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(54) **BLOOD OXYGEN CONCENTRATION ALGORITHM APPLIED IN A PHYSIOLOGICAL SIGNAL MEASUREMENT DEVICE**

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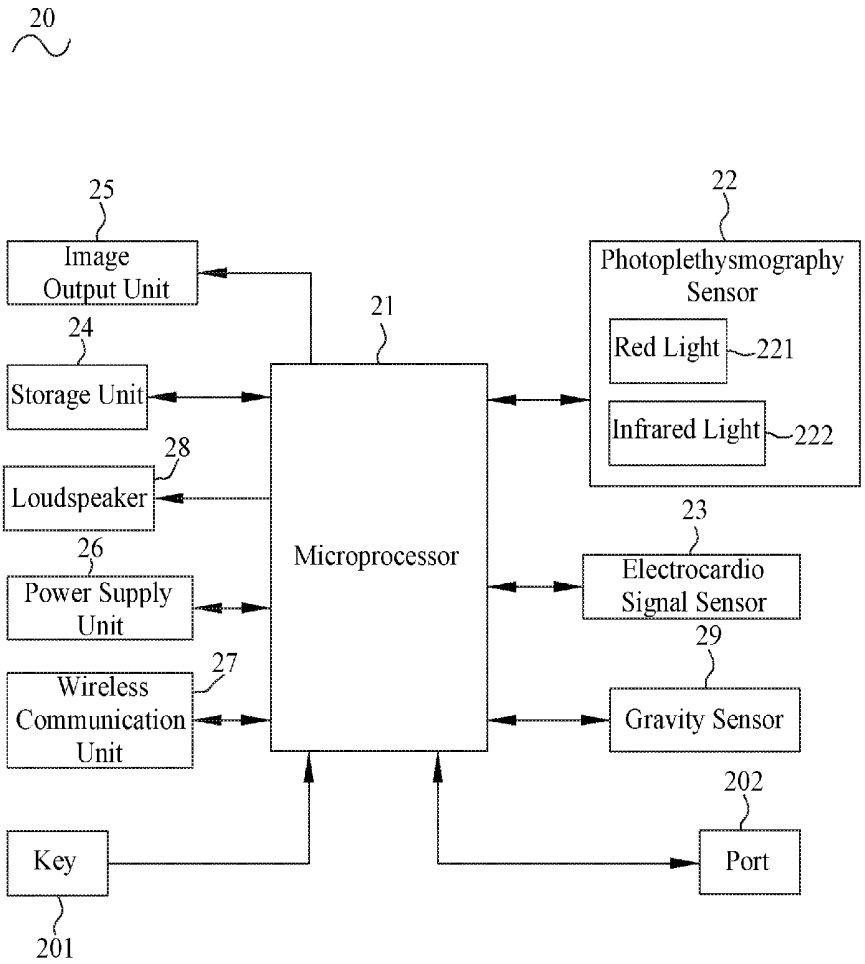
CPC ***A61B 5/0205*** (2013.01); ***A61B 5/742*** (2013.01); *A61B 5/0402* (2013.01); ***A61B 5/14546*** (2013.01); ***A61B 5/02125*** (2013.01)

(57) **ABSTRACT**

A physiological signal measurement device includes a shell, a pair of induction sheets mounted to the shell, and a circuit board assembly mounted in the shell. The circuit board assembly includes a microprocessor, a photoplethysmography sensor electrically connected with the microprocessor, and an electrocardio signal sensor. The photoplethysmography sensor senses photoplethysmography signals of blood vessels reflected by the finger parts. The electrocardio signal sensor is electrically connected with the microprocessor and the pair of the induction sheets. The pair of the induction sheets respectively contact with finger parts of two hands to form a loop for sensing trace amounts of electrical signals generated from heart beats.



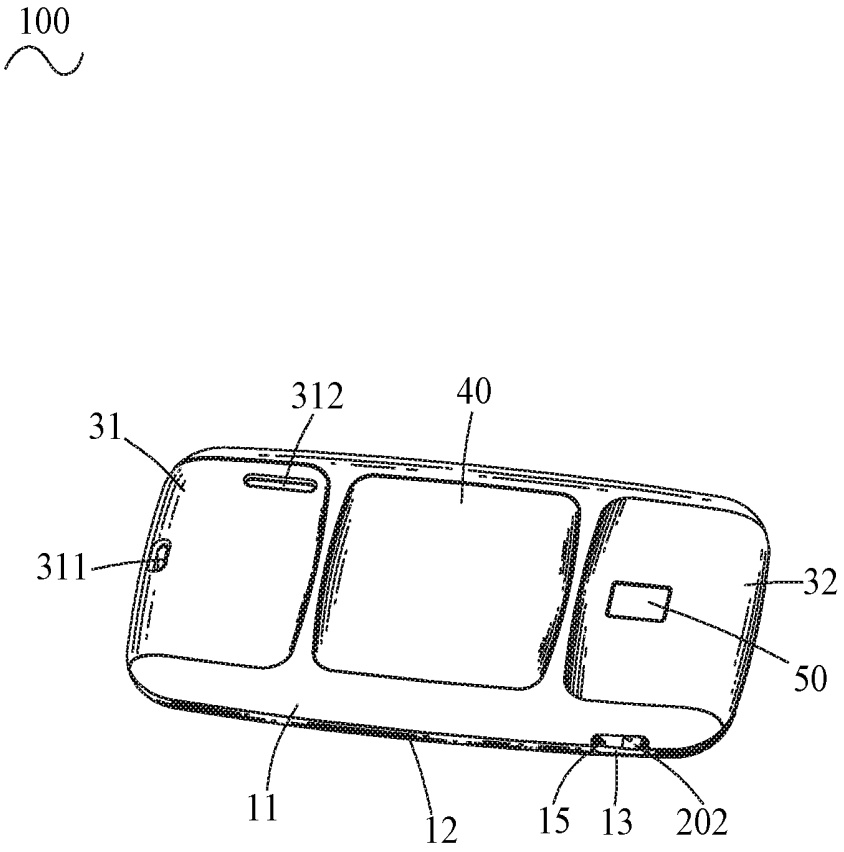
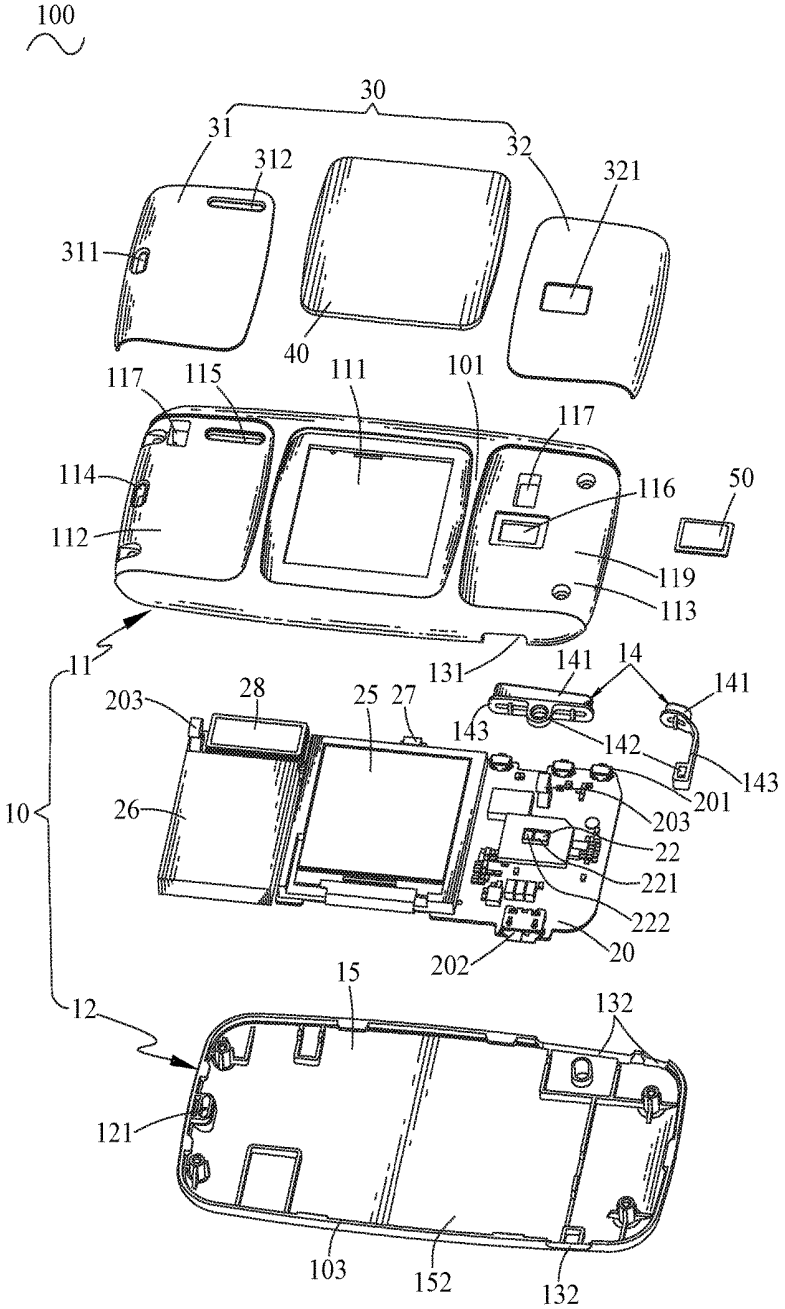


FIG. 1


100
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141
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25
27
143
142
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10
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203
22
221
222
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202
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103
152
132

FIG. 2

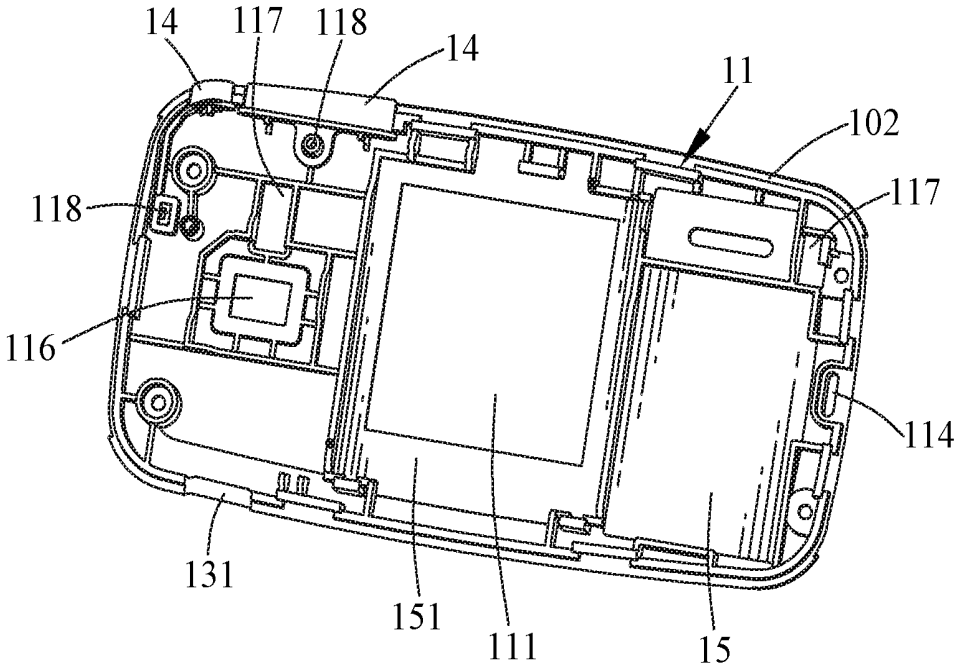

FIG. 3

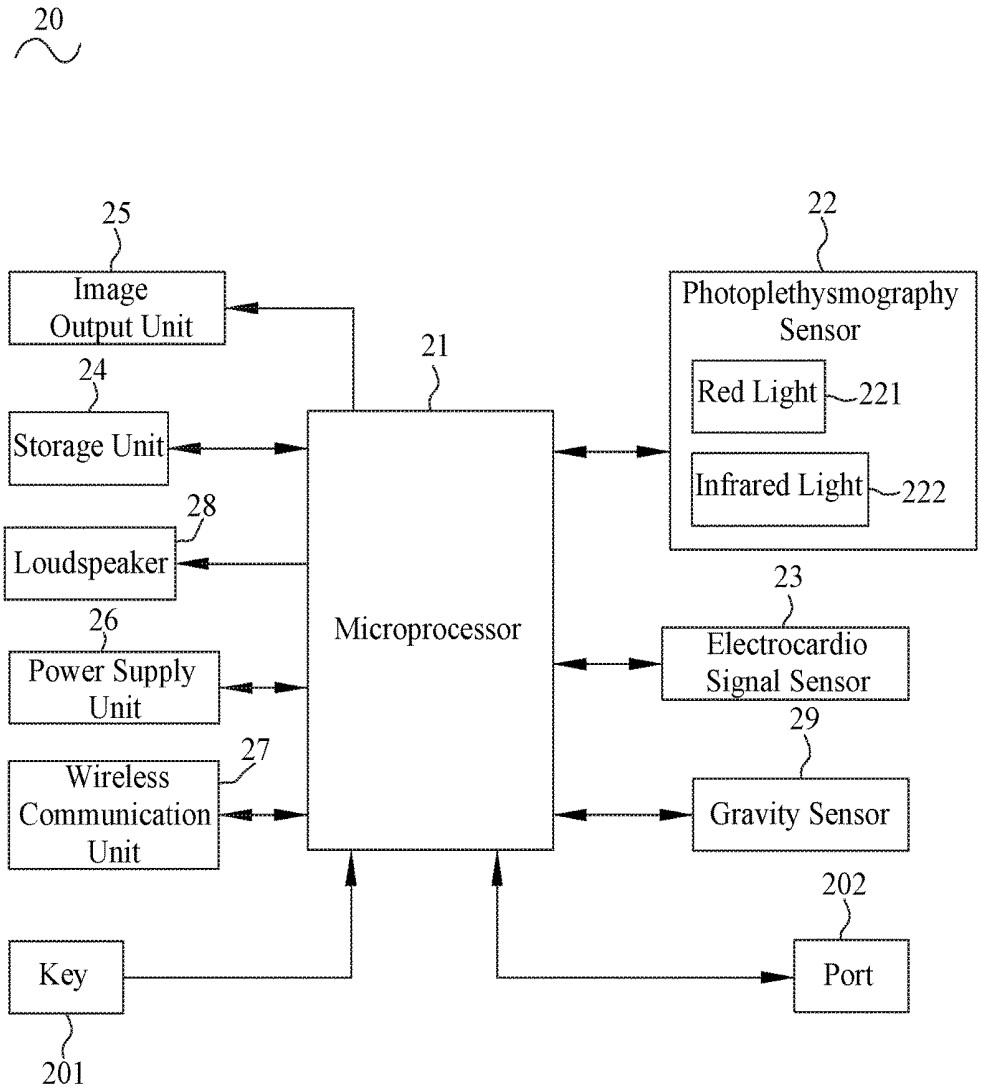
20
25
Image Output Unit
24
Storage Unit
28
Loudspeaker
26
Power Supply Unit
27
Wireless Communication Unit
Key
201
21
Microprocessor
22
Photoplethysmography Sensor
Red Light
221
Infrared Light
222
23
Electrocardio Signal Sensor
29
Gravity Sensor
202
Port

FIG. 4

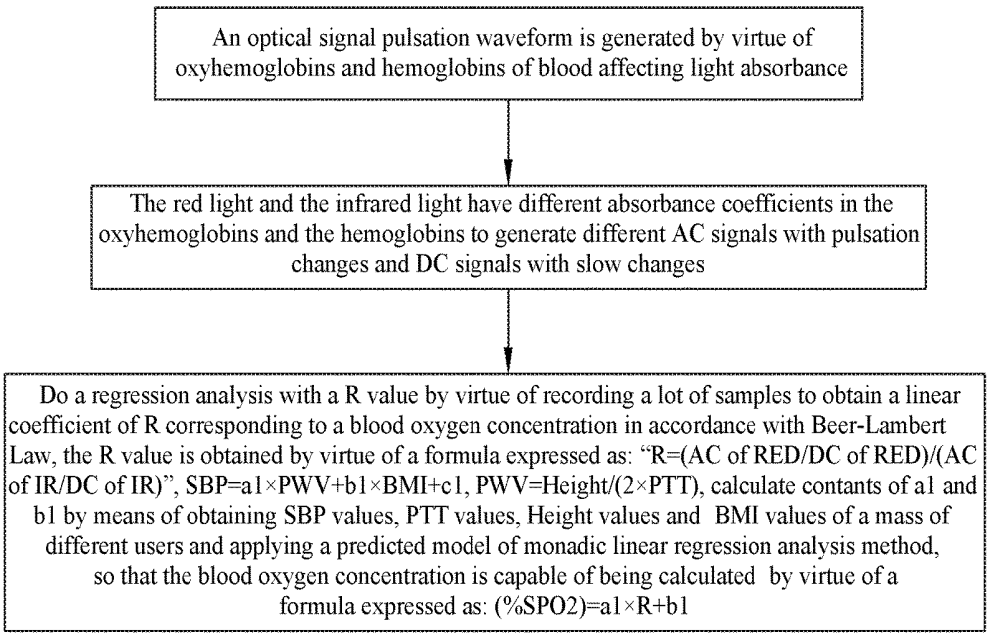
An optical signal pulsation waveform is generated by virtue of oxyhemoglobins and hemoglobins of blood affecting light absorbance
The red light and the infrared light have different absorbance coefficients in the oxyhemoglobins and the hemoglobins to generate different AC signals with pulsation changes and DC signals with slow changes
Do a regression analysis with a R value by virtue of recording a lot of samples to obtain a linear coefficient of R corresponding to a blood oxygen concentration in accordance with Beer-Lambert Law, the R value is obtained by virtue of a formula expressed as: "R=(AC of RED/DC of RED)/(AC of IR/DC of IR)", SBP=a1×PWV+b1×BMI+c1, PWV=Height/(2×PTT), calculate contants of a1 and b1 by means of obtaining SBP values, PTT values, Height values and BMI values of a mass of different users and applying a predicted model of monadic linear regression analysis method, so that the blood oxygen concentration is capable of being calculated by virtue of a formula expressed as: (%SPO2)=a1×R+b1

FIG. 5

BLOOD OXYGEN CONCENTRATION ALGORITHM APPLIED IN A PHYSIOLOGICAL SIGNAL MEASUREMENT DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is a divisional application of U.S. application Ser. No. 15/657,685 which was filed on Jul. 24, 2017, which is based on, and claims priority from, Taiwan patent application no. 106101593, filed Jan. 17, 2017, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention generally relates to a device and an algorithm applied therein, and more particularly to a physiological signal measurement device and a blood oxygen concentration algorithm applied therein.

2. The Related Art

[0003] With the development of information technologies, a physiological signal measurement device has been used more and more widely. Physiological signals of a user are measured by virtue of the physiological signal measurement device. The physiological signals include blood pressure signals, blood oxygen signals and electrocardio signals for monitoring health conditions of the user in real time.

[0004] However, a volume of the physiological signal measurement device is usually larger that makes the physiological signal measurement device need to be used at home. As a result, the physiological signals of the user doing outdoor sports are inconveniently measured in the real time.

[0005] Thus, how to design an innovative physiological signal measurement device has become a problem which need be solved by an inventor, the innovative physiological signal measurement device is carried conveniently, and is capable of measuring the physiological signals in the real time.

SUMMARY OF THE INVENTION

[0006] An object of the present invention is to provide a physiological signal measurement device contacting with finger parts of two hands. The physiological signal measurement device includes a shell, a pair of induction sheets mounted to the shell, and a circuit board assembly mounted in the shell. The circuit board assembly includes a microprocessor, a photoplethysmography sensor electrically connected with the microprocessor, and an electrocardio signal sensor. The photoplethysmography sensor senses photoplethysmography signals of blood vessels reflected by the finger parts. The electrocardio signal sensor is electrically connected with the microprocessor and the pair of the induction sheets. The pair of the induction sheets respectively contact with the finger parts of the two hands to form a loop for sensing trace amounts of electrical signals generated from heart beats.

[0007] Another object of the present invention is to provide a blood oxygen concentration algorithm applied in a physiological signal measurement device. The physiological signal measurement device includes a photoplethysmography sensor. The photoplethysmography sensor includes red light and infrared light. Specific steps of the blood oxygen concentration algorithm are described hereinafter. An optical signal pulsation waveform is generated by virtue of oxyhemoglobins and hemoglobins of blood affecting light absorbance. The red light and the infrared light have different absorbance coefficients in the oxyhemoglobins and the hemoglobins to generate different AC signals with pulsation changes and DC signals with slow changes. AC signals denote alternating component signals, and DC signals denote direct component signals. Do a regression analysis with a R value by virtue of recording a lot of samples to obtain a linear coefficient of R corresponding to a blood oxygen concentration in accordance with Beer-Lambert Law. The R value is obtained by virtue of a formula expressed as: "R=(AC of RED/DC of RED)/(AC of IR/DC of IR)". AC of RED denotes alternating component amplitude of the red light. DC of RED denotes direct component amplitude of the red light. AC of IR denotes alternating component amplitude of the infrared light. And DC of IR denotes direct component amplitude of the infrared light. SBP=a1×PWV+b1×BMI+c1, PWV=Height/(2×PTT). PWV denotes a pulse wave velocity. SBP denotes systolic blood pressure. PTT denotes pulse transmit time, and BMI denotes a body mass index. Calculate contants of a1 and b1 by means of obtaining SBP values, PTT values, Height values and BMI values of a mass of different users and applying a predicted model of monadic linear regression analysis method, so that the blood oxygen concentration is capable of being calculated by virtue of a formula expressed as: (% SPO2)=a1×R+b1. SPO2 denotes pulse oxygen saturation.

[0008] As described above, the physiological signal measurement device completes measuring physiological signals which include heart rate signals, blood pressure signals, blood oxygen concentration signals and so on of the users in the real time by virtue of the photoplethysmography sensor and the electrocardio signal sensor of the circuit board assembly. Furthermore, the shell of the physiological signal measurement device is of the card shape, so a volume of the physiological signal measurement device is smaller for being carried conveniently to be used outside and at home. As a result, the physiological signals of the user doing outdoor sports is conveniently measured in the real time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention will be apparent to those skilled in the art by reading the following description, with reference to the attached drawings, in which:

[0010] FIG. **1** is a perspective view of a physiological signal measurement device in accordance with a preferred embodiment of the present invention;

[0011] FIG. **2** is an exploded prespective view of the physiological signal measurement device of FIG. **1**;

[0012] FIG. **3** is a perspective view of an upper shell of the physiological signal measurement device of FIG. **2**;

[0013] FIG. **4** is a block diagram of a circuit board assembly of the physiological signal measurement device of FIG. **2**; and

[0014] FIG. **5** is a flow chart of a blood oxygen concentration algorithm applied in the physiological signal measurement device in accordance with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] With reference to FIG. **1** to FIG. **3**, a physiological signal measurement device **100** in accordance with a preferred embodiment of the present invention is shown. A blood oxygen concentration algorithm is applied in the physiological signal measurement device **100**. The physiological signal measurement device **100** includes a shell **10**, a circuit board assembly **20**, a pair of induction sheets **30**, a screen cover **40** and an optical sensor cover **50**.

[0016] With reference to FIG. **1** to FIG. **3**, the shell **10** is of a card shape. The shell **10** includes an upper shell **11** and a lower shell **12**. The upper shell **11** has a top surface **101**, and a bottom surface **102** opposite to the top surface **101**. A lower portion of the upper shell **11** opens an upper receiving space **151** penetrating through a middle of the bottom surface **102** of the upper shell **11** in a downward direction. Two opposite ends of the top surface **101** of the upper shell **11** are recessed in the downward direction to form a first recess **112** and a second recess **113**. A bottom wall of the first recess **112** of the upper shell **11** opens an upper sling hole **114** and an internal loudspeaker hole **115**. A bottom wall of the second recess **113** defines a locating groove **119**. A bottom wall of the locating groove **119** opens an optical sensor hole **116** communicated with the locating groove **119**. In this preferred embodiment, a middle of the bottom wall of the locating groove **119** opens the optical sensor hole **116**.

[0017] The bottom wall of the first recess **112** and the bottom wall of the second recess **113** open two perforations **117**, respectively. Several portions of a bottom of the upper shell **11** protrude in the downward direction to form a plurality of protruding pillars **118**. Several portions of a bottom surface of a top wall of the upper receiving space **151** protrude in the downward direction to form the plurality of protruding pillars **118**. In this preferred embodiment, the upper sling hole **114**, the internal loudspeaker hole **115**, the optical sensor hole **116** and the two perforations **117** are communicated with the upper receiving space **151**. The upper shell **11** is covered on the lower shell **12** to form a receiving space **15** between the lower shell **12** and the upper shell **11**. The lower shell **12** has a superface **103** facing the bottom surface **102** of the upper shell **11**. An upper portion of the lower shell **12** opens a lower receiving space **152** penetrating through a middle of the superface **103** of the lower shell **12** in an upward direction.

[0018] The lower receiving space **152** is corresponding to and communicated with the upper receiving space **151** to form the receiving space **15**. An upper portion of the upper shell **11** opens an opening **111** penetrating through a middle of the top surface **101** of the upper shell **11** in the upward direction and extending to the upper receiving space **151** of the receiving space **15** in the downward direction. The opening **111** is communicated with the upper receiving space **151**. The opening **111** is located between the first recess **112** and the second recess **113**. The lower shell **12** opens a lower sling hole **121** corresponding to the upper sling hole **114** of the upper shell **11**. A periphery of the bottom surface **102** of the upper shell **11** is connected with a periphery of the superface **103** of the lower shell **12**. The downward direction is opposite to the upward direction.

[0019] A periphery of the shell **10** opens a plurality of assembling grooves **13**. Several portions of the periphery of the bottom surface **102** of the upper shell **11** and several portions of the periphery of the superface **103** of the lower shell **12** are recessed in opposite directions to form a plurality of upper assembling grooves **131** and a plurality of lower assembling grooves **132**. In this preferred embodiment, several portions of two opposite sides of the periphery of the bottom surface **102** of the upper shell **11** and several portions of two opposite sides of the periphery of the superface **103** of the lower shell **12** are recessed in the opposite directions to form the plurality of the upper assembling grooves **131** and the plurality of the lower assembling grooves **132**, respectively. The plurality of the lower assembling grooves **132** are matched with the corresponding pluality of the upper assembling grooves **131** to form the plurality of the assembling grooves **13**.

[0020] The shell **10** further includes a plurality of buttons **14**. Each of the plurality of the buttons **14** is assembled in one of the plurality of the assembling grooves **13**. Each of the plurality of the buttons **14** includes a pressing portion **141**, a ring-shaped assembling portion **142**, and a connecting portion **143** connected between the pressing portion **141** and the assembling portion **142**. The assembling portion **142** of each of the plurality of the buttons **14** is assembled to one of the protruding pillars **118** of the upper shell **11**. The connecting portion **143** of each of the plurality of the buttons **14** is received in the upper receiving space **151** of the upper shell **11**. The pressing portion **141** of each of the plurality of the buttons **14** is assembled to the one of the plurality of the assembling grooves **13** of the shell **10**.

[0021] Referring to FIG. **1**, FIG. **2** and FIG. **4**, the circuit board assembly **20** is mounted in the shell **10**. The circuit board assembly **20** is received in the receiving space **15**. The circuit board assembly **20** includes a microprocessor **21**, a photoplethysmography sensor **22**, an electrocardio signal sensor **23**, a storage unit **24**, an image output unit **25**, a power supply unit **26**, a wireless communication unit **27**, a loudspeaker **28** and a gravity sensor **29**.

[0022] The photoplethysmography sensor **22** is electrically connected with the microprocessor **21**. In use, the physiological signal measurement device **100** contacts with finger parts of two hands of a user. The photoplethysmography sensor **22** senses photoplethysmography signals of blood vessels reflected by the finger parts, and blood pressure values and blood oxygen concentration values are calculated by the microprocessor **21**. In this preferred embodiment, the photoplethysmography sensor **22** is assembled on a top of the circuit board assembly **20** and is located at one side of the second recess **113**. Specifically, the photoplethysmography sensor **22** is assembled in the optical sensor hole **116** of the second recess **113** of the upper shell **11** and exposed in the locating groove **119**. The optical sensor cover **50** is assembled in the locating groove **119** and is covered on the photoplethysmography sensor **22**. In use, the photoplethysmography signals of the finger parts are sensed by the photoplethysmography sensor **22** and are transmitted to the microprocessor **21** for a calculation.

[0023] The pair of the induction sheets **30** mounted to the shell **10**. The electrocardio signal sensor **23** is electrically connected with the microprocessor **21** and the pair of the induction sheets **30**. In use, the pair of the induction sheets **30** respectively contact with the finger parts of the two hands of the user to form a loop for sensing trace amounts of electrical signals generated from heart beats, and heart rate values are calculated by the microprocessor **21**. Specifically, the pair of the induction sheets **30** are respectively pressed by thumbs of the two hands of the user, at the moment, the

physiological signal measurement device **100**, the two hands and a body of the user form a measurement loop. The electrocardio signal sensor **23** senses the trace amounts of the electrical signals generated from the heart beats by virtue of the pair of the induction sheets **30** contacting with the finger parts of the two hands, and the trace amounts of the electrical signals are transmitted to the microprocessor **21** for being calculated.

[0024] In this preferred embodiment, specific steps of a blood pressure calculation method applied in the physiological signal measurement device **100** are described as follows. Set the photoplethysmography sensor **22** and the electrocardio signal sensor **23**, and establish a calculation formula of SBP (Systolic Blood Pressure) value which is expressed as: "SBP=a1×PWV+b1×BMI+c1", and a calculation formula of DBP (Diastolic Blood Pressure) value which is expressed as: "DBP=d1×SBP+e1". PWV=Height/(2×PTT), PWV denotes a pulse wave velocity, SBP denotes systolic blood pressure, DBP denotes diastolic blood pressure, PTT denotes pulse transmit time, and BMI denotes a body mass index. Calculate contants of a1, b1, c1, d1 and e1 by means of obtaining SBP values, DBP values, PTT values, Height values and BMI values of a mass of different users and applying a predicted model of monadic linear regression analysis method, the calculation formulas: "SBP=a1×PWV+b1×BMI+c1" and "DBP=d1×SBP+e1" are written to the microprocessor **21**.

[0025] In use, sample a photoplethysmography pulse signal and an electrocardio signal of the user, and calculate the PTT value of the user. Input the Height value and the BMI value of the user into the physiological signal measurement device **100**. The microprocessor **21** is capable of calculating the SBP value of the user, and then the DBP value of the user is directly calculated by virtue of the SBP value being applied in the calculation formula of the DBP value.

[0026] Referring to FIG. **1** to FIG. **5**, in this preferred embodiment, the photoplethysmography sensor **22** includes red light **221** and infrared light **222**. Specific steps of the blood oxygen concentration algorithm applied in the physiological signal measurement device **100** are described as follows.

[0027] Firstly, an optical signal pulsation waveform is generated by virtue of oxyhemoglobins (HbO2) and hemoglobins (Hb) of blood affecting light absorbance.

[0028] Secondly, the red light **221** and the infrared light **222** have different absorbance coefficients in the oxyhemoglobins and the hemoglobins to generate different AC signals with pulsation changes and DC signals with slow changes, AC signals denote alternating component signals, and DC signals denote direct component signals.

[0029] Thirdly, do a regression analysis with a R value by virtue of recording a lot of samples to obtain a linear coefficient of R corresponding to a blood oxygen concentration in accordance with Beer-Lambert Law, the R value is obtained by virtue of a formula expressed as: "R=(AC of RED/DC of RED)/(AC of IR/DC of IR)", AC of RED denotes alternating component amplitude of the red light **221**, DC of RED denotes direct component amplitude of the red light **221**, AC of IR denotes alternating component amplitude of the infrared light **222**, and DC of IR denotes direct component amplitude of the infrared light **222**, so that the blood oxygen concentration is capable of being calculated by virtue of a formula expressed as: (% SPO2)=a1×R+b1, SPO2 denotes pulse oxygen saturation.

[0030] The storage unit **24** is electrically connected with the microprocessor **21** for storing measured data of the physiological signal measurement device **100** which include data calculated by the microprocessor **21** in the storage unit **24**.

[0031] The image output unit **25** is electrically connected with the microprocessor **21** for displaying the measured data of the physiological signal measurement device **100** which include the data calculated by the microprocessor **21** in real time. In this preferred embodiment, the image output unit **25** is disposed to the top of the circuit board assembly **20** and is fixed in the opening **111** of the upper shell **11**. The screen cover **40** is assembled in the opening **111** and is covered on the image output unit **25**.

[0032] The power supply unit **26** is electrically connected with the microprocessor **21** to provide power signals for the circuit board assembly **20** to make the circuit board assembly **20** work.

[0033] The wireless communication unit **27** is electrically connected with the microprocessor **21** for making the measured data of the physiological signal measurement device **100** transmitted to a peripheral equipment in the real time.

[0034] The loudspeaker **28** is electrically connected with the microprocessor **21** for making the data calculated by the microprocessor **21** transmitted outside by sound signals. In this preferred embodiment, the loudspeaker **28** is disposed to the top of the circuit board assembly **20**, and is located under the first recess **112** of the upper shell **11**. Specifically, the loudspeaker **28** is mounted under the internal loudspeaker hole **115** of the first recess **112** of the upper shell **11**.

[0035] The gravity sensor **29** is electrically connected with the microprocessor **21**. Signals sensed by the gravity sensor **29** are provided for the microprocessor **21** to calculate data of step calculations and so on.

[0036] The circuit board assembly **20** further includes a plurality of keys **201**, a port **202** and two conductive elements **203**. The plurality of the keys **201** and the port **202** are disposed to a peripheral edge of the circuit board assembly **20**. The two conductive elements **203** are disposed to two opposite ends of the top of the circuit board assembly **20**. In this preferred embodiment, the plurality of the keys **201** and the port **202** are disposed to two opposite sides of the peripheral edge of the circuit board assembly **20**. The pressing portions **141** of the plurality of the buttons **14** of the shell **10** are disposed on the plurality of the keys **201**. Each of the plurality of the keys **201** has functions of turning on or switching off, ajusting volumes, going forward and receding, and so on. The port **202** is disposed to and corresponding to one of the plurality of the assembling grooves **13** of the shell **10**. The plurality of the keys **201** are disposed in the other assembling grooves **13** of the shell **10**. The two conductive elements **203** are received in and project out of the two perforations **117**, respectively. The physiological signal measurement device **100** proceeds charging and data transmissions by virtue of the port **202**.

[0037] The pair of the induction sheets **30** include a first pole piece **31** and a second pole piece **32**. The first pole piece **31** opens an external sling hole **311** corresponding to the upper sling hole **114** of the first recess **112** of the upper shell **11**. The first pole piece **31** opens an external loudspeaker hole **312** corresponding to the internal loudspeaker hole **115** of the first recess **112** of the upper shell **11**. The second pole piece **32** opens an external sensor hole **321** corresponding to and communicated with the optical sensor hole **116** of the

second recess **113** of the upper shell **11**. The first pole piece **31** is assembled in the first recess **112** of the upper shell **11** and is electrically connected with one of the two conductive elements **203** of the circuit board assembly **20** by virtue of one of the two perforations **117**. The external sling hole **311** of the first pole piece **31** is corresponding to and communicated with the upper sling hole **114** of the upper shell **11**. The external loudspeaker hole **312** of the first pole piece **31** is corresponding to and communicated with the internal loudspeaker hole **115** of the upper shell **11**. The second pole piece **32** is assembled in the second recess **113** and is electrically connected with the other conductive element **203** of the circuit board assembly **20** by virtue of the other perforation **117**. The optical sensor cover **50** is exposed in the external sensor hole **321**.

[0038] As described above, the physiological signal measurement device **100** completes measuring physiological signals which include heart rate signals, blood pressure signals, blood oxygen concentration signals and so on of the users in the real time by virtue of the photoplethysmography sensor **22** and the electrocardio signal sensor **23** of the circuit board assembly **20**. Furthermore, the shell **10** of the physiological signal measurement device **100** is of the card shape, so a volume of the physiological signal measurement device **100** is smaller for being carried conveniently to be used outside and at home. As a result, the physiological signals of the user doing outdoor sports is conveniently measured in the real time.

What is claimed is:

1. A blood oxygen concentration algorithm applied in a physiological signal measurement device, the physiological signal measurement device including a photoplethysmography sensor, the photoplethysmography sensor including red light and infrared light, the blood oxygen concentration algorithm comprising the steps of:

an optical signal pulsation waveform being generated by virtue of oxyhemoglobins and hemoglobins of blood affecting light absorbance;

the red light and the infrared light having different absorbance coefficients in the oxyhemoglobins and the hemoglobins to generate different AC signals with pulsation changes and DC signals with slow changes, AC signals denoting alternating component signals, and DC signals denoting direct component signals; and

doing a regression analysis with a R value by virtue of recording a lot of samples to obtain a linear coefficient of R corresponding to a blood oxygen concentration in accordance with Beer-Lambert Law, the R value being obtained by virtue of a formula expressed as: "R=(AC of RED/DC of RED)/(AC of IR/DC of IR)", AC of RED denoting alternating component amplitude of the red light, DC of RED denoting direct component amplitude of the red light, AC of IR denoting alternating component amplitude of the infrared light, and DC of IR denoting direct component amplitude of the infrared light, SBP=a1×PWV+b1×BMI+c1, PWV=Height/(2×PTT), PWV denoting a pulse wave velocity, SBP denoting systolic blood pressure, PTT denoting pulse transmit time, and BMI denoting a body mass index, calculating contants of a1 and b1 by means of obtaining SBP values, PTT values, Height values and BMI values of a mass of different users and applying a predicted model of monadic linear regression analysis method, so that the blood oxygen concentration is capable of being calculated by virtue of a formula expressed as: (% SPO2)=a1×R+b1, SPO2 denoting pulse oxygen saturation.

* * * * *

专利名称(译)	血氧浓度算法应用于生理信号测量装置中		
公开(公告)号	US20190117086A1	公开(公告)日	2019-04-25
申请号	US16/220968	申请日	2018-12-14
[标]申请(专利权)人(译)	正崴精密工业股份有限公司		
申请(专利权)人(译)	正崴精密工业股份有限公司.		
当前申请(专利权)人(译)	正崴精密工业股份有限公司.		
[标]发明人	LEE JAMES		
发明人	LEE, JAMES		
IPC分类号	A61B5/0205 A61B5/00 A61B5/021 A61B5/145		
CPC分类号	A61B5/0205 A61B5/742 A61B5/02125 A61B5/14546 A61B5/0402 A61B5/14551 A61B2560/04 A61B5/0245 A61B5/02416 A61B5/7235		
优先权	106101593 2017-01-17 TW		
外部链接	Espacenet USPTO		

摘要(译)

生理信号测量装置包括壳体，安装到壳体的一对感应片，以及安装在壳体中的电路板组件。电路板组件包括微处理器，与微处理器电连接的光电容积脉搏波传感器，以及心电信号传感器。光电容积脉搏波传感器检测由手指部分反射的血管的光电容积描记信号。心电信号传感器与微处理器和一对感应片电连接。这对感应板分别与两只手的指状部分接触，以形成用于感测由心跳产生的痕量电信号的环。