INTELLIGENT ACUPUNCTURE INSTRUMENT WITH LASER AND MICROCURRENT SYNERGISTIC CONTROL AND CONTROL METHOD THEREFOR

TECHNICAL FIELD

The present invention relates to the technical field of acupuncture devices, and particularly, to an intelligent acupuncture instrument with laser and microcurrent synergistic control and a control method therefor.

BACKGROUND

As a core therapeutic modality of traditional Chinese medicine (TCM), acupuncture has been widely recognized as an effective auxiliary comprehensive intervention approach in modern medicine. However, conventional acupuncture therapy relies heavily on the operator's personal experience and technique, presenting issues such as low standardization of treatment, patient fear of needle insertion, and a potential risk of cross-infection.

With the advancement of medical device technology, instruments employing physical energy to simulate the effects of traditional acupuncture have emerged, such as laser acupuncture instruments and electroacupuncture therapeutic apparatuses. Laser acupuncture instruments utilize low-energy laser irradiation at specific wavelengths on acupoints to produce photobiomodulation effects, offering the advantages of being painless and non-invasive. Electroacupuncture therapeutic apparatuses, on the other hand, apply microcurrents to acupoints via electrodes to simulate the "de qi" sensation of acupuncture. The two types of devices have achieved a certain level of standardization and replicability in treatment.

However, current physiotherapy devices still exhibit significant limitations. Firstly, most devices offer a single functionality, providing only one form of energy, either laser or electrical stimulation, and thus fail to simulate the combined treatment concept of "acupuncture and moxibustion applied together" as practiced in clinical TCM, resulting in a therapeutic efficacy ceiling. Secondly, existing devices are predominantly "open-loop" systems. The output parameters (e.g., power, intensity, duration) of these systems rely on preset operator inputs and cannot be dynamically adjusted during treatment based on the real-time physiological state of the patient's treatment site, lacking precision and personalization. Finally, the treatment logic of such devices is largely based on modern physical parameters and fails to systematically incorporate the philosophy of syndrome differentiation and treatment from TCM, resulting in a weak

connection with the theoretical foundations of traditional acupuncture.

Therefore, there is an urgent need in the industry for a novel intelligent acupuncture device capable of integrating multiple forms of physical energy and intelligently adjusting treatment based on real-time feedback, allowing for a more comprehensive simulation of the therapeutic essence of traditional acupuncture under non-invasive conditions and a further enhancement of therapeutic efficacy and clinical adaptability.

SUMMARY

To solve the problems raised in the above background, an objective of the present invention is to provide an intelligent acupuncture instrument with laser and microcurrent synergistic control.

To realize the above objective, the present invention provides an intelligent acupuncture instrument with laser and microcurrent synergistic control, including a host machine and a handheld treatment probe, in which:

the handheld treatment probe is internally equipped with:

a laser emission module, configured to emit a laser toward a treatment site;

a microcurrent stimulation module, configured to output microcurrent to the treatment site; and

a biosensing module, configured to collect impedance signals of tissue at the treatment site in real time;

a control module is arranged inside the host machine, and is connected to the laser emission module, the microcurrent stimulation module, and the biosensing module, respectively; and

the control module is configured to dynamically adjust output parameters of the laser emission module and the microcurrent stimulation module according to a preset synergistic rule and in combination with the impedance signals collected in real time, to realize closed-loop synergistic control.

Preferably, the laser emission module includes a laser diode, a drive circuit, and an optical lens.

Preferably, the microcurrent stimulation module includes a constant current source circuit, a waveform generator, and a pair of surface electrodes.

Preferably, the biosensing module includes an impedance analysis unit and a pair of detection electrodes, and the impedance analysis unit is configured to measure impedance by

applying a high-frequency detection signal.

Preferably, the preset synergistic rule for the control module includes a temporal synergistic rule and a feedback synergistic rule; the temporal synergistic rule is configured to control the laser emission module and the microcurrent stimulation module to operate alternately according to a preset non-overlapping time sequence; and the feedback synergistic rule is configured to adjust output parameters of the laser emission module and the microcurrent stimulation module based on changes in the impedance signals collected in real time.

Preferably, at least one treatment mode formulated based on the principle of syndrome differentiation and treatment in TCM is pre-stored in the control module; and the preset synergistic rule is a programmatic rule that is defined and solidified within the selected treatment mode.

A control method for an intelligent acupuncture instrument with laser and microcurrent synergistic control includes the steps of:

S1, collecting, by a biosensing module, a tissue impedance signal of a treatment site in real time;

S2, generating a synergistic control signal according to a preset synergistic rule and in combination with the impedance signal; and

S3, performing, based on the synergistic control signal, coordinated adjustment on output parameters of a laser emission module and a microcurrent stimulation module.

Consequently, the present invention, by employing the aforementioned intelligent acupuncture instrument with laser and microcurrent synergistic control and the control method therefor, has the following beneficial effects.

1. By integrating laser and microcurrent according to a preset synergistic rule and incorporating built-in TCM treatment modes as its operational framework, the instrument translates the combined techniques of "needling" and "moxibustion" from traditional acupuncture, along with the principle of syndrome differentiation and treatment, into precisely executable programmed energy output. This simulates the core effects of traditional therapies under non-invasive conditions, thereby enhancing treatment standardization and the predictable stability of therapeutic efficacy.

2. In the present invention, a closed-loop synergistic control system is established by introducing biological impedance signals as real-time feedback. The device is capable of

dynamically adjusting output parameters based on the immediate physiological state of the treatment site, effectively reducing reliance on operator experience and operational uncertainty during treatment, thereby rendering the therapy more targeted and safer.

The technical solutions of the present invention are further described below in combination with the embodiments and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an overall configuration of an intelligent acupuncture instrument with laser and microcurrent synergistic control according to the present invention.

FIG. 2 is an overall schematic structural diagram of the intelligent acupuncture instrument with laser and microcurrent synergistic control according to the present invention.

FIG. 3 is a flowchart of a control method of the intelligent acupuncture instrument with laser and microcurrent synergistic control according to the present invention.

DETAILED DESCRIPTION

The detailed description of the embodiments of the present invention provided in the accompanying drawings is not intended to limit the scope of the claimed invention, but is merely representative of selected embodiments of the present invention. Based on the embodiments of the present invention, all other embodiments obtained by those of ordinary skill in the art without creative effort fall within the scope of protection of the present invention.

Embodiment

As shown in FIGS. 1 and 2, the present invention provides an intelligent acupuncture instrument with laser and microcurrent synergistic control. The intelligent acupuncture instrument includes a host machine and a handheld treatment probe, which are connected via a detachable cable or wireless connection. The host machine incorporates a built-in power source and core processing circuitry, while the handheld treatment probe integrates all components for direct interaction with the treatment site.

The casing of the handheld treatment probe is fabricated from medical-grade insulating material. Its front end forms an integrated treatment head, which internally houses the following modules.

A laser emission module is configured to emit a laser towards the treatment site. It includes a laser diode, a drive circuit, and an optical lens. The drive circuit receives adjustment signals from the control module to provide a constant power drive for the laser diode. The laser diode

preferably emits visible red light with a central wavelength of 650 nm (with a range of 630-670 nm). An optical lens (e.g., a plano-convex lens with a focal length f=10 mm) is positioned in front of the laser diode to focus/collimate the emitted laser beam into a uniform spot with a diameter of approximately 3-5 mm, which exits from the light output window at the probe's front end.

A microcurrent stimulation module is configured to output microcurrent to the treatment site. It includes a constant current source circuit, a waveform generator, and a pair of surface electrodes. The waveform generator (e.g., a digital-to-analog converter (DAC)-based chip) can generate bidirectional pulsed waves (such as square waves or dense-sparse waves) with a frequency range of 1 Hz-100 Hz and adjustable amplitude. The constant current source circuit receives the waveform signal and converts it into a strictly consistent, load-independent constant safe current (e.g., 0.1-2.0 mA), which is output via a pair of medical-grade stainless steel surface electrodes embedded at the probe's front end, each having a diameter of approximately 5 mm.

A biosensing module is configured to collect impedance signals of tissue at the treatment site in real time. It includes an impedance analysis unit and a pair of detection electrodes. The impedance analysis unit is configured to measure impedance by applying a high-frequency detection signal.

A control module is arranged inside the host machine. In this embodiment, the control module employs a controller, which is connected to the laser emission module, the microcurrent stimulation module, and the biosensing module, respectively. The impedance analysis unit employs a four-electrode method or a multiplexed two-electrode method for measurement. A safe, high-frequency (e.g., 50 kHz) weak alternating-current (AC) detection signal is applied to the tissue via one pair of detection electrodes, while the responsive voltage is measured across the same pair or another pair of electrodes. Through processes such as demodulation, amplification, and calculation, a complex impedance magnitude or resistive component reflecting the tissue state is obtained. The detection electrodes and the therapeutic surface electrodes are arranged spatially adjacent to each other.

The control module is configured to dynamically adjust output parameters of the laser emission module and the microcurrent stimulation module according to a preset synergistic rule and in combination with the impedance signals collected in real time, to realize closed-loop synergistic control.

The preset synergistic rule in the control module includes a temporal synergistic rule and a feedback synergistic rule. The temporal synergistic rule controls the laser emission module and the microcurrent stimulation module to operate alternately according to a preset non-overlapping time sequence. For example, the control module may first activate the laser emission module to operate for 60 seconds, pause for 2 seconds after completion, and then activate the microcurrent stimulation module to operate for 180 seconds. The feedback synergistic rule adjusts the output parameters of the laser emission module and the microcurrent stimulation module based on changes in the impedance signals collected in real time. For instance, a rule may be set as follows: using the impedance at the start of treatment as a baseline, if the real-time impedance decreases by more than 15%, it is determined that tissue permeability has improved, and the microcurrent intensity is increased by 20%; if the real-time impedance increases, the current intensity is maintained or slightly reduced.

At least one treatment mode formulated based on the principle of syndrome differentiation and treatment in TCM is pre-stored in the control module, and the preset synergistic rule is a programmatic rule that is defined and solidified within the selected treatment mode.

As shown in FIG. 3, a control method for an intelligent acupuncture instrument with laser and microcurrent synergistic control includes the following steps:

In S1, a tissue impedance signal of a treatment site is collected in real time by the biosensing module.

In S2, a synergistic control signal is generated according to a preset synergistic rule, in combination with the impedance signal.

In S3, based on the synergistic control signal, coordinated adjustment of output parameters of the laser emission module and the microcurrent stimulation module is performed.

Therefore, by employing the aforementioned intelligent acupuncture instrument with laser and microcurrent synergistic control and the control method therefor, the present invention translates TCM treatment principles into programmable preset modes, integrates the synergistic control of laser and microcurrent, and incorporates real-time feedback based on bioimpedance, thereby establishing an intelligent acupuncture system capable of delivering personalized, precise, and non-invasive treatment.

Finally, it is to be noted that the above embodiments are only used for stating the technical solutions of the present invention, but are not a limitation. Although the present invention has

been described in detail with reference to the preferred embodiments, it is to be understood by those of ordinary skill in the art that modifications or equivalent replacements to the technical solutions of the present invention may still be made without departing from the spirit and scope of the technical solutions of the present invention.