808nm High-Power Semiconductor Laser Therapeutic Apparatus Based On LPC2138

Biao Wang*
Changchun Institute of Optics Fine Mechanics and Physics
Chinese Academy of Sciences
Changchun, China
E-mail: wb5996@163.com

***Abstract*—In this paper, we designed an intelligent 808nm high-power semiconductor laser therapeutic apparatus with the LPC2138 ARM processor. The laser is driven by the digital constant current source module, and the apparatus has good human-machine interaction performance on account of set the parameters intelligently. The function such as operation mode, output power, output pulse width and pulse cycle could be easily set through the TFT touch screen. The application software could transmission the log data to the computer by the USB interface in order to check and study the records later.**

Keywords-LPC2138; 808nm; High-Power; Semiconductor Laser Therapeutic Apparatus

I. INTRODUCTION

At present, the laser therapeutic apparatus is one of the medical equipment which be introduced rapidly by hospital due to the widely applied in ophthalmology, surgery, gynecology, cardiovascular division, skin, and other fields of disease treatment[1]. The semiconductor laser has be paid much attention in the laser therapeutic apparatus because of small size, light weight, high efficiency, low cost, long life, easy to transmission with the optical fiber and other advantages[2]. Therefore, the semiconductor laser has very broad application and development prospect. However, the laser therapeutic apparatus in our country hospital are mostly dependent on import which is not only high price, but also inconvenience for maintainability.

In order to change the current situation which the laser therapeutic apparatus is dependent on import, and replace the imported products with the independent research and development products. We developed a new kind of laser therapeutic apparatus which used 808nm high-power semiconductor laser as the core, and LPC2138 as the central processor. 808nm laser has widely attention in the research and development in medical instruments due to the advantages as weak absorption of water, strong absorption of melanin and hemoglobin and moderate depth of penetration organization. Compared with other types of microprocessor, LPC2138 as a new type of ARM microprocessor has many advantages such as rich peripherals interface, high efficiency and stability, easy to implement the complex task and especially suitable for application in laser therapeutic apparatus which need multitasking occasion.

II. SYSTEM DESIGN

Laser therapeutic apparatus is composed of LPC2138 main control module, laser digital constant current source modules, touch screen human-machine interactive module and computer software. The apparatus has a variety of laser output mode configuration, intelligent setting function for output laser parameters, control function for the output laser time, storage function for save the medical log data and transfer function for upload the log data to computer via USB. Figure 1 Shows the Product Photo of “808nm High-Power Semiconductor Laser Therapeutic Apparatus”, of which each function indexes reach or exceed the technology level of imported similar products.

The block diagram of 808nm high-power semiconductor laser therapeutic apparatus shown in figure 2, LPC2138 as the main controller, use the digital constant current source to driver 808nm semiconductor laser module, the TFT touch screen as human-machine interaction module which is used to set the laser operate parameters and other functions. The apparatus has FLASH storage function which used for the storage log data of treatment. At the same time, Apparatus has a micro-printer to meet the printing needs for log data of treatment. It could transfer the log data to computer through USB data communication module, and with the application software for doctor check and research the treatment log data.

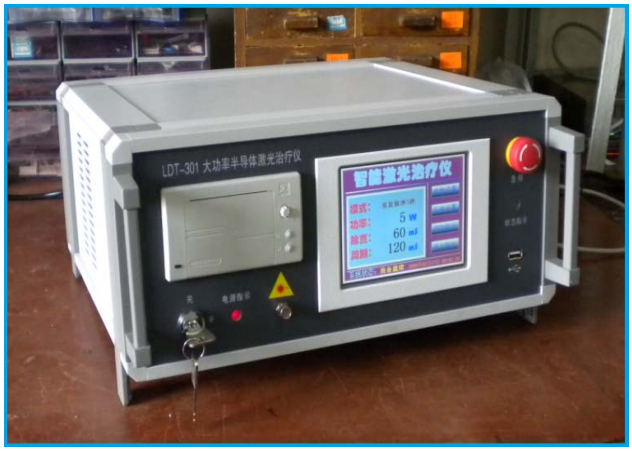

Figure 1.Product Photo of 808nm High-Power Semiconductor Laser Therapeutic Apparatus

978-0-7695-4623-0/11 $26.00 © 2011 IEEE
DOI 10.1109/ICBMI.2011.2

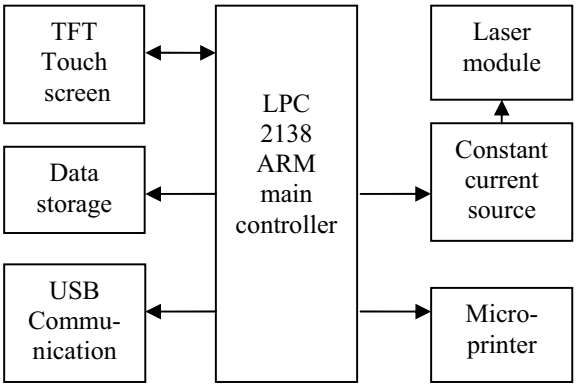

Figure 2. System block diagram of laser therapeutic apparatus

III. HARDWARE DESIGN

A. *Laser module*

This semiconductor laser therapeutic apparatus combined six 5W single-tube lasers to a 808nm high-power laser that the maximum output power up to 30W[3]. In the design, the single-tube lasers are installed by ladder-shaped distribution in the heat sink, use of non-spherical micro-cylindrical lens for fast axis beam collimation and spherical cylindrical lens for slow axis beam collimation[4]. To realize the focus of the fast and slow axis through the two groups of cylinder lens, and the laser beam are coupled into the fiber with the core diameter is 200um and numerical aperture is 0.22 to output at last[5]. Figure 3 shows the characteristic curve of the laser module, curve A shows the laser current and the output power relation, and curve B is the voltage-current characteristic of the laser. From the chart we could see that the laser threshold current if 0.5A, the maximum output power is 30W, the rated current is 5.17A and the rated voltage is 11.29V.

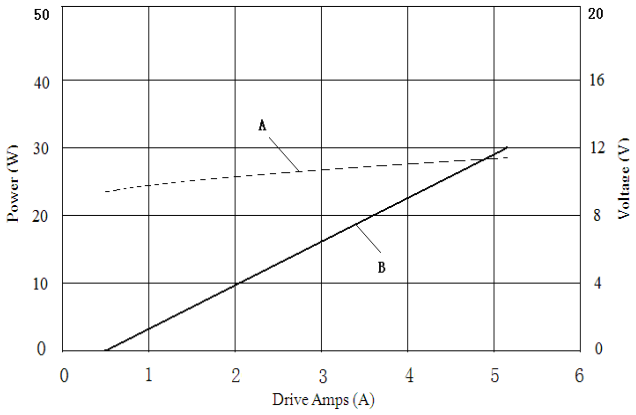

Figure 3. Characteristic curve of 808nm High-Power Semiconductor Laser

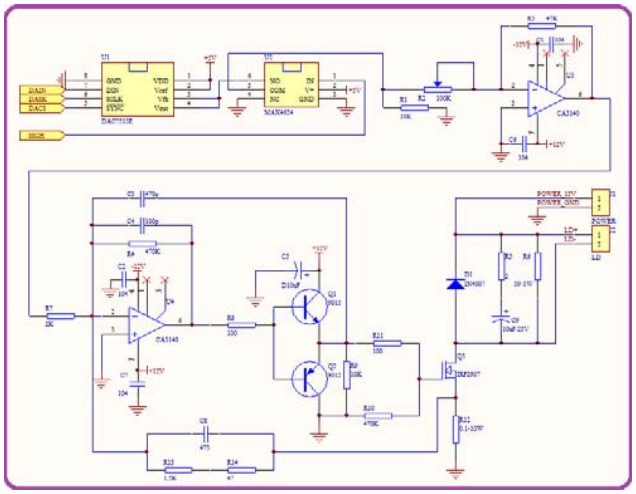

Figure 4. Schematic diagram of Digital controlled constant current source module

B. *Digital controlled constant current source module*

High-power semiconductor laser generally uses the constant current driving mode[6]. For the convenience of control laser power output, this apparatus used the digital constant current source driver and the schematic diagram is shown in figure 4.

The main microprocessor LPC2138 controls the DAC7513E(U1) which is 12 bit digital-analog converter to output 0-5V digital controlled voltage signal through SPI interface with the pin DAIN, DASK and DACS. This voltage signal are input to high-speed analog switch MAX4624(U2) and be controlled by a GPIO pin SSCH of LPC2138 to make the output voltage signal on or off[7]. So we could get a digital controlled voltage signal with variable of output voltage, period and duty-cycle.

The digital controlled voltage signal is input to the MOSFET IRF2907(Q3) through the voltage-current convert circuit by two amplifier CA3140 (U3 and U4). By changing the open and close degree of MOSFET to control the current of laser (J2), and then control the laser output power. Thus, by the program set of LPC2138 we could make the laser output power, pulse width and duty-cycle to produce various kinds of laser output mode to treatment different diseases.

IV. SOFTWARE DESIGN

Apparatus system software used TFT touch screen as the human-machine interaction[8], and designed a graphics library software system named "CUST-GUI V1.02" to complement the multiple operation.

Figure 5 shows the main operating menu of this laser therapeutic apparatus, including main menu (Figure 5A), parameter setting menu (Figure 5B) and system setting menu (Figure 5C). On the left side of the main menu is the laser working combination parameter display frame, including laser operate mode, output power, pulse width and duty-cycle. On the right side are four control buttons, by click those could enter into next level menu of parameter

(A) (B) (C)

Figure 5. Main menu of laser therapeutic apparatus

setting or menu of system setting, or control the laser output start or stop. At the bottom of the main menu is the system status bar which used to display the current system status and time.

Parameter setting menu is one of the second level menu of the system. It has four options for laser operate parameter setting, they are laser operate mode, laser output power, pulse width and duty-cycle. Among them, laser operate mode setting menu include operation mode setting and output laser time setting, and we could get different laser output mode through the combination of the different parameter setting.

The system setting menu is the other second level menu of the system, including data transmission, file management, system time setting and version information. The four three level menu function are shown as follow: the data transmission menu is used to transfer the log data of treatment to computer through USB interface, the file management menu is used to show, check and print the log data of treatment, the system time setting menu is used to adjust the real time of the whole system, the version information menu is used to display some information of the system software about the apparatus such as the software version and instructions for use.

V. CONCLUSION

The apparatus was designed user-friendly using TFT touch screen and self-developed "CUST-GUI V1.02" graphics library software system. It has USB communication, data storage and printing functions, convenient operation and easy to use. This apparatus has many advantages such as high electro-optical conversion efficiency, small size and lower operating cost. At present, it has completed dental-related clinical trials in the Second Hospital of Jilin University, and the investigations in our study showed that irradiance of 15.5W and exposure time of 5s per spot in continuous output mode for 808nm diode laser seemed to be an appropriate choice for laser skin welding. The performance of this apparatus indicators have met or exceeded the level of similar imported products, and the cost is only 1/3 of the imported products. Therefore, the laser therapeutic apparatus has extensive market and application prospect in our country.

ACKNOWLEDGMENT

This work is supported by the Key technology development plan project of Jilin, China (Project No. 20100352)and Special scientific research project of Suzhou Institute of Biomedical Engineering and Technology (SIBET), Chinese Academy of Sciences (CAS) (Project No. 091901L090). The author thanks Miss Wenbo Wang for her help during the experiments, and also thanks the editor and reviewers for their comments and suggestion.

REFERENCES

[1] LI Y H, HU L M. “New Application and Progress of Semiconductor Lasers in Medical Field”, OME Information, vol. 27, pp. 27-34, July，2010.

[2] ZOU W D, WEI S Q, CHEN M, FANG W Q, ZHOU R G. “Design of a High Power Diode Laser Therapeutic Instrument”, APPLIED LASER, Vol.22，pp.415-418, August，2002.

[3] SHAN X N, LIU Y, CAO J SH.“808nm kW-output high-efficiency diode laser sources”, Opt. Precision Eng., Vol.22，pp.452-456, February，2011.

[4] WANG Y, ZHANG Y, QIN L, LIU Y, WANG L J.“Measurement of packaging-induced strain in high power diode laser bar”, Opt. Precision Eng., Vol.18，pp. 1951-1958, September，2010.

[5] WANG X P, LIANG X M, LI Z J, WANG B B, WANG L J.“880 nm semiconductor laser diode arrays and fiber coupling module”, Opt. Precision Eng., Vol.18，pp. 1021-1027, May，2010.

[6] CONG M L, LI L, CUI Y S, ZHANG ZH Q,WANG Y D.“Design of high stability digital control driving system for semiconductor laser”, Opt. Precision Eng., Vol.18，pp. 1629-1636，July，2010.

[7] ZHANG P L,SHI Y SH,SHI Y H,YIN X L.“Research Status and Progress of High Power Backlight LED Driving Circuit”, Chinese Journal of Liquid Crystals and Display, Vol.25，pp. 68-74，February，2010.

[8] SH J G, DENG CH J.“Design of Serial TFT-LCD Display Terminal Based on Two-Stage Driving”, Chinese Journal of Liquid Crystals and Display, Vol.26，pp. 73-77，February，2011.