acclimatization, or a physical work degree. The conventional heat stress monitoring methods have used only the WBGT index for environmental temperature and humidity, resulting in inaccurate monitoring.

[0066] The work load of the heat stress estimation value may be converted from the heart rate. A lead electrocardiograph (ECG) may be used to measure the heart rate. A method of estimating the work load from the heart rate may use a well-known estimation method (Shaver, Essentials of Exercise Physiology, Section Three, The Heart and Exercise, Burgess Publishing Company, pp. 74-93, 1981).

[0067] The WBGT index of the heat stress estimation value may be calculated from the temperature or the humidity. An optimum WBGT index may be attained for each individual in real time by obtaining temperature and relative humidity data

[0069] Here, T_a is a temperature ($^{\circ}\text{C.}$) of a wet ball, and e is a steam pressure, or humidity (hPa) of water.

[0070] The steam pressure can be calculated from temperature and relative humidity using Formula 2.

$$e = rh / 100 \times 6.105 \times \exp(17.27 \times T_a / (237.7 + T_a)) \quad [\text{Formula 2}]$$

[0071] Here, rh is relative humidity (%).

[0072] The climate acclimatization of the heat stress estimation value may be calculated from the recent work record. The climate acclimatization is defined as a process in which the user slowly acclimatizes to a climate for one or two weeks. Once the user acclimatizes to the climate, it has been found that the user begins to sweat at a lower temperature so that a user's body can prevent itself from accumulating heat. Climate acclimatization is difficult to measure in a quantitative manner. However, the climate acclimatization may be estimated using a three-week's work record.

[0073] The physical work degree of the heat stress estimation value may be calculated from the weight and the motion acceleration. The physical work degree may be estimated by combining acceleration data measured by a sensor of the portable data transmission device 10 with weight data that is input by the user. The estimation above may be suitable for athletes who generally move their entire bodies. On the other hand, the estimation above may not be suitable for operators who mainly just move their arms and legs. Practical acceleration data may be used to measure a user's work time and recess time.

[0074] Estimating heat stress from the estimation values and determining whether the heat stress is extreme may be carried out with reference to Table 1. Table 1 shows a reference for screening heat stress exposure provided by the American Conference of Governmental Industrial Hygienists (ACGIH, 2000 TLVs and BEIs, Cincinnati: ACGIH, p. 183, 2000). Table 1 may be used to facilitate a determining whether the heat stress is extreme in an initial stage.

TABLE 1

work loads	Acclimatized				Un-acclimatized			
	light	middle	heavy	extreme	light	middle	heavy	extreme
100% work	29.5	27.5	26		27.5	25	22.5	
75% work	30.5	28.5	27.5		29	26.5	24.5	
25% recess								
50% work	31.5	29.5	28.5	27.5	30	28	26.5	25
50% recess								
25% work	32.5	31	30	29.5	31	29	28	26.5
75% recess								

from a sensor attached to a user's body. For example, an on-chip sensor (Sensirion, Swiss), in which a relative humidity sensor is integrated with a temperature sensor, may be used to measure the temperature and the humidity. A relative humidity of gas is highly dependent on its temperature. Thus, a humidity sensor has to be used at the same temperature as the air in which the relative humidity will be measured.

[0068] The WBGT is influenced by air flow (wind), air temperature, humidity, and insolation. The WBGT may be estimated using the following Formula in an environment providing normal insolation and mild wind (American College of Sports Medicine, Med. J. Aust., Dec. 876, 1984).

$$WBGT = 0.567 \times T_a + 0.393 \times e + 3.94 \quad [\text{Formula 1}]$$

[0075] In Table 1, each numeral represents a WBGT index.

[0076] For example, a work or recess ratio may be determined by using the calculated heat stress estimation values, that is, acclimatization/un-acclimatization, work load, and WBGT index, with reference to Table 1. For example, if the user acclimatizes to climate in a middle work load with a WBGT index of 29.5, it will be found that 50% work and 50% recess are suitable.

[0077] In the heat stress management method, the alarm signal is generated when the user is under extreme heat stress. For example, as described above, if 50% work and 50% recess are determined to be an optimum condition, that is, if 30-minute recess is required after every 30-minute work

period, the alarm signal may be sent to the user or supervisor, thirty minutes after an operation begins.

[0078] In addition, the heat stress management method may further include automatically writing a report regarding a user's heat stress, if requested. The report may include the basic data, the biometric data, the environmental data, and the heat stress estimation value.

[0079] The invention can also be embodied as computer readable codes on a computer readable recording medium. The computer readable recording medium is any data storage device that can store data which can be thereafter read by a computer system. Examples of the computer readable recording medium include read-only memory (ROM), random-access memory (RAM), CD-ROMs, magnetic tapes, floppy disks, optical data storage devices, and carrier waves (such as data transmission through the Internet). The computer readable recording medium can also be distributed over network coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

[0080] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. The exemplary embodiments should be considered in descriptive sense only and not for purposes of limitation. Therefore, the scope of the invention is defined not by the detailed description of the invention but by the appended claims, and all differences within the scope will be construed as being included in the present invention.

1. A portable data transmission device comprising:
 - a detachable element which is detached from and attached to a user;
 - a biometric data sensor which is connected to the detachable element, and measures a user's biometric data;
 - an environmental data sensor which measures data of an environment surrounding the user; and
 - a wireless transmission unit which wirelessly transmits the measured data.
2. The portable data transmission device of claim 1, further comprising:
 - an A/D converter which converts the analog data measured by the sensors to digital signal; and
 - a controller which controls the operation of the wireless transmission unit.
3. The portable data transmission device of claim 1, wherein the sensors and the wireless transmission unit are disposed on a flexible substrate, and the detachable element comprises flexible waterproof cases which encompass the flexible substrate, and an adhesive layer which is coated on one of the outer surfaces of the cases and is detachable from and attachable to a user's skin.
4. The portable data transmission device of claim 3, wherein the cases are made of a silicon rubber.
5. The portable data transmission device of claim 1, wherein the biometric data comprises heart rate and motion acceleration, and the environmental data comprises temperature and humidity.
6. A heat stress management system comprising:
 - a portable data transmission device comprising a detachable element which is detached from and attached to a user, a biometric data sensor which is connected to the detachable element, and measures user's biometric data,

an environmental data sensor which measures data of an environment surrounding the user, and a wireless transmission unit which wirelessly transmits the measured data; and

a monitoring device which wirelessly receives the biometric data and the environmental data from the wireless transmission unit of the portable data transmission device, and converts the received biometric data, the environmental data, and user's basic data that is input in advance, into a heat stress estimation value, thereby remotely monitoring the user's heat stress.

7. The heat stress management system of claim 6, wherein the biometric data comprises heart rate and motion acceleration, the environmental data comprises temperature and humidity, and the basic data comprises weight and recent work record.

8. The heat stress management system of claim 7, wherein the heat stress estimation value is a work load converted from the heart rate, a WBGT (wet bulb globe temperature) index converted from the temperature and humidity, a climate acclimatization converted from the recent work record, or a physical work degree converted from the weight and motion acceleration.

9. The heat stress management system of claim 6, wherein the monitoring device converts the biometric data and the environmental data, which are wirelessly received from the portable data transmission device, and the input basic data into the heat stress estimation value, and estimates a user's heat stress therefrom, and if the user's heat stress is determined to be extreme, an alarm signal is automatically generated.

10. The heat stress management system of claim 6, wherein the monitoring device is portable.

11. The heat stress management system of claim 6, further comprising a portable data receiving/sending device which wirelessly receives the biometric data and the environmental data from the portable data transmission device, and wirelessly sends the received data to the monitoring device.

12. The heat stress management system of claim 6 or 11, wherein the portable data transmission device, the monitoring device, and the portable data receiving/sending device communicate with one another wirelessly by using Bluetooth, Zig Bee, a high frequency RF signal, a wireless LAN, a CDMA mobile phone network, a GSM mobile phone network, or a Terrestrial Trunked Radio (TETRA).

13. A heat stress management method comprising:

- receiving user's basic data;
- wirelessly receiving user's biometric data and environmental data;
- converting the received data into a heat stress estimation value;
- estimating a user's heat stress from the heat stress estimation value; and
- generating an alarm signal if the user's heat stress is extreme.

14. The heat stress management method of claim 13, wherein the basic data comprises weight and recent work record, the biometric data comprises heart rate and motion acceleration, and the environmental data comprises temperature and humidity.

15. The heat stress management method of claim 14, wherein the heat stress estimation value is a work load converted from the heart rate, a WBGT (wet bulb globe temperature) index converted from the temperature and humidity, a

climate acclimatization converted from the recent work record, or a physical work degree converted from the weight and motion acceleration.

16. The heat stress management method of claim **13**, further comprising automatically writing a report regarding the user's heat stress, if requested.

17. The heat stress management method of claim **16**, wherein the report comprises the basic data, the biometric data, the environmental data, and the heat stress estimation value.

* * * * *

专利名称(译)	便携式数据发送装置，以及使用该装置管理热应力的系统和方法		
公开(公告)号	US20090198112A1	公开(公告)日	2009-08-06
申请号	US12/096371	申请日	2006-02-28
[标]申请(专利权)人(译)	韩国电子通信研究院		
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摘要(译)

实时定位系统 (RTLS) 中的高精度时钟同步装置，包括光发送/接收单元，用于从时钟同步服务器接收时钟信息帧，串行并行地转换接收的时钟信息帧，以及发送/接收时钟信息数据和时钟信息;偏移估计单元，用于从串并转换的时钟信息帧中检测前导信号和时钟信息信号，通过将检测到的前导信号与检测到的时钟信息信号进行比较来计算相位差值，并输出基于该偏移值的偏移值。计算出的相位差值;时钟同步单元，用于根据偏移值和时钟信息帧将本地时钟值更新为时钟同步服务器的时间。

