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Prototype for optical applications that microscopically affect the cancer cell diagnosis in biological sciences

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Abstract

Optical applications can microscopically affect the samples in cancer diagnosis. These applications can help the detection of unique characteristics. The detection happens regarding the propriety of light to penetrate and lose energy via absorption and scatters properties of the sample. Hence, these properties advance the first step towards to designing devices, measuring methods and treatment protocols. An example is the detection and research about cancer cells, because their high resistance and cells division. A disease case, when the cancerous tissue invades a healthy tissue through the blood irrigation, or a cells culture creation makes it necessary a detection method to find the cells, so the relevancy to define the light wavelength is high. With this reality, our lab started to research about characteristics of cancer cells and their light wavelength compatibility. The cancer cells studied are two types of skin cancer, the first type is a basal cell carcinoma and the second type is the melanoma. These two types are the most frequent cancer in the world, especially in Brazil, because of the high sunlight. Find the basics characteristics of these two types, the group proposed to design a equipment with a compatible light wavelength to detect these characteristics. The first prototype here presented was assembled using LEDs (Light Emission Diode) as start base to design the equipment, because of their large light wavelength.

dermatoscopy, light absorbency, experimental microscopy

1. Introduction

The optical properties of a tissue affect both diagnosis and treatment, because the property of light to penetrate and interact the tissue is the main point in the diagnosis applications. The detection happens regarding the propriety of light to penetrate and lose energy via absorption and scatters properties of the sample. Hence, these properties advance the first step towards to designing devices, measuring methods and treatment protocols [5]. An example is the study and diagnosis of cancer cells, because their high resistance and cells division. A disease case, when the cancerous tissue invades a healthy tissue through the blood irrigation, or a cells culture creation makes it necessary a detection method to find the cells, so the relevancy to define the light wavelength is high[1,5]. The skin cancer has long been used as a main study to the detection and diagnosis. A great number of researchers have studied the skin features to determine the key points for detection and they are melanin and haemoglobin concentrations, the depth and diameter of blood vessels, the depth of pigmented skin lesions, the maturity and depth of bruises and keratin fibber arrangements [1]. With this reality, our lab started to research about characteristics of cancer cells and their light wavelength compatibility. The cancer cells studied are two types of skin cancer, the first type is a basal cell carcinoma and the second type is the melanoma. These two types are the most frequent cancer in the world, especially in Brazil, because of the high sunlight [6]. Find the basics characteristics of these two types, the group proposed to design a equipment with a compatible light wavelength to detect these characteristics. The first prototype here presented was assembled using LEDs (Light Emission Diode) as start base to design the equipment, because of their large light wavelength.

2. Methodology

A basal cell carcinoma is characterized by having a "pearly" appearance, has a consistence lesion, thin blood vessels and, in some advanced cases, a gradual evolution in size. For melanoma cases, their characteristics are the same for a BCC and the pigmentation caused by melanin [5].

In dermatology, the usual equipment uses white light to detect the border lines of melanoma and the BCC pearly appearance. The research group decided to detect the haemoglobin concentration and the depth and number of blood vessels of lesion, to detect not only the cancer itself, but the metabolism.

2.1. Blood and blood vessel optical properties

The optical properties of blood differ from those of other tissues within skin, because the blood does not contain significant intercellular scatterers. [1] So, the optical properties are determined from distribution and concentration of erythrocytes. Despite a number of investigations, many of them used randomly distributed and oriented erythrocytes and that are not representative of blood appears in dermis [2]. To the author knowledge, the optical properties of dermal blood vessel have not been investigated directly [1]. However, studies about the absorption and scatter have been made. The absorption has two further peaks in the green-yellow region and the dominant peak in the blue region and is called Soret band [2, 3]. And the scattering in the blood vessels in the skin is significant; inclusive the refraction effects and varies with location and depths [1].

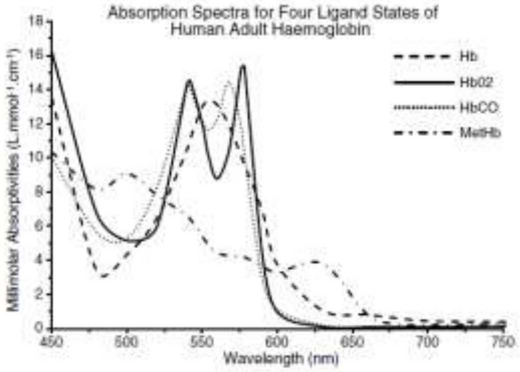

Figure 1. Absorption spectra of deoxyhemoglobin (Hb), oxyhemoglobin (HbO2), carboxyhemoglobin (HbCO), and methemoglobin (MetHb) in the visible region [1].

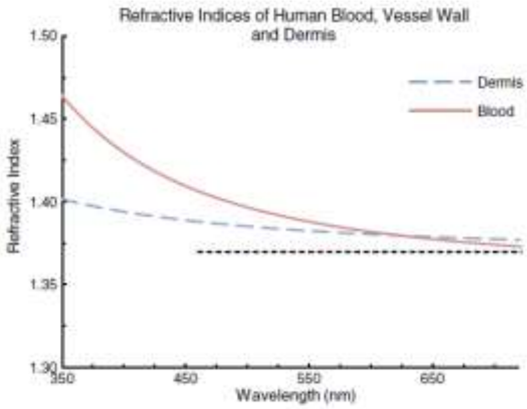

Figure 2. Refractive indices of human blood,vessel wall and Dermis [1].

2.2. Prototype project

With the range of wavelengths able to detect the concentration and depths of erythrocytes, our laboratory was performed a series of experiments to determine the wavelength range of high bright led, because their structure has a wide wavelength range with a significant power range. The LED tested is green, blue, yellow and red will be tested by a diffraction experiment with a light sensor CI-6504A. After the testing, we use the solidworks program to project the equipment and test with a research group in AC Camargo Cancer Center.

3. Development

In table 1, it presents the LED's wavelengths by diffraction diagram and light potential using a photometer. And the Figure 3, it presents the first prototype. The reason is the green light its one of peaks of absorption spectra, Figure 1, and the start of refraction equal value of dermis. The prototype has been designed to support eight high luminescence LED's with a 3V lithium battery and a 10x magnification lens, Figure 3. The group expectation is to detect the blood vessels of BCC and melanoma.

Table 1 LED's characteristics

Code	Color	wavelength	Vf(V)	IV(mcd)	Angle
SS5R4UCCC	Red	620-630	2.5V	10000	30
SS5Y4UCCC	Yellow	585-595	2.5V	10000	30
SS5G4UCCC	Green	515-525	3.3V	10000	30
SS5B4UBCCC	Blue	460-470	3.3V	5500	30

Figure 3. The first prototype, designed to support eight LED's with a 3 Volts battery.

After, the first prototype has been given to AC Camargo Cancer Center, to be tested by the dermatologists.

4. Preliminary Results

After a first attempt with the prototype, they had difficult to see the vessels, because of high luminecence of the light in the skin area, making too bright and the problem with the lens characteristics. If compared with the usual equipment, despise the difference with light wavelength, it's possible to conclude the next prototype needs a great improvements.

5. Conclusion

After the preliminary results, the next prototype needs to improve a great number of details, for example, the lens type are polarized, because it helps the light to overcome the loss of energy by scatters components in the skin, in another types, they used a liquid to increased the refraction; another is the homogeneity of the light, the first prototype used 5mm LED's for the first instance, because the preoccupation is the loss of the light in the epidermis and dermis, so they used a high luminescence first, but this option create a problem instead, because the high brightness that can overshadow details in the images and the size of LED's, even is a 10 times magnifying lens, the focus distance is about 5mm to 10mm, increasing the problem of overshadow too. In the next prototype, it going to use minor sized LED's, SMD types, to overcome the problem of size and homonogeity. The lens problem needs more attention because the dimensions of lens and the angle type polarization needs study. So, the first prototype helps to see the real problems in the detection affairs and contributed to see the obstacles to overcome.

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