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Original Paper Physica Medica - Vol. XVIII, N. 2, April-June 2002

A fast voxel-based Monte Carlo method for scanner- and patient-specific dose calculations in computed tomography

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Abstract

It is difficult to determine the patient dose caused by CT examinations from the manufacturer's technical specifications of the scanner, because with these the scanner is only characterized roughly and the geometry of the patient is not taken into account at all. To remedy this lack of information concerning the patient dose we have developed a fast voxel-based Monte Carlo program (ImpactMC) to calculate dose distributions specifically for both the respective CT scanner and the individual patient anatomy. The calculations are performed on a 3-D voxel volume that can be filled with either the CT data of patients or mathematical phantoms converted to voxel volume data. In addition information about the scanner, e.g., scanner geometry, pre-filtration and shaped filters, and about the scanning parameters, e.g., tube current, slice thickness and pitch, has to be provided. According to these parameters the dose distribution in the 3-D voxel volume is then calculated by the Monte Carlo method. Several variance reduction techniques were implemented to minimize the time for calculation. To validate the program, the calculated results were compared with the results obtained with Monte Carlo-based programs (EGS4), measured CTDI values and published values of organ dose calculations. Typically, the differences were less than 5%. The time for calculation depends on the capability of the PC system, the 3-D volume and the simulated problem. E.g. the effective dose for a CT examination of the liver is calculated in less than three minutes with an uncertainty of less than 1% standard deviation. Moreover, the program allows the quantification of the potential of dose reduction techniques and the optimization of the respective method – specific to the scanner and the patient.

KEYWORDS: Computed Tomography (CT), Monte Carlo method, Patient Dose.

Original Paper Physica Medica - Vol. XVIII, N. 2, April-June 2002

Use of mammographic film-screen-cassette combination for portal localization imaging with a 4 MV X-ray unflattened beam

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Abstract

Use of mammographic film-screen-cassette combination for routine external beam radiation therapy with linear accelerators is proposed and described. The proposal is based on a special diagnostic mode developed by us on a Clinac18 (Varian Associates). A 4 MeV electron beam normally incident on the thinner of the two existing ports of the all-Cu-radiotherapeutic target produces an unflattened x-ray beam considerably enriched (up to 8.1%) with low-energy ($\leq$ 150 keV) photons. It is proposed and proved both by Monte Carlo calculations and experimentally that such an unflattened beam can be effectively used in conjunction with a mammographic film-screen combination for the production of adequate quality localization portal images in routine radiotherapy on a daily basis. A Kodak MIN-R mammographic film-cassette combination, with a strong low-energy response, was used for this purpose. Because of its high sensitivity, (Γ = 4.7), 0.25 cGy doses at cassette position are adequate, when compared with 5 cGy doses usually required in megavoltage portal imaging avoiding unnecessary additional dose. The weight of the plastic MIN-R cassette is almost four times less than metal-screen cassettes used in megavoltage radiotherapy, thus providing easier handling. A technique of utilizing the unflattened portal imaging beam was proposed and developed based on the time-setting termination of the radiation beam. A special phantom for portal imaging systems calibration was used. An optical density of 1.5 was selected in order to achieve around 0.25 cGy dose at the cassette position. Portal films taken with the mammographic system in conjunction with an unflattened 4 MV x-ray beam both an anthropomorphic phantom and routine radiotherapy show the improvements in contrast and resolution.

KEYWORDS: Portal imaging, linear accelerator, mammographic system, low absorbed dose.

Technical Note Physica Medica - Vol. XVIII, N. 2, April-June 2002

Randomness and determinism in human heart-beat dynamics: Recurrence plot analysis

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Abstract

A new method of recurrence plots was used for the analysis of the heart-beat intervals of a young and old subjects. As we have found the simple deterministic chaos is not likely explanation for the time variability of inter-beat intervals, which must be considered as a mixture of deterministic and stochastic chaos. We have demonstrated that the data obtained from old subjects have a more deterministic origin and the data obtained from young subjects are more random and complex. The complex dynamics of the healthy heart-beat arise from numerous coupled control systems and feedback loops that regulate the cardiac cycle on different time scales. Aging has a profound impact on many of the interacting neural and endocrine mechanisms that regulate heart rate, which may explain why the heart-rate time series looses much of its complex, irregular behavior.

KEYWORDS: Heart physiology, Time series, Nonlinear dynamics, Recurrence plots.

EFOMP Document Physica Medica - Vol. XVIII, N. 2, April-June 2002

Serious Deficiencies in Numbers of Medical Physics Experts in Diagnostic Radiology*

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Abstract

A joint statement by the European Association of Radiology, the European Federation of Organisations for Medical Physics and the European Congress of Radiology.

KEYWORDS: Medical Physics Expert, Diagnostic Radiology, Staffing level.

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