The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

DESIGN OF THE THERMAL ABLATION TREATMENT OF SKIN CANCER

Luiz F. S. Ferreira[1], Leonardo A. B. Varon[2],

Helcio R. B. Orlande[3] and Bernard Lamien[4]

[1] Federal University of Rio de Janeiro, Brazil, luiz.ferreira.mec@gmail.com
[2] Universidad Santiago de Cali, Colombia, leonardo.bermeo00@usc.edu.co
[3] Federal University of Rio de Janeiro, Brazil, helcio@mecanica.coppe.ufrj.br
[4] Ecole Polytechnique de Ouagadougou, Burkina Faso, lamienbernard@hotmail.com

Key Words: *Parametric analysis, uncertainty quantification, Metropolis-Hastings algorithm.*

This work deals with the optimal design of two different protocols for the thermal ablation treatment of skin cancer, by considering uncertainties in the model parameters. Heating of the tissues that include a tumor was promoted by a diode laser. Nanoparticles were supposed uniformly distributed in the epidermis and in the tumor, to concentrate the thermal damage in the region of interest [1,2]. The protocols examined here involved one single treatment session with: (i) a sequence of laser pulses with the same fluence rates; or (ii) continuous heating with laser fluence rate given by a linear combination of two periodic functions with different amplitudes and frequencies. The optimal design problems were solved with the Markov Chain Monte Carlo method, by applying a modified version of the Metropolis-Hastings algorithm with sampling by blocks of parameters [3,4]. The two parameter blocks were given by the properties of the tissues and by the design variables. Parameters in the first block were sampled from their prior distributions obtained from the literature data, while random-walk proposal distributions were used to generate the candidate samples of the design variables. Therefore, the posterior distribution of the design variables was estimated for the protocols examined, taking into account uncertainties in the model parameters and the desired statistical distribution of the thermal damage in the region of interest. The stochastic simulation based on the Metropolis-Hastings algorithm with sampling by blocks of parameters resulted in optimal thermal damages that followed the desired probability distribution function with small uncertainties.

REFERENCES

[1] B. Lamien, H. Orlande, G. Elicabe, A. Maurente. State estimation problem in the hyperthermia treatment of tumors loaded with nanoparticles. *Proceedings of the 15th International Heat Transfer Conference - Kyoto,* 2014.
[2] M. Larreur, B. Lamien, H. Orlande, Optimization of the hyperthermia treatment of a skin tumor containing nanoparticles. *VIII International Conference on Computational Methods for Coupled Problems in Science and Engineering - Sitges,* 2019.
[3] D. Gamerman, H. Lopes, *Markov chain Monte Carlo: stochastic simulation for Bayesian inference,* CRC Press, 2006.
[4] M. Ozisik, H. Orlande, *Inverse Heat Transfer: Fundamentals and Applications – Second Edition,* CRC Press, 2021.