NUMERICAL SIMULATION USING PARTIAL DIFFERENTIAL EQUATIONS FOR MODELING AND CONTROL OF MEDICAL RADIATION FIELDS

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Rezumat. *Această lucrare prezintă o nouă abordare, bazată pe un model de ecuaţii cu derivate parţiale (EDP), pentru modelarea analogică şi simularea numerică a proceselor biomedicale cu parametrii distribuiţi. Astfel de procese redau penetrarea radiaţiilor în radioterapie sau în tehnicile de investigare radiologică. Studiul de faţă simulează propagarea prin diferite medii. O caracteristică importantă a metodei propuse este aceea de a simula propagarea prin medii neomogene, cum ar fi ţesuturile umane. Lucrarea oferă un punct de plecare în tehnica controlului automat al dispozitivelor radiologice.*

Abstract. *This paper presents a novel approach, based on a partial differential equation (PDE) model, for analogical modeling and digital simulation of biomedical processes with distributed parameters. Such processes include penetration of radiation during radiation therapy or radiological imaging techniques. The present study simulates the propagation of radiation through different media. A valuable feature of the proposed method is its ability to simulate propagation along inhomogeneous media such as human tissues. It offers a starting point for automated control of radiological devices.*

Keywords: partial differential equations, distributed parameters, radiation field, propagation

1. Introduction

Medical research and practice offers numerous applications for numerical simulation [1-4]. One such application, automated control of radiation field intensity generated during radiation therapy, constitutes an efficient method to reduce unnecessary radiation exposure for both patient and device operator [5, 6]. The aim of our study has been to develop a model for radiation field control at various tissue locations investigated or treated using radiological devices.

The phenomenon of radiological field spreading is represented on Cartesian coordinate system (0p; 0q; 0r) in figure 1. A possible pattern of spread is considered, particularly in relation to these axes and in relation to time (t). The radiation field intensity $y(t, p, q, r)$ is shown in figures 1b, 1c, and 1d, in which:

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