Reconstruction of Needle Tracts from Fluoroscopy in Prostate Brachytherapy

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Purpose: In prostate brachytherapy, a surgeon implants radioactive seeds using needles to irradiate cancer while sparing healthy tissue. Seed positions can be reconstructed from fluoroscopic images taken before and after the procedure to assess quality. Reconstructing needles from these seed positions can help us to better understand needle bending, tissue deformation and seed migration. It can also be used for needle-needle ultrasound-fluoroscopy registration for intraoperative dose assessment and planning.

Methods: Needle reconstruction can be formulated as an assignment problem, where each seed is matched to the seed next to it along the length of a needle. Since seed assignment costs can be represented as a bipartite graph, the global lowest-cost solution can be found by the Hungarian Algorithm in polynomial time. Our method uses the Hungarian Algorithm to find the best seed assignments, and then uses these assignments to trace all of the needles.

Results: Prostates were simulated as spheres, with needles curved toward the central axis. Seeds were placed on needles with a random perturbation of up to 1/3 of the needle spacing. With these simulated seed positions, our method resulted in over 95assigned to the correct neighbour and correct needle in less than 5s at 2.00GHz and 1GB RAM. Furthermore, the algorithm was tested on one clinical data set, with a success rate of over 98The combination of speed and accuracy suggests that the algorithm may be used for intraoperative applications.