ELECTRONICAL SYSTEM FOR IRRADIATION OF BIOLOGICAL TISSUES

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Abstract **Reduction of the postoperative time, acceleration of wound healing, stimulating the regeneration processes, acceleration of wound healing - are questions that interested physicians all the time. In addition, patients would be appreciate if they were discharged earlier.**

Fortunately was noticed an effect of acceleration of cell division under influence of light with certain wavelengths.

We decided to create a device, which would allow controlling the procedure of illumination. This device permits controlling of light power, form of pulse, time of procedure.

Nowadays, device is under test in laboratory, where some sell cultures are exposed to illumination. After procedure, some key parameters of biological materials are measured. We expect some positive results.

Index Terms **— infrared light, led-matrix, light therapy, low power laser therapy, medical device.**

I. INTRODUCTION

This paper gives brief description of device for irradiation of biological tissues. Is describes main concept, basic elements of the system, and technical parameters.

II. DESCRIPTION

Reducing the duration of post-operation regeneration, namely biological tissues regeneration – is a permanent concern for practical medicine, as well as for fundamental science. Both of them are trying to reveal general regularities of regeneration process. Actual and previous research confirm confirms the need for application of irradiation within a large range of wavelengths, which can elucidate this vitally important for the human body process. [1,2]

Device for controlled irradiation of biological tissues performs the following requirements:

- Possibility of choosing the power of irradiation within wide limits;
- Possibility of setting the duration of irradiation procedure;
- Possibility of setting the regime of irradiation (with constant power level, with variable power level);
- Possibility of programming the procedure beforehand, which gives the opportunity to use the device without human participation.

Developed device allows in a user-friendly mode to select irradiation intensity, duration of procedure, calculates the dose of emitted energy and measures the temperature of the irradiated surface using contactless pyrometric method.

As a light-emitter LED are used. This allows to make the device more compact, lightweight and economical. Also, the possibility of LED-panel replacement. Thereby user gets an opportunity of changing the panels from a big range of LED- matrices with different wavelengths. Moreover, it is not necessary to change the module of control and power supply unit, changing the light-emitting panel.

Now, two wavelength modules are available to the user (950 nm and 650 nm, red and infrared parts of the spectrum). Panels have the area of 105 cm2, and radial intensity 1 W/sr.

On the basis of the optical model of skin tissue, the distribution of absorbed light power by unit volume of tissue and blood, were calculated conditions for multiple power distribution for different structural tissues and biophysical parameters. Modeling is based on the equation of radiative transfer. The modeling results show that it is possible to control the amount of energy absorbed at different depths of bio tissue by selecting an appropriate wavelength of radiation. This can be used for selectively and directed to certain depths influence, thereby increasing the efficiency of the procedure.

Results of studies of the irradiation effect on biological tissues showed that low-level light therapy of red and infrared spectrum accelerates the process of tissue regeneration, reduces the rehabilitation and contributes to wounds cicatrisation.

III. DEVICE TECHNICAL CARACTERISTICS

Main technical characteristics of device are following:

- Light wavelength - 640/950/860
- Radiation power - 0 - 1W
- Power supply type - 220V; 2A;
- Work-mode C - irad. const.
- Work-mode P - irad. pulsat.
- Impulse form for mode P:
  - sine, pulse,
  - sawtooth, (managed)
- Working frequency for mode P: 0 – 20 kHz
- LCD display - alfanumeric 16x1
- Keyboard - 4x3

Device consists of two main parts: light-emitter (LED-array) and the control module.

LED-array serves as light emitter (fig.1). It is designed to be compact, easy to use, easy to replace.

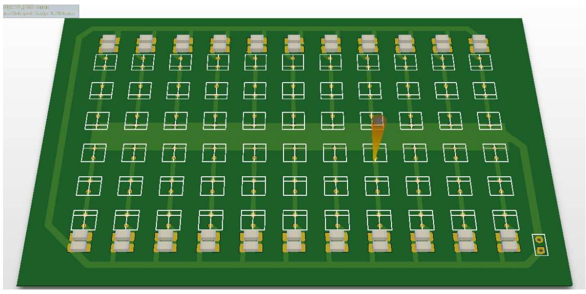

Fig. 1. LED matrix

TABLE I. EMITTER MAIN CARACTERISTICS

Parameter	Value
Forward voltage	1.5 V
Temperature coefficient of V_f	-1.8 mw/K
Reverse current	10 uA
Junction capacitance	125 pF
Radiant intensity	180mW/sr
Radiant power	50 mW
Temperature coefficient V_e	-0.35 %/K
Angle of half intensity	±10 deg
Peak wavelength	850 nm
Spectral bandwidth	40 nm
Temperature coefficient λ_p	0.25 nm/K
Rise time	20 ns
Fall time	13 ns
Cut-off frequency	18 MHz

Another part of device is control part. This part consists of: current regulator, microprocessor unit, LCD, keyboard. This part provides to user comfortable way to work with device and to manage the process of irradiation.

For every sub-module is designed and wrote software driver. (Fig. 2) Every driver was tested. The whole system was subjected to unity tests.

Also, was applied concept of «local» micro-services, i.e. every driver works like a separate system. And only the external interface (api) is available for interaction.

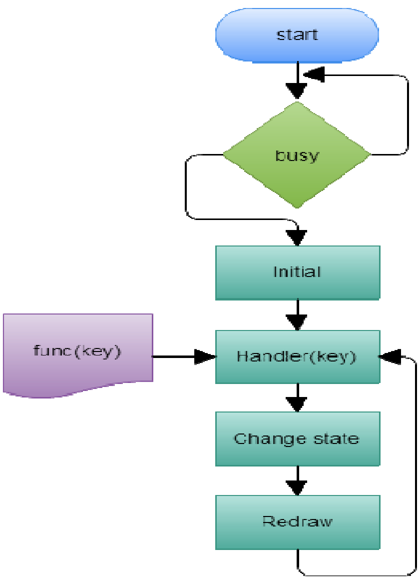

Fig. 2. Flow-chart for LCD-driver

All algorithms are written in C++, using modern concept of programming: Object-Oriented Programming. This concept provides good opportunities of continuous development, integration and easy support.

Due to the fact that we aspired to do our device cheap and compact we used small display. This creates some problems with user interface. It is difficult to make user interface informative, intuitive, clear, and easy to use. (Fig.3)

However, user interface was implemented. It is not fully intuitive, but it's really easy to be accustomed to use it.

Fig. 3. Control module. Example of user interface.

IV. CONCLUSION

Final phase of our work is laboratory investigation of effects provided by light action. Preliminary results show that infrared light positive influence on cellular division. However it is very important to make very attentive and careful study, not to provoke cancerous cell division.

Also, it would be interesting to continue studies not only with IR light, but with ultraviolet as well. It's known antibacterial effect of ultraviolet spectrum of light. It is possible, that selective influence of certain wavelengths would intensify regeneration process.

V. ACKNOWLEDGMENT:

This work is financially supported by the Supreme Council for Research and Technological Development of the Academy of Sciences of Moldova, Project No. 13.820.19.04/BA and by the Belarus Republican Fund for Basic Research according to Project No. F13MLD-018.

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