OPTICAL METHOD OF THE DETECTION OF SOME TUMORS

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The presented optical method of an early detection and a diagnostics of tumors is a modern technologically advanced system of assessing displasy of tissues and cancer modifications of the skin and in cavities of a human body. The idea of the functioning of this system is based on a spectrum analyses in the visible range of light emitted by the investigated tissues after they have bee excited by radiation at suitable wavelengths. The investigated tissues were early submitted to photosensitive effects. The elaborated system makes if possible to diagnostic of the surface of the skin and tissues inside the body by means of an optical fiber endoscope with an adequate elaborate fitting module. The spectral analysis of photoluminescent light emitted by the tested tissues permits to acieve pseudocoloured pictures which provide information about the level of displastic and cancer changes.

Keywords: cancers detection, optical biopsy, photodynamic therapy, pattern recognition methods

1. INTRODUCTION

An early detection of a cancer illness decides about the effectiveness of its therapy [1-3]. The shortening of diagnostic processes permits earlier therapeutic decisions. Looking for methods of earlier detections of tumors has made three scientific polish groups, viz.: the Centre for Laser Diagnostic and the Therapy at Medical University of Silesia, the Institute of

Physics at Silesian University of Technology and Institute of Medical Technology and Equipment ITAM to elaborate a system for surface tissues diagnostics by means of optical biopsy.

In result of cancerogenesis processes in cancer cells specific chromothophores are accumulated, which are not present in proper cells and tissues [4,5].

It is characteristic that the chromothophores are accumulated in various levels of cancerogenesis.

Own investigations have shown that a spectral analysis of fluorescence can make it possibile to classify testing tissues into tree groups, viz. as: unchanging, precancerious and cancerious. Optical biopsy permits to differentiate the intensity of displasy and may be much more sensitive than histopatological tests.

2. THE IDEA OF THE DETECTION OF CANCER TISSUES

The rule of operation of the elaborated method is based on the difference between the spectra of healthy and cancer tissues.

The measuring system consists of an optical and mechanical coupling system for testing of the skin and an additionally of the optical fiber endoscope for testing the cavity of body tissues, an UV illuminator, a programmable optical filter, an optical amplifier, a CCD high sensitive transducer (camera) and a computer with an adequate, specially elaborated numerical program (Fig. 1).

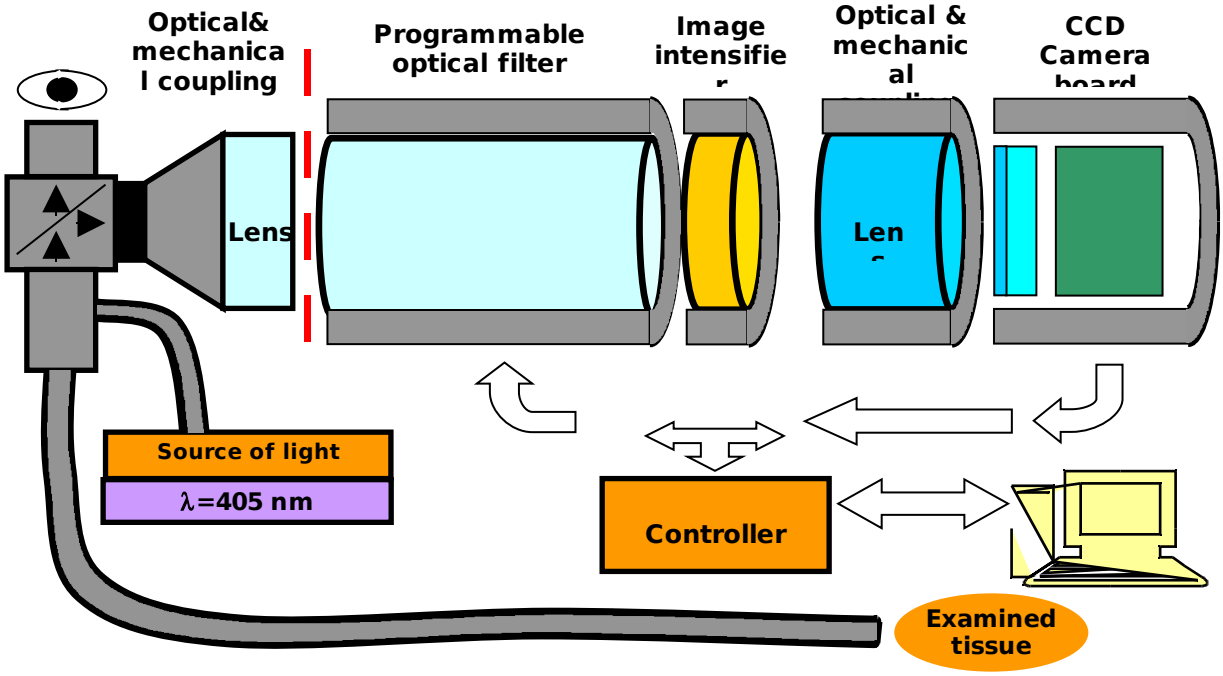

Fig. 1 The idea of the spectrometric method for an early detection and diagnostics of tumors.

By means of a CCD transducer series of pictures of the tested tissues are obtained. Each picture is formed for adequate wavelength of photoemitted light, determined with the using the programmable optical filter, in the λ range: 575 - 645 nm, by 5 nm step). Those pictures use of saved in the computer memory and next programmably analyzed. The same points from all the pictures obtained for different wavelengths are analyzed and next for each point its spectral characteristic (Fig. 2 and Fig. 3) is formed.

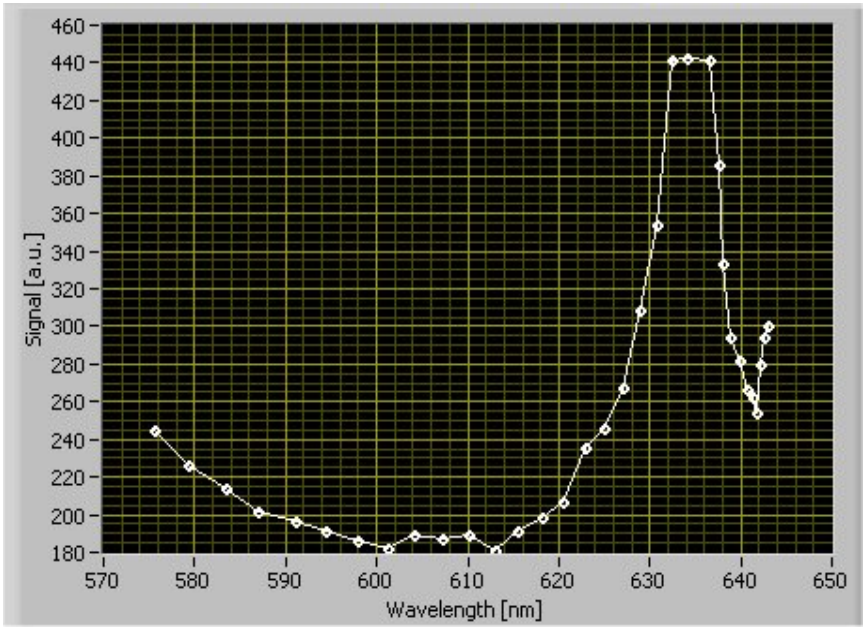

Fig. 2 The averaging spectral characteristics of the point with cancer changes.

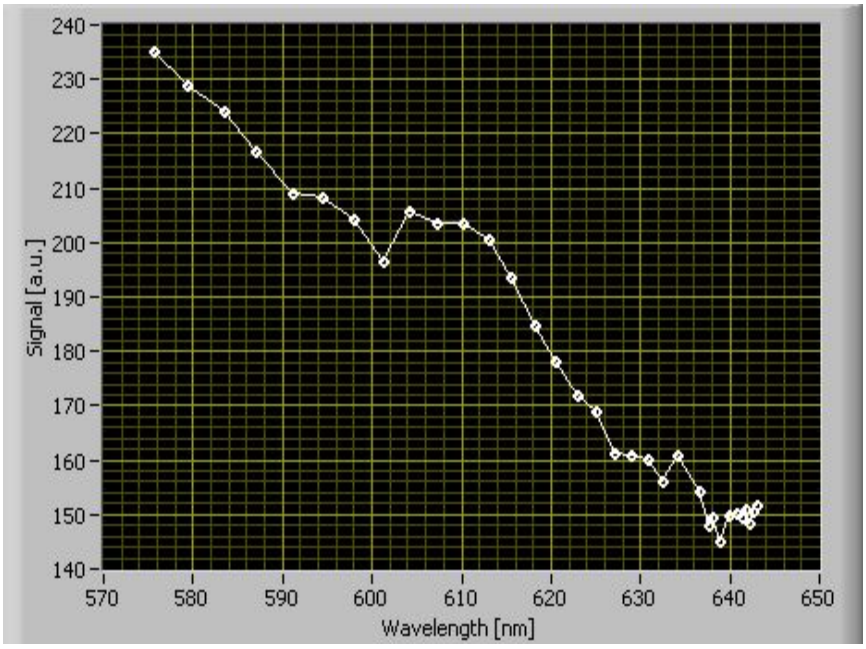

Fig. 3 The averaging spectral characteristics of the point without cancer changes.

3. ANALYSIS OF PHOTOLUMINESCENT PICTURES

Obtained by means of such a method the spectral characteristics of all the points of the tested region, are submitted to of an analysis of shape correlation. In result of correlation analyze one obtains the correlation coefficients, which are the base of forming a pseudocoloured map of dispalstic or cancer testing tissues, which are the base for their medical diagnosis. (Fig. 4).

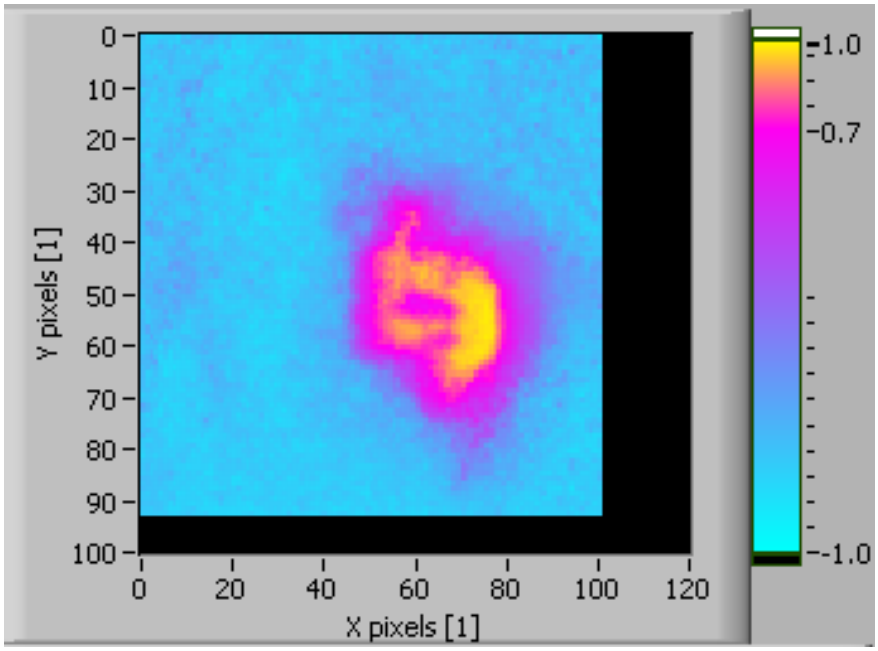

Fig. 4 Pseudocoloured correlation picture of the tested surface.

The yellow colour presents the region with the highest value of the spectral correlation coefficient, in which the displastic or cancer changes are the highest. Changes of the colour from yellow, through violet to bleu inform about the number decreasing of cells with cancer changes. The blue colour presents cells without displastic and cancer changes.

The proposed system of cancer cells detection with using of spectral photoemission analysis is the first diagnostic system of this kind all over the world used for the detection of dyspalstic and cancer tissues.

The advantages of the system elaborated by us are:

- The possibility of diagnosing displastic and cancer changes on the surface with various dimensions, from such big as a back or thorax, to such small as, part of a nose or part of an eyelid.
- The possibility of repeated testing of tissues from their easy and noninvasive realization. Repetitions of testing of this same region provides a chance of tracking pathological changes in arbitrary time.

- The reduction of taking histopathological samples, which makes the testing processes more comfortable for the patients and provides at once results of the analysis.
- The possibility of repeated testing in order to control the therapy.
- Shortening of the time for decisions concerning the cancer therapy.
- The higher probability of detecting cancer changes.

4. DIAGNOSTIC POSSIBILITIES OF THE ELABORATED METHOD. CONCLUSIONS

The known and used medical photoluminescent systems for the assessment of cancer changes in human tissues applying photosensibilitors can determine only the intensity of the shining of tissues in the red part of the spectrum of light [6,7].

In opposite to medical procedures applied so far, our system permits:

- to analyze the full emitting spectrum and cells diagnostics in any selected part of the tested area of a patient,
- to analyze the photoluminescent spectrum within the range: 575 - 645 nm,
- to analyze precisely the photoeluminescent change dynamics in real time, e.g. before and after photodynamic therapy,
- to enhance considerably the sensitivity of cancer detection (2-3 times) in comparison with the actually used photodynamic apparatus.

The application of our system in clinical practice causes:

- an essential shortening of the diagnostic process of cancer detection,
- a restriction of the number of samples for histopatological tests,
- a shortening of the time of final therapeutic decisions,
- a control of therapy efficiency,
- an improvement of the patient's comfort,
- a reduction of the costs of therapy.

ACKNOWLEDGEMENT

The work was sponsored by the Polish Ministry of Science and High Education within the Grant 3T11E 002 29

REFERENCES

1. J. Hung, S. Lam, J.C. Le Riche, B. Palcis, *Lasers Surg. Med.* 11, 90-96 (1991).
2. S. Lam, B. Palcic, D. McLean, J. Hung, M. Koberlik, A.E. Provio, *J. Photochem. Photobiol.* 30, 333-341 (1999).
3. C. Zhou, *J. Photochem. Photobiol.* vol. 30, (1999), 375-386.
4. A. Sieron, P. Gibinski, T. Woznica, *Acta Bio-Optica et Informatica Medica* 13/4, 359-360 (2007).

5. S. Sutton, *Pharmaceutical Microbiology Forum* 12/8, 3-13 (2006).
6. H. Podbielska, A. Sieron, W. Strek, Photodynamic diagnostics and therapy, Wydawnictwo medyczne Urban & Partner, Wroclaw, 2004 (in polish).
7. O. Coppelloti Krupa, S. Ferro, K. Kassab, G. Roncucci, G. Jori, *Acta miomedical Engineering* 2, 115-120 (2007).