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SimUVEx v2: a Numeric Model to Predict Anatomical Solar Ultraviolet Exposure

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1. Introduction

Solar ultraviolet (UV) radiation has a dual effect on human health: low UV doses promote the photosynthesis of vitamin D and regulate calcium and phosphorus metabolism, while an excessive UV exposure is the main cause of skin cancer, along with eye diseases and premature skin ageing. The link between UV radiation levels and UV exposure is not fully understood since exposure data are limited and individual anatomical variations in UV doses are significant.

SimUVEx is a numeric simulation tool that uses 3D graphic techniques to estimate the dose and distribution of anatomical UV exposure received on the basis of ground irradiation and morphological data.

The second version (SimUVEx v2) intend to move from individual-based to population-based exposure assessments expanding temporal, spatial and morphological simulation capabilities and improving the meteorological model to provide UV irradiance data for the whole of Switzerland (eventually the whole of Europe).

2. Materials and Method

SimUVEx is a prediction model of individual UV exposure based on the adaptation of 3D rendering techniques and 3D human modelling to estimate the exposure of a 3D virtual manikin characterised as a triangular mesh surface. Each triangle receives a certain quantity of solar energy depending on the direct, diffuse and reflected radiation, the body surface orientation to the sun and the shadows from other parts of the body.

The application is based on VCG (Visualization and Computer Graphics Library), an open source C++ library for handling and processing triangle meshes, and implemented as a plug-in in MESHLAB, an open source system for computing and editing 3D triangular meshes.

The purpose of the application is to read the irradiation datasets of one-minute time resolution and sets the 3D manikins in various postures to simulate outdoor occupational and leisure activities, with the possibility to rotate each position every 15 minutes.

3. Radiation-body interaction Modeling

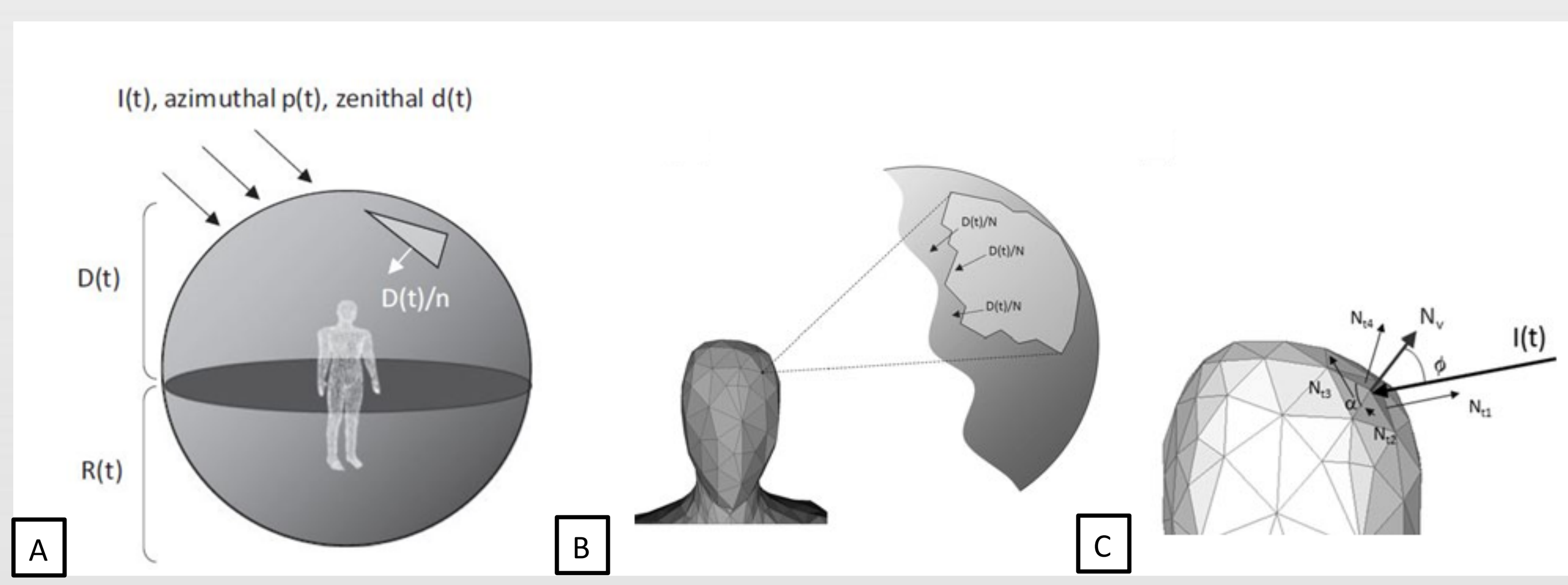

Figure 1. Irradiation model including direct I(t), diffuse D(t) and reflected R(t) components (A). Light–body interaction modeling: example of a visibility map used in the case of diffuse or reflected irradiation (B), computing the energy received by a vertex for a given light ray (C).

4. SimUVEx v2 Modeling Tool

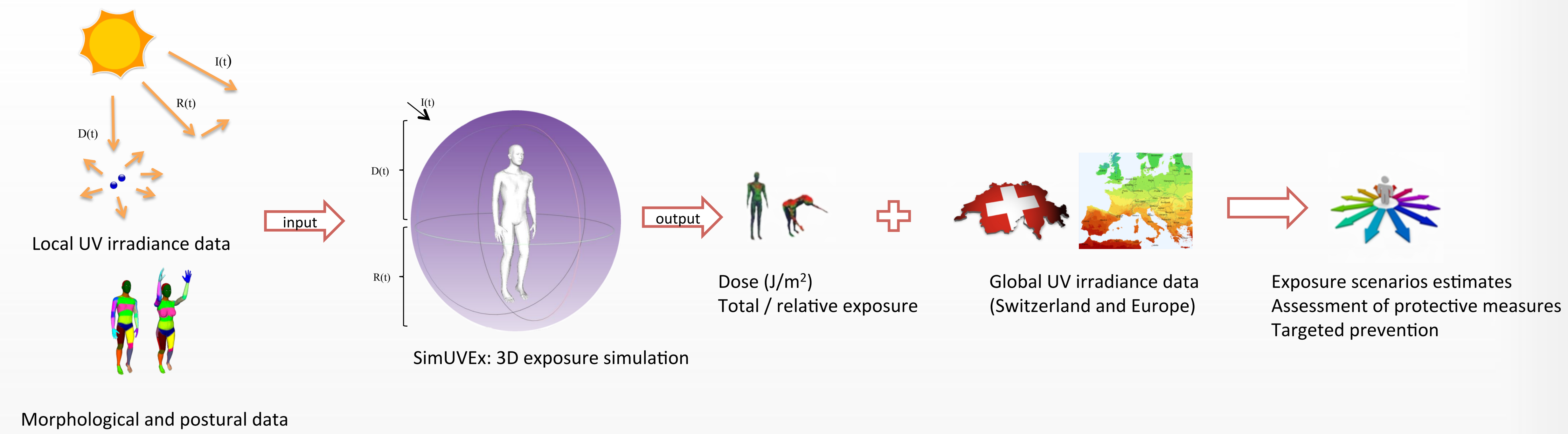

Figure 2. Schematic view of SimUVEx v2.

Table 1. Comparison between SimUVEx v1 and SimUVEx v2 .

SimUVEx version 1: Main Achievements	**SimUVEx version 2: Developments**
•One morphology (adult man); •Accurate prediction of anatomical zone exposure; •Estimation of all components of UV radiation (direct, diffuse and reflected) for anatomical zones; •Individual UV dose predicted from readily available data (UV erythemal irradiance); •Confirmation daily doses exceeding recommended exposure for outdoor workers; •SCC (squamous cell carcinoma) qualified as an occupational disease.	•Integration of gender- and age-related morphologies (adult man, adult woman, child, heavy man); •Accurate face modeling with different sun protections; •Improving manikin resolution; •New postures (leisure time); •Development of the model simulation capabilities to cover long exposure periods and different scenarios; •Expanding spatial resolution (Switzerland - Europe); •Improvement meteorological features; •Incorporation of realistic values regarding sun protective factors (clothing, hair, sun creams, etc.).

5. Perspectives

Inexpensive tool that requires no individual exposure (dosimetric data), but only postural information and ambient ground irradiance data.

Produce reference dose ranges for common outdoor occupational and leisure activities.

Identify high-risk situations.

Assess most effective sun protection strategies.

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