PREDICTING OCULAR EXPOSURE TO PREVENT ADVERSE EFFECTS TO HUMAN HEALTH

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1. BACKGROUND

Several ocular pathologies can result from an overexposure of ultraviolet radiation [1] and blue light [2]. Understanding the relation between exposure and onset disease is important from a medical and prevention perspective.

2. PROBLEM

There are a multitude of light conditions which can include a wide variety of light sources. Measuring how much light is absorbed by ocular tissue is challenging and cannot be always performed.

3. METHOD

One possible solution to the difficulty in determining ocular dose is the use of a numerical model that can estimate this value in arbitrary situations by means of numerical simulations.

An appropriate choice for this problem turned out to be the division of the model into three distinct parts, each of which dealing with a precise phenomenon.

The parts of which the entire model is made up are:

1. LIGHTING MODEL

Light sources (natural and artificial) are described mathematically and geometrically through 3D computer techniques, focusing on ultraviolet radiation and blue light emitters.

2. SURFACE MODEL

The face anatomy is represented by a complex surface, made up of numerous flat triangles in order to approximate the real shape, taking into account the external ocular features that can affect the final value.

3. EYE MODEL

Human eye anatomy is described in terms of physiology data available in the literature and it is represented by different (bi)-spherical optical surfaces in the 3D space of simulation.

All parts work together through interfaces in order to determine how light rays are projected from the light source in the eye tissues and with what energy.

Some comparisons were made to verify the results of the model and perform validation. In particular, the model was compared with the experimental measurements, replaying the same experimental situation, and, where possible, a comparison with the analytical results

4. IMPLEMENTATION

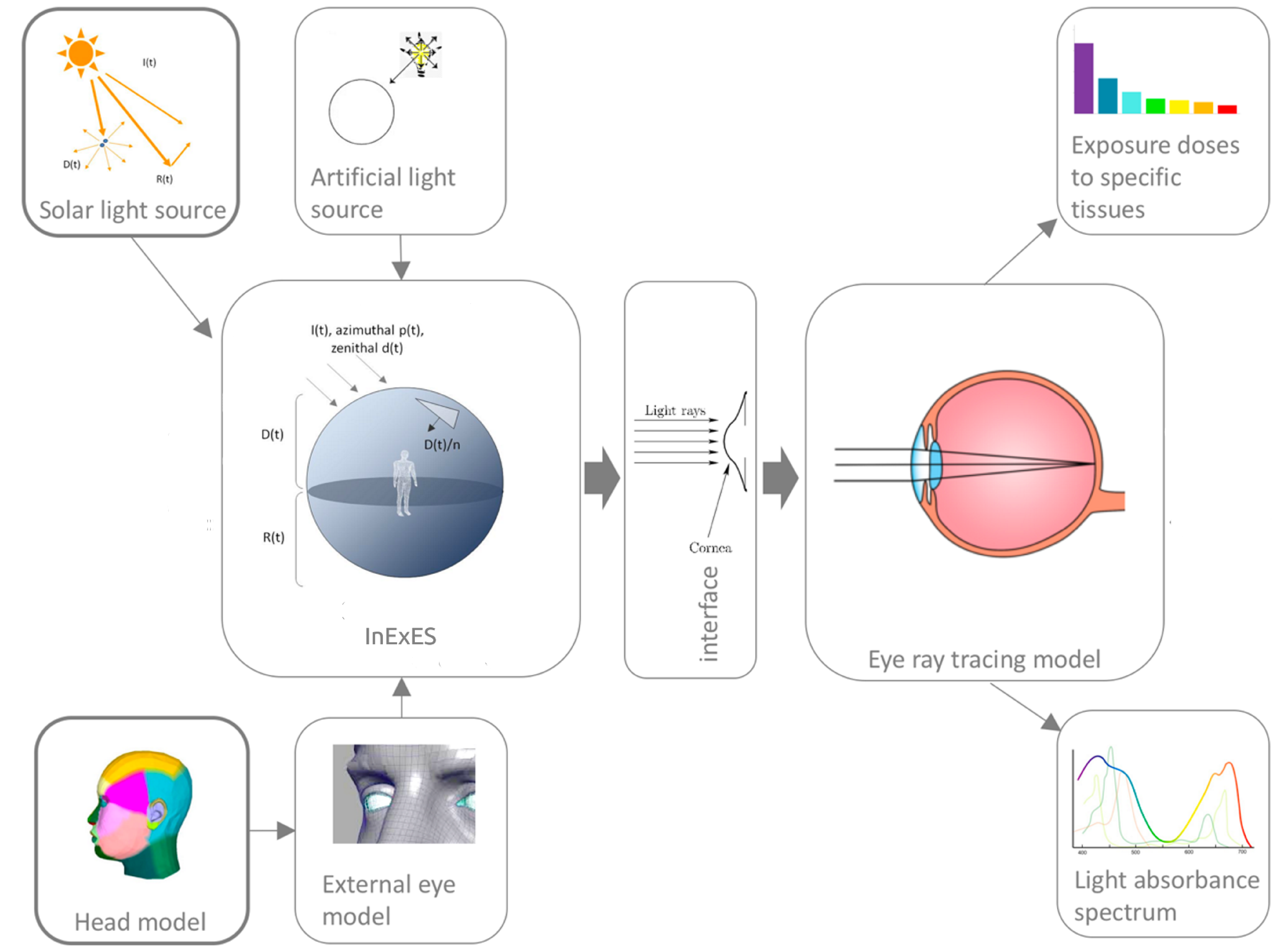

Figure 1: diagram of the model.

5. APPLICATION

The model was used to investigate the level of protection provided by human eyelashes against UV-B rays [3]. The results shown how the protection can reach values of around 50% and an average value of 12-14%.

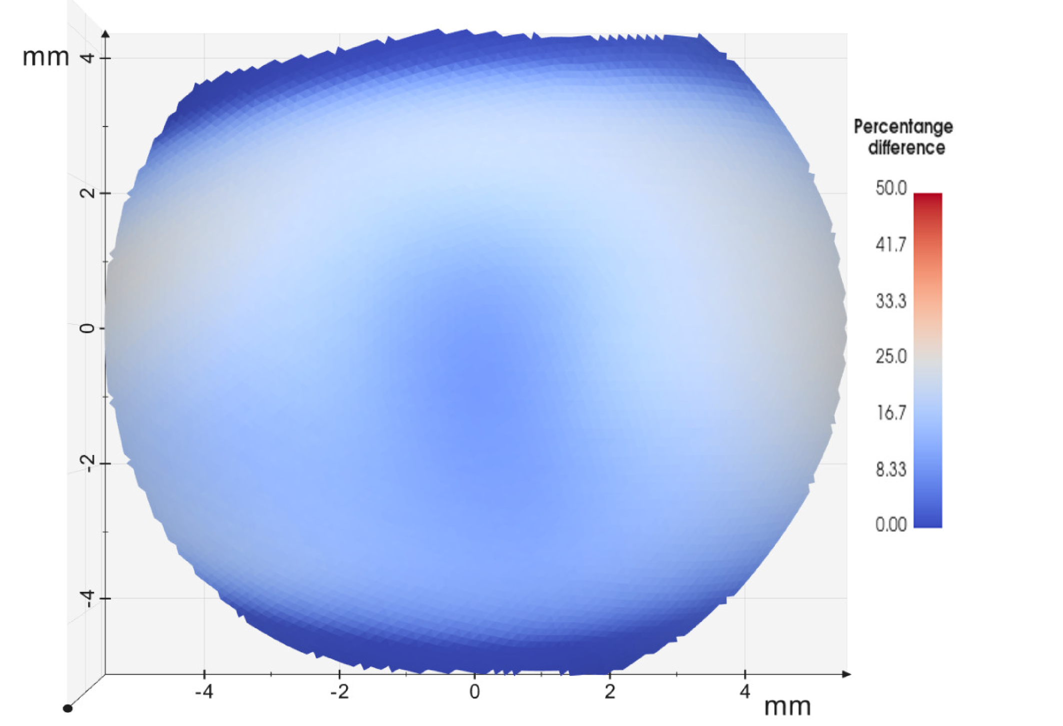

Figure 2: percentage distribution of the protection provided by both upper and lower eyelashes for a left cornea and a diffused isotropic light source of UV-B.

6. FUTURE PERPECTIVES

The possibility of creating arbitrary scenarios makes this method versatile as well as adapted to the different applications. The relative simplicity with which the model has been composed also makes it easy for future extensions, such as the inclusion of new (artificial) light sources or the use of non-emmetropic eyes.

Future plans include the participation of ophthalmologists for applications specifically concerning the inner eye. Some open questions in the field of ophthalmology will be explored by using laboratory measurements and numerical simulations performed with the model.

The modelling of different optical phenomena and the availability of different eye models will make it possible to investigate particular scenarios and study how light is distributed over the various optical components of the eye in the short and long term.

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ACKNOWLEDGEMENTS

This research is developed within the framework of the project InExES: "Internal and External Eye Simulation", which is financially supported by the Velux Stiftung in Zurich.

Project website at: https://inexes.unige.ch/