AUTOMATIC BEAM'S EYE VIEW

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The main goal of intensity-modulated radiation therapy (IMRT) planning is to find an optimal compromise between delivering a high dose to the tumour and sparing the critical structures from unnecessary overdosages. Finding the optimal IMRT treatment plan is, in fact, a large-scale optimization problem due to the many possible parameter configurations accomplished by the two clusters: the beam orientations which are determined by a set of gantry and table angles and the beam intensity profiles. In order to solve the problem in reasonable time, the variables of beam orientations are fixed (more often equidistantly), hence being excluded from the optimization process. During the last decade, optimization of beam orientations in IMRT has been shown to be successful in improving the treatment plan. A stochastic selector is usually used for optimizing beam orientation, and then some objective inverse treatment planning algorithm is run for the optimization of beam intensity profiles. The overall time needed to solve the inverse planning for every random selection of beam orientations becomes excessive. Thus, the choice of beam orientations in IMRT treatment planning is still a time-consuming trial-and-error procedure based on intuition and empirical knowledge in spite of the fact that the optimum beam configuration may be counterintuitive. The present work presents an algorithm for systematic selection of beam orientations in IMRT treatment. This algorithm approximates beam intensity profiles iteratively instead of doing it for every selection of beam orientation, saving a considerable amount of calculation time. Every iteration goes from an N-beam plan to a plan with N+ 1 beams. Beam selection criteria are based on a score function that minimizes the deviation from the prescribed dose and on a reject-accept procedure that excludes ineffectual beams when combined with the already chosen ones. In other words, it automatically utilizes the methods of beam’s eye view and observer’s view which are recognized for beam orientation in conventional conformal radiation therapy. To illustrate its efficiency, the algorithm has been applied to a toy example where optimality is trivial and to three real clinical cases: a prostate carcinoma, a tumour in the head and neck region, and a paraspinal tumour. In comparison with the standard equally spaced beam plans, improvements are reported in all the three clinical examples even, in some cases, with a fewer number of beams. A fewer number of beams is always desirable without compromising the quality of the treatment plan. This results in a shorter treatment delivery time which reduces potential errors in terms of patient movements and decreases discomfort as well as the risk of second cancers in the future.