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The investigation of the optical characteristics of tissue samples for creating a phantom head

Identification of intracranial hematoma is extremely important in traumatic brain injury. Our task is to create a device that quickly detects the presence of intracranial injuries. Possible solution of this problem is to use a diagnostic spectroscopy in the optical wavelength range. With proper technical support is possible to investigate the organs and tissues of animals and humans, without violating their integrity and without causing any damage to the body. First of all we need to design the layout of the human head for investigation. This article presents the results of the study of the optical characteristics of the tissues and substances samples that can replace them to create a phantom head, by using a photometric sphere.

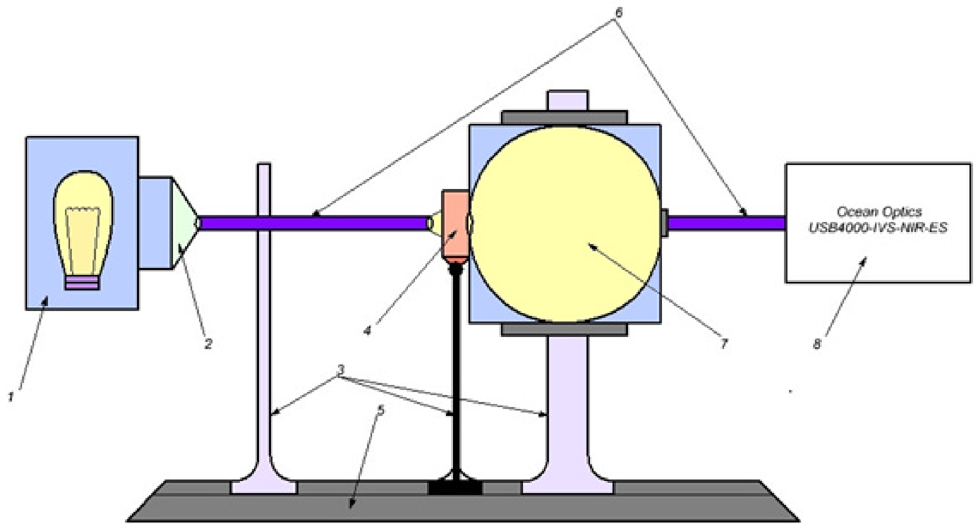


Fig. 1. The Scheme of the experiment.
1 – source of radiation in a wide range of wavelengths (halogen lamp); 2 – collimator; 3 – brackets; 4 – biotissue sample; 5 – optical bench; 6 – fiber; 7 – integrating sphere; 8 – photographic recorder

Using the bracket (3) an integrating sphere (7) is assigned on the optical bench (5). The object of study (4) is in front of the entrance window of integrating sphere. The radiation from the (1) halogen lamp shines through the biotissue sample (4). The light is supplied through the optical fiber (6) to the sample under investigation. The intensity of the radiation trapped in the field after its passage through the object is measured by an Ocean Optics spectrograph model USB4000-IVS-NIR-ES (8). Halogen lamp is used as the source of monochromatic radiation (1). The luminous flux is focused on a spot with a diameter of 1 cm using the colimator (2). The task of this empirical study was: firstly, to determine the optical characteristics of the brain tissue and to pick up substances capable of replacing them to build the phantom in an optimal way; secondly, to test how the optical characteristics of the samples at all wavelengths change.

To determine the optical characteristics of the samples at all wavelengths, a monochromatic source (halogen lamp) was used

The samples were placed in a rectangular cuvette made of a cover glass thickness of 0.1 mm.

From the above graphs we can conclude that due to the lack of distinct peaks in the intensity across the wavelength range and the apparent similarity of the graphs of the absorption spectra of brain tissue and mayonnaise, it can be concluded that firstly, mayonnaise is an acceptable alternative for the modelling of brain tissue in phantom; secondly, specific wavelength for to these tissues has not been detected because the intensity distribution of the absorption by the sample radiation is almost direct parallel in the whole range of wavelengths, indicating equal absorption of any of them.

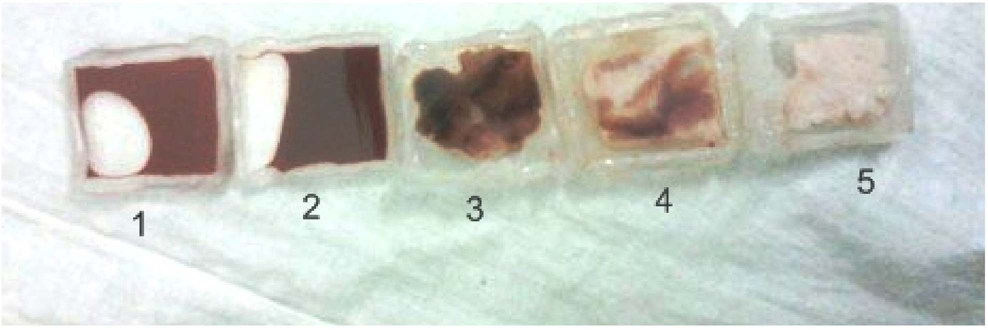


Fig. 2. Samples:
1 – no clotted blood; 2 – clotted blood; 3–5 – different parts of the brain tissue of the pig

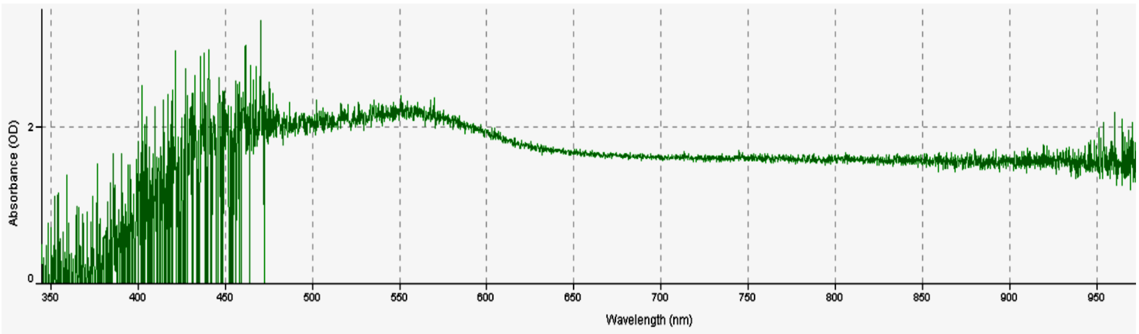
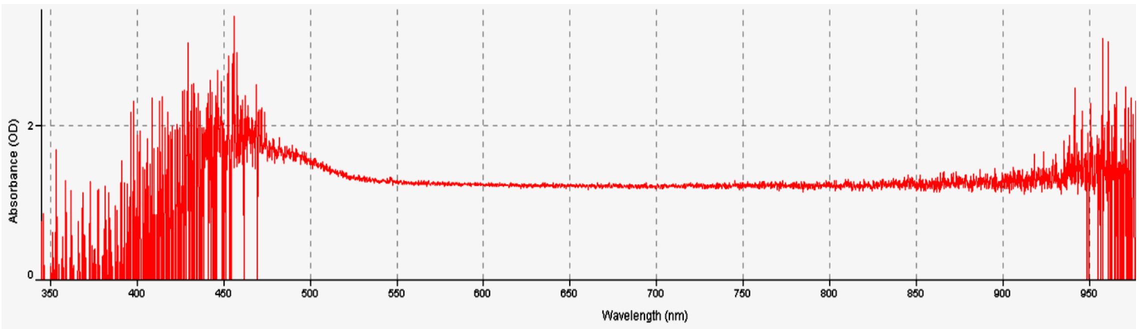


Fig. 3. Absorption Spectrum of brain tissue



Exception is when a brain tissue absorbs in the red range 10 % bigger than the mayonnaise, which is caused by the blood supply to this organ. It will be taken into account, by adding organic dye to the mayonnaise. Also this measure is necessary due to the fact that the amplitude of the intensity of radiation absorption by the brain is slightly higher than the mayonnaise.

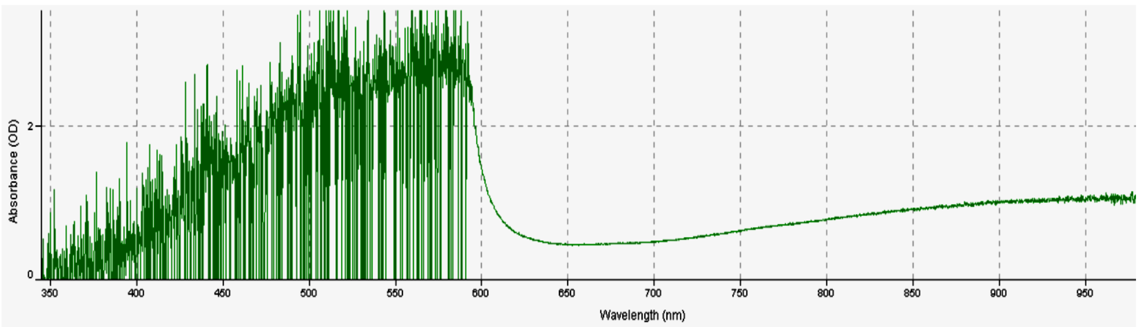


Fig. 5. Absorption Spectrum of coagulated blood

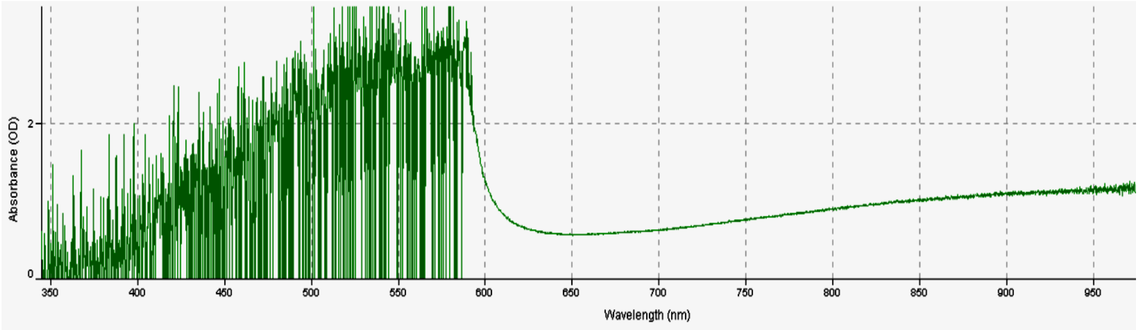


Fig. 6. Absorption Spectrum is not coagulated blood

It is obvious that the resulting graphs are identical, the only difference is that the amplitude of the absorption of clotted blood is more than not coagulated. The largest amplitude of the absorption is in the red wavelength region, which is yet more proof that this region is specific for blood.