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Wearable device for pain treatment by compound photo-chemical action principle

Abstract

Disclosed is a body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions. According to one aspect of the present invention, there is provided the body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions including a body portion in which a plurality of transmission holes are formed so that light is transmitted therethrough, a circuit board disposed inside the body portion, a built-in battery disposed inside the body portion, a first light irradiating portion electrically connected to the circuit board and configured to irradiate blue light-emitting diode (LED) light through the transmission holes of the body portion, and a second light irradiating portion electrically connected to the circuit board and configured to irradiate low-level laser light through the transmission holes of the body portion, wherein each of the first and second light irradiating portions is provided to cause at least two or more photo-biochemical reactions among cell activation, cell regeneration, cell division, blood flow improvement, vasodilation, cell degradation, and nerve stimulation on tissue in a body part to be treated through simultaneous or alternate light output.

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Background/Summary

TECHNICAL FIELD

(1) The present invention relates to a body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions.

NATIONAL RESEARCH AND DEVELOPMENT PROJECT THAT SUPPORTS THIS INVENTION

(2) [Project identification number] 1920007 [Project number] D1920007 [Department name] Gyeonggi-do [Project management (specialty) organization name] Gyeonggi Business & Science Accelerator

[Research Project Name] [Title of project] Development of a pain treatment device, which combines intermittent ultrasound technology and cold laser technology and is capable of simultaneously treating superficial and deep muscles for acute pain, a pain platform in which pain management may be customized. [Contribution rate] 1/1 [Project execution organization name] WellsCare Co.,Ltd [Research period] Feb. 1, 2020-Jan. 31, 2021

BACKGROUND ART

(3) Low-level lasers (LLLs) are known through various clinical data to cause various effects such as pain relief, blood flow improvement, blood flow enhancement, skin regeneration, cell activation, fat reduction, and cell stimulation depending on a specific wavelength range. Compared to high-level lasers used for the purpose of destruction or intentional damage or necrosis of skin tissue, the low-level laser, which has a wavelength band of 600 nm or more with a relatively low output of 100 mW or less, is relatively safe and has effects of promoting metabolism, revitalizing cells, and increasing immunity and thus has a function of recovering damaged cell tissue. In particular, when the low-level laser having a wavelength band of 800 nm or more is selectively irradiated on acupoints, it is known to have a function of relieving pain in skin or muscle and promoting the healing of an affected region by achieving the same effect as acupuncture or moxibustion treatment.

PRIOR ART DOCUMENT

Patent Document

(4) Korean Patent Application Publication No. 10-1006764 (publication date: Jun. 23, 2015)
DISCLOSURE
Technical Problem
(5) The present invention is directed to providing a body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions, which is capable of causing two or more photo-biochemical reactions in a treatment site using light-emitting diode (LED) light and low-level laser light.
Technical Solution
(6) According to one aspect of the present invention, there is provided a body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions, the apparatus including a body portion in which a plurality of transmission holes are formed so that light is transmitted therethrough, a circuit board disposed inside the body portion, a built-in battery disposed inside the body portion, a first light irradiating portion electrically connected to the circuit board and configured to irradiate blue light-emitting diode (LED) light through the transmission holes of the body portion, and a second light irradiating portion electrically connected to the circuit board and configured to irradiate low-level laser light through the transmission holes of the body portion, wherein each of the first and second light irradiating portions is provided to cause at least two or more photo-biochemical reactions among cell activation, cell regeneration, cell division, blood flow improvement, vasodilation, cell degradation, and nerve stimulation on tissue in a body part to be treated through simultaneous or alternate light output.
(7) The first light irradiating portion may include at least one blue LED element that has a wavelength range of 440 nm to 460 nm and is configured to suppress a pain-inducing factor by improving a supply of oxygen and nutrients to a muscle in a light irradiated region by a principle of promoting generation and circulation of nitric oxide (NO).
(8) The second light irradiating portion may include a first element having a wavelength range of 630 nm to 680 nm, a second element having a wavelength range of 800 nm to 850 nm, and a third element having a wavelength range of 900 nm to 920 nm, wherein the first element may be used for a purpose of relieving pain in a treatment site, the second element may be used for a purpose of cell regeneration or cell activation in the treatment site, the third element may be used for a purpose of nerve stimulation in the treatment site, and at least two elements among the first to third elements may operate simultaneously.
(9) The apparatus may further include an ultrasonic element provided in the body portion and controlled to simultaneously or alternately generate at least one ultrasonic energy of 1 MHz and 3 MHz toward a body.
(10) At least two of the first light irradiating portion, the second light irradiating portion, and the ultrasonic element may be controlled to simultaneously emit light.
(11) The apparatus may further include an ultrasonic element provided in the body portion and controlled to simultaneously or alternately generate ultrasonic energy for treatment of superficial muscle and ultrasonic energy for treatment of deep muscle.
(12) At least two of the first light irradiating portion, the second light irradiating portion, and the ultrasonic element may be controlled to simultaneously emit light.
(13) The body portion may further include a heating portion configured to provide thermal energy to a treatment site for thermal treatment.
(14) The heating portion may include a heat sink provided to absorb heat from the second light irradiating portion, a heating element configured to heat the heat sink, a temperature sensor configured to sense a temperature of the heat sink, and a controller configured to control the heating element according to the temperature of the heat sink by detecting a temperature signal from the temperature sensor.
(15) The apparatus may further include a biometric signal detection sensor installed in the body portion and configured to detect a biometric signal of a user in order to control an operation mode

of the light irradiating portion.

Advantageous Effects

(16) According to the present invention, two or more photo-biochemical reactions can be caused in a treatment site using light-emitting diode (LED) light and low-level laser light.

Description

DESCRIPTION OF DRAWINGS

(1) FIG. **1** is a view illustrating a body-wearable apparatus set for treating pain by a principle of complex photo-biochemical actions, a cradle, and a remote controller according to one embodiment of the present invention.

(2) FIG. **2** is a perspective view illustrating a body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to one embodiment of the present invention.

(3) FIG. **3** is a rear view illustrating the body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to one embodiment of the present invention.

(4) FIG. **4** is an exploded view illustrating the body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to one embodiment of the present invention.

(5) FIG. **5** is a cross-sectional view illustrating an internal configuration of the body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to one embodiment of the present invention.

(6) FIGS. **6**A and **6**B are views illustrating a band member for attaching the body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to one embodiment of the present invention to a human body.

(7) FIG. **7** is a flowchart illustrating a method of controlling the body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to one embodiment of the present invention.

(8) FIG. **8** is a rear view illustrating a body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to another embodiment of the present invention.

(9) FIG. **9** is a rear view illustrating a body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to still another embodiment of the present invention.

DESCRIPTION OF REFERENCE NUMERALS

(10) **10**: body-wearable apparatus set for treating pain by a principle of complex photo-biochemical actions **20**: peripheral region **30**: central region **40**: band **100**: body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions **110**: body portion **111**: first light irradiating portion **112**: blue LED **113**: second light irradiating portion **114**: first element **116**: second element **118**: third element **119**: ultrasonic element **119***a*: first ultrasonic element **119***b*: second ultrasonic element **120**: biometric signal detection sensor **121**: oscillator **122**: circuit board **124**: built-in battery **126**: battery housing **130**: heating portion **132**: heating element **134**: heat sink **135**: insertion hole **136**: control button portion **140**: remote controller **150**: cradle

MODES OF THE INVENTION

(11) The present invention may be modified in various forms and have various embodiments, and thus particular embodiments thereof will be illustrated in the accompanying drawings and described in the detailed description. It should be understood, however, that there is no intent to limit the present invention to the particular forms disclosed, but on the contrary, the present invention is to cover particular modifications, equivalents, and alternatives falling within the spirit and scope of the present invention. In describing the present invention, detailed descriptions of well-known technologies will be omitted when it is determined that they may obscure the gist of

the present invention.
(12) It should be understood that, although the terms “first,” “second,” and the like may be used herein to describe various components, these components should not be limited by these terms. The terms are used only for the purpose of distinguishing one component from another component.
(13) The terms used herein are for the purpose of describing particular exemplary embodiments only and are not intended to be limiting to the present invention. A singular expression includes a plural expression unless the context clearly indicates otherwise. In the present application, it will be further understood that the terms “comprise,” “comprising,” “include,” and/or “including,” when used in this specification, specify the presence of stated features, integers, steps, operations, components, parts and/or groups thereof but do not preclude the presence or addition of one or more other features, integers, steps, operations, components, parts and/or groups thereof.
(14) Hereinafter, embodiments of a body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions and a body-wearable apparatus set **10** for treating pain by a principle of complex photo-biochemical actions, and a method of controlling the same according to the present invention will be described in detail with reference to the accompanying drawings, and in this case, the same or corresponding elements will be given the same reference numbers regardless of drawing symbols, and redundant descriptions will be omitted.
(15) According to the present embodiment, as shown in FIGS. **1** to **6**B, there is provided the body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions, which includes a body portion **110**, in which a plurality of transmission holes are formed so that light is transmitted therethrough, a circuit board **122** disposed inside the body portion **110**, a built-in battery **124** disposed inside the body portion **110**, a first light irradiating portion **111** electrically connected to the circuit board **122** and configured to irradiate light-emitting diode (LED) light through the transmission holes of the body portion **110**, and a second light irradiating portion **113** electrically connected to the circuit board **122** and configured to irradiate low-level laser light through the transmission holes of the body portion **110**, wherein the second light irradiating portion **113** includes a plurality of laser elements that irradiate low-level laser light of different wavelength bands to a treatment site for two or more photo-biochemical reactions, and the photo-biochemical reactions include at least one of cell activation, cell regeneration, cell division, blood flow improvement, vasodilation, cell degradation, and nerve stimulation.
(16) Hereinafter, each component of the body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions according to the present embodiment will be described with reference to FIGS. **1** to **5**.
(17) As shown in FIGS. **2** and **3**, the body portion **110** has a plate shape and may be easily attached to a treatment site. The plurality of transmission holes may be formed in one surface of the body portion **110** so that light is transmitted therethrough.
(18) Insertion holes **135** may be formed in the other surface of the body portion **110** so that a band **40** is inserted therethrough. The body portion **110** may be disposed to correspond to the treatment site by inserting the band **40** through the insertion holes **135** and may be stably seated as the band **40** is fixed to a body of a user.
(19) In addition, a control button portion **136** through which a power supply and an operation mode may be controlled may be formed on the body portion **110**.
(20) As shown in FIGS. **4** and **5**, the built-in battery **124** may be formed inside the body portion **110**. The built-in battery **124** is charged by a cradle **150** or a charger and may supply power for a light treatment.
(21) The body portion **110** may include a battery housing **126** configured to accommodate and protect the built-in battery **124**. The battery housing **126** may include a protrusion on one side thereof.
(22) More specifically, the protrusion may form a predetermined clearance to prevent a short circuit that may occur between the circuit board **122** and the built-in battery **124**.

(23) Further, the protrusion may press a heating element **132** such that the heating element **132** is pressed against an inner surface of a treatment-performing-surface side of the body portion **110**. Accordingly, heat of the heating element **132** may be more effectively transmitted toward the treatment-performing-surface side of the body portion **110**.
(24) Further, since the heating element **132** is located on an end surface of the protrusion, a deterioration phenomenon that may occur when the heating element **132** and the built-in battery **124** come into contact with each other may be prevented.
(25) The circuit board **122** may be mounted inside the body portion **110** so as to correspond to positions of the transmission holes.
(26) The first light irradiating portion **111** may be electrically connected to the circuit board **122** and irradiate LED light through the transmission holes of the body portion **110**.
(27) Further, the second light irradiating portion **113** may be electrically connected to the circuit board **122** to irradiate the LED light through the transmission hole of the body portion **110**. The second light irradiating portion **113** may include first elements **114**, second elements **116**, and a third element **118**.
(28) According to the present embodiment, as a light treatment is applied by the body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions, photo-biochemical reactions such as cell activation, cell regeneration, cell division, blood flow improvement, vasodilation, cell degradation, nerve stimulation, pain relief, and blood flow enhancement may occur in the treatment site.
(29) The photo-biochemical reactions may occur by irradiating LED light and a low-level laser of a specific wavelength band to the treatment site.
(30) In this case, as the first light irradiating portion **110** irradiates light of a blue LED **112** having a wavelength range of 440 nm to 460 nm to the treatment site, pain perceived by the user may be relieved and a natural recovery force may be increased. As an example, the blue LED **112** may include at least one blue LED element having a specific wavelength of 453 nm. A blue LED light source having a wavelength of 453 nm has a critical significance of promoting the generation and circulation of nitric oxide (NO) when it irradiates light to the body as compared to a blue LED light source of other wavelength bands, thereby improving the supply of oxygen and nutrients to muscles and simultaneously reducing pain transmission. Accordingly, the muscles may be relaxed and the pain may be relieved. In particular, the nitric oxide (NO) has been clinically proven to exhibit antioxidant, cell protection, and anti-inflammatory properties, and may protect muscles and nerves from damage and help prevent further injuries.
(31) Each of the first elements **114** irradiates a low-level laser having a wavelength range of 630 nm to 680 nm to the treatment site, thereby more effectively relieving pain perceived by the user. As an example, the first element **114** may include a low-level laser element that emits a laser having a wavelength of about 650 nm to 660 nm. The first element **114** described above may amplify the production of ATP cells in mitochondria in a protein cell so that a photo-biochemical principle for replacing damaged cells having a pain-inducing factor is exhibited as an activation principle of normal cell regeneration.
(32) Each of the second elements **116** irradiates a low-level laser having a wavelength range of 800 nm to 850 nm to the treatment site, thereby improving blood flow and causing cell regeneration or cell activation of the treatment site. As an example, the second element **116** may include a low-level laser element that emits a laser having a wavelength of 820 nm to 840 nm. The second element **116** causes capillaries to expand to accelerate blood flow, thereby exhibiting an effect of improving blood flow.
(33) The third element **118** irradiates a low-level laser having a wavelength range of 900 nm to 990 nm to the treatment site to stimulate nerves in the treatment site, thereby treating pain. As an example, the second element **116** may include a low-level laser element that emits a laser having a wavelength of about 903 nm to 930 nm, which is known to exhibit a pain-relieving effect by a

nerve stimulation principle.
(34) More specifically, as shown in FIGS. **3** and **4**, at least two elements of the first element **114** to the third element **118** may operate simultaneously. Since two or more elements simultaneously irradiate low-level lasers to the treatment site to cause complex photo-biochemical reactions, the treatment effect on the treatment site may be increased further.
(35) In addition, the second elements **116** and the third element **118** may be arranged in a central region **30** of the body portion **110**, and the first elements **114** and the blue LED **112** may be arranged in a peripheral region **20** of the body portion **110**.
(36) In this case, the second elements **116** may be disposed to be spaced apart from both sides of the third element **118**, and the first elements **114** may be arranged to surround the central region **30**, and the LED elements may be arranged in the peripheral region **20** to surround the first elements **114**.
(37) By arranging the laser elements in such a structure, the third element **118** is located on a blood vessel of the user to promote or improve the flow of a specific blood flow, and the remaining first elements **114** and the second elements **116** may more effectively treat pain by irradiating light to the treatment site in a relatively large region.
(38) Meanwhile, as shown in FIGS. **3** and **4**, the body portion **110** may further include a heating portion **130** configured to provide thermal energy to the treatment site for thermal treatment, and the heating portion **130** may include a heat sink **134** configured to absorb heat from the second light irradiating portion, the heating element **132** configured to heat the heat sink **134**, a temperature sensor configured to sense a temperature of the heat sink **134**, and a controller configured to control the heating element **132** according to the temperature of the heat sink **134** by detecting a temperature signal from the temperature sensor.
(39) The heating portion **130** provides thermal energy to the treatment site to expand a blood vessel of the user, improve blood flow, and promote blood circulation, thereby aiding in pain relief.
(40) Here, the heating portion **130** is designed to be heated by the heating element **132** to directly provide thermal energy to the treatment site and may transmit heat generated from the first light irradiating portion **111** and the second light irradiating portion **113** to the heat sink to indirectly transmit additional heat to the treatment site and surrounding portions thereof.
(41) As shown in FIG. **4**, in order to more efficiently transmit heat, the heating element **132** may be designed to be in contact with the heat sink, but the heating element **132** may be designed not to be in contact with the heat sink **134**.
(42) In addition, in order to control the operation mode of the light irradiating portion, the body portion **110** may further include a biometric signal detection sensor **120** installed therein and configured to detect a biometric signal of the user.
(43) In this case, the biometric signal detection sensor **120** may measure electromyogram, electrocardiogram, ballistocardiogram, seismocardiogram, and photoplethysmogram. It is possible to suggest an optimal treatment method for pain perceived by an individual by detecting the biometric signal of the user and quantifying the pain by the biometric signal detection sensor **120**.
(44) In addition, the body portion **110** may include an oscillator **121** therein to apply vibration energy to the treatment site. As the vibration energy is transmitted to the treatment site at the same time as the light treatment, muscles may be relaxed to relieve pain.
(45) Hereinafter, a method of controlling the body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions according to the present invention will be described.
(46) First, user information including body information and indication may be received from a user through a user terminal (S**110**).
(47) In this case, the body information includes at least one of gender, age, height, and weight, and the indication information may include at least one of a type of indication the user is suffering from, a pain site, and a cause and a symptom of the pain.

(48) As described above, since the user information is collected as a database, a server may provide operation mode information optimized to a user's body condition and state.
(49) After the user information is collected from the user, a biometric signal of the user may be detected through a biometric signal detection sensor **120** (S**120**), and this biometric signal and the user information described above are comprehensively considered so that an operation mode of each of light irradiating portions **111** and **113** may be recommended (S**130**).
(50) In the database of the server, biometric signal data of a normal person may be stored. Accordingly, the server may compare and analyze the detected biometric signal with the normal person's biometric signal having body information corresponding to the user. That is, the server may compare the user's biometric signal with a reference range of the normal person to set any one of a plurality of modes as the operation mode, and output the set operation mode to a display of the user terminal.
(51) For example, the biometric signal detection sensor **120** may detect a surface electromyogram signal of the user.
(52) An electromyogram is a biometric signal in which tension generated in a muscle, which is overworked due to excessive exercise or fatigued due to a chronic disease, is detected as an electrical signal and may represent pain caused by musculoskeletal disorders as accurate and objective numerical values.
(53) When voltage or current of the treatment site is detected by the biometric signal detection sensor **120**, the server may calculate an effective value for detecting a representative value of an electromyogram signal frequency.
(54) In another example, the biometric signal detection sensor **120** may be attached to the skin to simultaneously measure electrocardiogram, ballistocardiogram, and seismocardiogram.
(55) The ballistocardiogram is an electrical record of vibrations according to a heartbeat, which is generated by the rise and fall of blood flow when blood is released into the aorta by the contraction of heart, and represents the momentum of blood ejected by the heart.
(56) The electrocardiogram is a recording of an activity current, which is generated in a heart muscle according to the beating of a heart, using an ammeter.
(57) The seismocardiogram is a signal reflecting a physical activity of a cardiovascular system according to a blood flow/blood pressure, contraction/relaxation of a heart, and the like rather than an electrical signal of the heart.
(58) The server may detect and store the biometric signal using at least one biometric signal detection sensor **120**, analyze the detected signal to extract as a specific point, and calculate cardiovascular parameters using the extracted specific point.
(59) More specifically, the server may extract, as the specific point, a point where a slope of the biometric signal is zero and derive at least one of an isovolumic contraction time (ICT), an isovolumic relaxation time (IRT), a left ventricular ejection time (LVET), a pre-ejection period (PEP), and myocardial perfusion imaging (MP1) from the position, interval, amplitude, and frequency of the extracted specific point as the cardiovascular parameters.
(60) When the calculation of the cardiovascular parameters is completed, the server may output the cardiovascular parameters to the user terminal.
(61) More specifically, the plurality of modes may include first to third modes, and the light irradiating portion may include an LED element configured to emit LED light, and a first element **114**, a second element **116**, and a third element **118**, each of which is configured to emit low-level laser light.
(62) When the biometric signal is less than the reference range, the first mode, in which a blue LED **112** and the first element **114** operate, may be set as the operation mode.
(63) When the biometric signal corresponds to the reference range, the second mode, in which the first element **114** and the second element **116** operate, may be set as the operation mode.
(64) When the biometric signal exceeds the reference range, the third mode, in which the second

element **116** and the third element **118** operate, may be set as the operation mode.
(65) When the light irradiating portion operates in the second and third modes, a vibrator operates so that vibration energy is provided to the treatment site, and the vibrator may generate the vibration energy, in which at least one of a vibration period and a vibration intensity is different, in the second and third modes.
(66) When the operation mode is recommended as described above, the user may put the body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions on the treatment site and operate the body-wearable apparatus **100** by setting the operation mode and a treatment time.
(67) Thereafter, when a light treatment is completed, the server may receive a satisfaction index for the light treatment from the user through the user terminal (S**140**). In this case, the server may confirm a change value of the biometric signal of the user before and after the light treatment by continuously monitoring the biometric signal of the user using the biometric signal detection sensor **120**.
(68) Accordingly, the server may analyze the biometric signal of the user and the satisfaction index to calculate a pain relief index (S**150**).
(69) More specifically, the pain relief index may be calculated by adding an addition index according to the biometric signal to the satisfaction index, which is input by the user, when the biometric signal exceeds the reference value, and the pain relief index may be calculated as the satisfaction index itself when the biometric signal is less than or equal to the reference value.
(70) When the pain relief index is greater than or equal to the reference index, the server may maintain the operation mode of the light irradiating portion (S**160**).
(71) On the other hand, when the pain relief index is less than the reference index, the server may receive a problem factor from the user and may reset the operation mode of the light irradiating portion according to the problem factor (S**160** and S**170**).
(72) In this case, the problem factor may include at least one of an intensity of the light irradiating portion and the treatment site.
(73) When the problem factor is the intensity of the light irradiating portion, the server may reset the operation mode so that at least one of an operation time and an output of the light irradiating portion is increased.
(74) When the problem factor is the treatment site of the light irradiating portion, the server may adjust the treatment site of the light irradiating portion according to the user information including at least one of height, weight, age, and gender of the user, thereby resetting the operation mode.
(75) More specifically, acupuncture point information of a human body may be stored in the database. The treatment site may be reset as an acupuncture point located at a peripheral portion of a pain portion is reset according to the pain portion that is input to the user information.
(76) As described above, when the operation mode of the light irradiating portion is reset according to the problem factor, the reset operation mode is output to the user terminal, thereby providing feedback about the problem factor re-input by the user.
(77) On the other hand, a body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions according to another embodiment of the present invention will be described with reference to FIGS. **8** and **9**.
(78) In the case of the body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions according to the present embodiment, there is a difference from the above-described embodiment in that an ultrasonic element is disposed in a central region, and thus, hereinafter, the present embodiment will be described focusing on an ultrasonic element **119** that is different from the above-described embodiment.
(79) As shown in FIG. **8**, a body portion may further include the ultrasonic element **119**.
(80) In addition, second elements **116** and the ultrasonic element **119** may be disposed in a central region **30** of the body portion.

(81) The ultrasonic element **119** may simultaneously or alternately irradiate a plurality of ultrasonic waves having different frequencies to a treatment site.
(82) For example, the ultrasonic element **119** may alternately generate ultrasonic energy of 1 MHz and 3 MHz. For example, the ultrasonic element **119** may irradiate the ultrasonic energy to the treatment site while modulating the frequency at intervals of three seconds.
(83) As the ultrasonic element **119** irradiates the ultrasonic energy of a frequency of 1 MHz to the treatment site, it is possible to perform treatment by stimulating a deep muscle at a depth of 1 cm to 5 cm from a treatment-performing-surface, and as the ultrasonic element **119** irradiates the ultrasonic energy of a frequency of 3 MHz to the treatment site, it is possible to perform treatment by stimulating a superficial muscle at a depth of 0.7 cm from the treatment-performing-surface.
(84) The ultrasonic element **119** described above may be formed to be thin and small in size so as to be installed inside a small device having a relatively small size.
(85) Further, a body-wearable apparatus **100** for treating pain by a principle of complex photo-biochemical actions according to still another embodiment of the present invention will be described with reference to FIG. **9**.
(86) According to the present embodiment, second elements **116**, a third element **118**, and a plurality of ultrasonic elements **119** may be disposed in a central region **30** of a body portion. The ultrasonic elements **119** include a first ultrasonic element **119***a* and a second ultrasonic element **119***b*, and the first and second ultrasonic elements **119***a* and **119***b* may irradiate ultrasonic energy of different frequencies. For example, one of the first and second ultrasonic elements **119***a* and **119***b* may be an ultrasonic element having a frequency of 1 MHz, and the other one may be an ultrasonic element having a frequency of 3 MHz. As another example, the first and second ultrasonic elements **119***a* and **119***b* may be elements capable of irradiating 1 MHz and/or 3 MHz. In this case, the ultrasonic elements **119** independently control each of the first and second ultrasonic elements **119***a* and **119***b* to simultaneously emit 1 MHz or 3 MHz to a human body or alternately emit 1 MHz and 3 MHz to the human body. 1 MHz of the first ultrasonic element **119***a* is used for treatment of deep muscle located at a depth of about 20 mm to 40 mm from a skin surface, and 3 MHz of the second ultrasonic element **119***b* may be used for treatment of superficial muscle located at a depth of about 1 mm from the skin surface. As described above, the ultrasonic element **119** may be provided to enable effective pain treatment by applying ultrasonic energy so as to simultaneously and/or alternately treat the superficial muscle and the deep muscle in a pain region. The ultrasonic elements **119** may be disposed to be spaced apart from both sides of the third element **118** to transmit ultrasonic energy to a large region.
(87) As described above, since a low-level laser and ultrasonic energy that are effective in pain relief and blood flow improvement are complexly irradiated on a treatment site, a treatment effect on a pain site may be further increased so that a user may perform continuous pain treatment and reduce treatment costs even when the user does not directly visit a hospital.
(88) The embodiments of the present invention have been described above. However, it should be noted that those skilled in the art and understanding the present invention may easily suggest other embodiments by addition, modification, and removal of the components within the same spirit, but these are construed as being included in the spirit of the present invention.

Claims

1. A body-wearable apparatus for treating pain by a principle of complex photo-biochemical actions, the apparatus comprising: a body portion in which a plurality of transmission holes are formed so that light is transmitted therethrough; a circuit board disposed inside the body portion; a built-in battery disposed inside the body portion; a first light irradiating portion electrically connected to the circuit board and configured to irradiate blue light-emitting diode (LED) light through the transmission holes of the body portion; and a second light irradiating portion

electrically connected to the circuit board and configured to irradiate low-level laser light through the transmission holes of the body portion, wherein each of the first and second light irradiating portions is provided to cause at least two or more photo-biochemical reactions among cell activation, cell regeneration, cell division, blood flow improvement, vasodilation, cell degradation, and nerve stimulation on tissue in a body part to be treated through simultaneous or alternate light output, wherein the first light irradiating portion comprises a plurality of blue LED elements irradiating the blue LED light having a wavelength range of 440 nm to 460 nm, wherein the second light irradiating portion comprises: a plurality of first elements irradiating low-level laser light having a wavelength range of 630 nm to 680 nm for cell regeneration; a plurality of second elements irradiating low-level laser light having a wavelength range of 800 nm to 850 nm for blood flow improvement; and a third element disposed in a central region of the body portion and irradiating low-level laser light having a wavelength range of 900 nm to 920 nm for treating pain by nerve stimulation, wherein the plurality of the second elements are disposed in the central region of the body portion and disposed adjacent to the third element, wherein the plurality of the first elements are disposed in a peripheral region of the body portion around the central region of the body portion, wherein the plurality of blue LED elements are disposed in the peripheral region of the body portion around the plurality of the first elements, wherein the plurality of the first elements, the plurality of second elements, and the third element operate with the plurality of blue LED elements simultaneously, wherein the plurality of the second elements disposed adjacent to the third element irradiate the low-level laser light having the wavelength range of 800 nm to 850 nm to a periphery of a nerve to which a light treatment by the third element is applied, so as to contribute to treating the pain by improving blood flow through causing vessels to expand to accelerate blood flow, wherein the plurality of the first elements disposed around the third element and the plurality of the second elements irradiate the low-level laser light having the wavelength range of 630 nm to 680 nm to a periphery of the nerve to which the light treatment by the third element is applied and of the vessels to which a light treatment by the plurality of second elements is applied, so as to contribute to treating the pain by activating normal cell regeneration through amplifying a production of ATP cells in mitochondria in a protein cell, and wherein the plurality of blue LED elements disposed around the plurality of the first elements irradiate the blue LED light having the wavelength range of 440 nm to 460 nm to a periphery of tissue to which the light treatment by the plurality of first elements, the plurality of second elements, and the third element are applied, so as to contribute to treating the pain by improving supply of oxygen and nutrients to muscles and reducing pain transmission through promoting generation and circulation of nitric oxide (NO).

2. The apparatus of claim 1, further comprising an ultrasonic element provided in the body portion and controlled to simultaneously or alternately generate at least one ultrasonic energy of 1 MHz and 3 MHz toward a body, wherein the first light irradiating portion, the second light irradiating portion, and the ultrasonic element simultaneously emit light.

3. The apparatus of claim 2, wherein the body portion further includes a heating portion configured to provide thermal energy to a treatment site for thermal treatment, wherein the heating portion includes a heat sink provided to absorb heat from the second light irradiating portion, a heating element configured to heat the heat sink, a temperature sensor configured to sense a temperature of the heat sink, and a controller configured to control the heating element according to the temperature of the heat sink by detecting a temperature signal from the temperature sensor.

4. The apparatus of claim 2, further comprising a biometric signal detection sensor installed in the body portion and configured to detect a biometric signal of a user in order to control an operation mode of the first and second light irradiating portions.

5. The apparatus of claim 1, further comprising an ultrasonic element provided in the body portion and controlled to simultaneously or alternately generate ultrasonic energy for treatment of superficial muscle and ultrasonic energy for treatment of deep muscle, wherein the first light

irradiating portion, the second light irradiating portion, and the ultrasonic element simultaneously emit light.

6. The apparatus of claim 5, wherein the body portion further includes a heating portion configured to provide thermal energy to a treatment site for thermal treatment, wherein the heating portion includes a heat sink provided to absorb heat from the second light irradiating portion, a heating element configured to heat the heat sink, a temperature sensor configured to sense a temperature of the heat sink, and a controller configured to control the heating element according to the temperature of the heat sink by detecting a temperature signal from the temperature sensor.

7. The apparatus of claim 5, further comprising a biometric signal detection sensor installed in the body portion and configured to detect a biometric signal of a user in order to control an operation mode of the first and second light irradiating portions.

8. The apparatus of claim 1, wherein the body portion further includes a heating portion configured to provide thermal energy to a treatment site for thermal treatment, wherein the heating portion includes a heat sink provided to absorb heat from the second light irradiating portion, a heating element configured to heat the heat sink, a temperature sensor configured to sense a temperature of the heat sink, and a controller configured to control the heating element according to the temperature of the heat sink by detecting a temperature signal from the temperature sensor.

9. The apparatus of claim 1, further comprising a biometric signal detection sensor installed in the body portion and configured to detect a biometric signal of a user in order to control an operation mode of the first and second light irradiating portions.

10. The apparatus of claim 1, wherein the body portion further includes a heating portion configured to provide thermal energy to a treatment site for thermal treatment, wherein the heating portion includes a heat sink provided to absorb heat from the second light irradiating portion, a heating element configured to heat the heat sink, a temperature sensor configured to sense a temperature of the heat sink, and a controller configured to control the heating element according to the temperature of the heat sink by detecting a temperature signal from the temperature sensor.