Development of a Light Source Layout for a New Method for Multispectral Image Processing of Skin Neoplasms

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Annotation

The necessity of developing a special light source for a new method of multispectral image processing of skin neoplasms is substantiated. An optical scheme of the developed light source is given, as well as a block diagram for its implementation. The selection of the main components, as well as checking their performance.

Introduction

1. Currently existing methods for diagnosing malignant neoplasms have a number of disadvantages and cannot meet all the requirements for their determination, and according to the compiled general structure of oncological morbidity in the Russian Federation, skin cancer is the leading one (10.9%).
2. An urgent problem to solve is the loss of part of the information due to the limited wavelength range on which the measurements are made.
3. One of the ways to eliminate this problem is the development of a new method for digital multispectral image processing of skin neoplasms.
4. This is ensured, through the use of a special light source that allows you to control the wavelengths necessary for the study of ZNK.

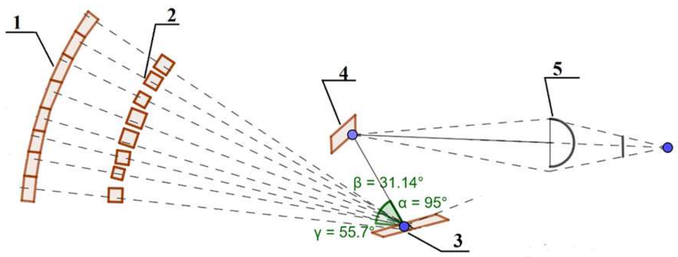

Fig 1. Optical scheme of the light source

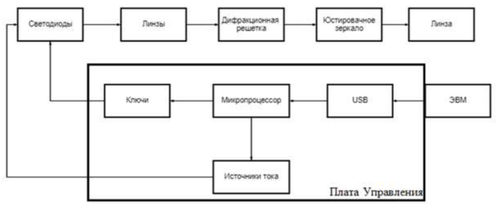

Fig. 2. Structural diagram of the light source layout

Methods and materials

1. The main task is the formation of a light beam with a program-controlled spectrum. The signal coming from the computer switches the spectral intervals of illumination of the object under study. Through the expander, this beam illuminates it, and the required image is captured by the camera. The resulting sequence of monochrome images is processed on a computer.
2. The light source layout consists of 16 LEDs located along the radius from the center of the diffraction grating. At a focal distance from them, there are lens segments that form beams of collimated light. After diffraction, the light flux from all LEDs propagates in the direction of 95 degrees to the plane of the diffraction grating and hits the lens that forms a converging light beam. Switching the wavelength is carried out by applying current to the selected LED.

Calculations

These are the power calculations, confirming the performance of the product compared to the experimental results.

$$P = 4 \times \pi \times Pem \times sin2\,(\varphi/2) \quad (1),$$

where φ is a diffraction angle, calculated as:

$$d(sin\,\varphi - sin\,\varphi') = k\,\lambda \quad (2)$$

Measured power values:

To lens segment: P=5.2 mW

After lens segment: P=0.038 mW

After grating: P=0.016 mW

Table 1. Values of diffraction angles

λ, nm	φ, ◦	λ, nm	φ, ◦
727	31.0813	941	43.9376
780	34.0727	990	47.2687
834	37.2335	1047	51.4307
887	40.4703	1100	55.6742

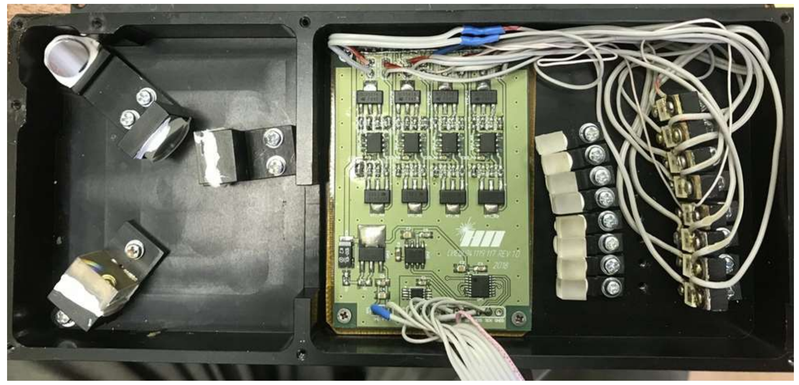

Fig 3. Assembled layout

Conclusion

Thus, a special light source with a program-controlled spectrum in the wavelength range of 700-1100 nm has been developed. The functioning of the developed layout was tested, confirming its operability. The work contributes to the development of the method of multispectral image processing of skin neoplasms, and the obtained structure of the light source model is the first stage in the design of an experimental sample of a device that implements multispectral diagnostics of LNV..

References

1. Ed. HELL. Kaprina, V.V. Starinsky, A.O. Shakhzadova. Malignant neoplasms in Russia in 2020 (morbidity and mortality) - M.: MNIOI im. P.A. Herzen - branch of the Federal State Budgetary Institution "NMITs Radiology" of the Ministry of Health of Russia, - 2021 - ill. – 252 p.
2. H. Sung. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries / H. Sung, J. Ferlay, RL Siegel // CA Cancer J. Clin. - 2021. Vol. 71(3). - P. 209–249.
3. Solodyankina T.N. Dermoscopy as a method for diagnosing skin melanoma / T.N. Solodyankin. – Vladivostok; Publishing house of Vlaivostok State Medical University, 2009. - 4
4. Zhao, J, Lui, H. Real-time Raman spectroscopy for automatic in vivo skin cancer detection: an independent validation/ Zhao, J, Lui, H., Kalia, S., Zeng, H // Analytical and Bioanalytical Chemistry. - 2015.Vol. 407.-P. 8373–8379.
5. Bratchenko I. Combined Raman and autofluorescence ex vivo diagnostics of skin cancer in near infrared and visible regions/ Bratchenko I., Artemyev D., Myakinin O. // J. Biomed. Opt. - 2017. Vol. 22(2). - P. 027005.
6. Zaichenko K.V., Gurevich B.S., Kiseleva K.R. Experimental substantiation of the spectrophotometric method for analyzing the nature of skin neoplasms // Proceedings of the International Scientific and Practical Conference “Actual Problems and Innovative Technologies in the Field of Natural Sciences”. Tashkent. Uzbekistan. Volume-2. 2020. P.520-524

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