AbstractID: 4845 Title: Genetic Evolutionary Taboo Search: a Novel Approach for Optimal Marker Placement in Infrared Patient Positioning

Purpose: To develop the methods of a novel approach for optimal marker placement in infrared patient positioning.

Method and Materials: A non-deterministic optimization technique (Genetic Evolutionary Taboo Search, GETS), combining genetic algorithms and taboo search, was implemented. A population-based evolution is generated, where adaptive memory features guide the evolutionary process to thoroughly explore the solution space. Preset taboo solutions are introduced to reject marker configurations resulting collinear from the point of view of infrared cameras. The GETS algorithm was tested on 10 prostate patients: treatment planning CT scans were segmented to provide 3-D representation of PTV (prostate + seminal vesicles), OARs (bladder and rectum) and skin surface model. Segmented data were fed to the GETS algorithm to obtain optimized configurations of markers, minimizing the target registration error (TRE), to be compared to a random configuration. The changes in the optimal marker configuration when OARs are included within the target were also investigated.

Results: The GETS algorithm yielded a significant improvement in TRE values: optimal configurations ensured a 26.5% mean TRE decrease. Common features in the optimal marker configurations were found for the 10 patients group, being optimized solutions symmetrically distributed, with markers mostly placed on lateral sides. Optimal marker configurations when OARs were included within the target resulted in a similar spatial distribution, if compared to the PTV-only condition. The implemented memory-based design resulted in improved gene expression over the evolution process, with respect to memoryless genetic algorithms.

Conclusion: The GETS algorithm revealed high performance in solving the optimal marker placement problem, leading to improved marker configuration for stereophotogrammetric patient positioning in radiotherapy. Memory features ensured enhanced capabilities in exploring the solution space, if compared to conventional genetic optimization. The application of the new algorithm to a 10 patient group provided practical indications toward better marker placement for prostate cases.