Fluence Map Non-Linear Continuous Optimization for IMRT Treatment Planning

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Radiation therapy is one of the treatments used for cancer patients. Its aim is to destroy cancer cells through radiation, but at the same time spare healthy tissue that can also be damaged by radiation. Intensity Modulated Radiation Therapy (IMRT) is one type of radiation therapy where it is possible to modulate the radiation intensities that are delivered to the patient from each radiation incidence. One of the problems that has to be solved during treatment planning is to find the best possible intensity profiles (fluence maps) for each radiation direction (fluence map optimization – FMO). This is usually done by resorting to an optimization programming model, which requires the treatment planner to define several different parameters (like weights and lower/upper bounds). The tuning of these parameters is usually done by resorting to a lengthy trial-and-error procedure: the planner tries a set of parameters, solves the optimization problem and performs dosimetric calculations to check whether the current solution is complying with the medical prescription. If it is not, then he changes the model's parameters, and tries again.

We propose a completely different methodological approach for FMO. A non-linear unconstrained continuous programming model will be used, and will be iteratively solved by having the model's parameters changed in an automated way using a fuzzy reasoning inference system. This methodology releases the human planner from trial-and-error procedures, being a completely automated approach for FMO. The planner is only asked to define the constraints that should be satisfied so that a treatment plan is considered admissible. The proposed methodology is able of calculating high quality solutions in reasonable computational times. Computational results using retrospective treated head-and-neck cancer patients will be shown.