

Purpose:

The development of PR-Creator, GUI interface software that generates proton radiographic images for online patient setup and real-time tumor tracking in proton beam therapy.

Methods:

The PR-Creator was developed using MATLAB and produces proton radiographic images, PR-Images that can be used for in-room patient imaging. The GEANT4 Monte Carlo, MC, toolkit was used to simulate the proton transport through a patient to generate particle information for PR-Creator. Proton scanning beam of 230 MeV and 330 MeV and the MGH 230MeV-double-scattered beam were used. The MC-simulations provide the proton energy, Cartesian coordinates and direction cosines in two planes (1 entry and 1 exit) placed either side of the patient. The 230 MeV and 330 MeV have a CSDA range in water of 32.95 cm and 60.20 cm, respectively, which is sufficient to penetrate an adult trunk.

Results:

The functionality of PR-Creator can be divided into two main domains: 1)image reconstruction and 2)image analysis. The image reconstruction generates images using in-house developed reconstruction algorithm that allows 1)proton energy selection (or range cuts), 2)angular selection from in-to-out positions, 3)cosine-directional-motion selection and 4)multiple Coulomb scattering de-convolution kernels. The image analysis allow 1)region-of-interest, ROI, contouring 2)line-of-interest contouring, LOI, 3)intensity thresholding to change contrast between tumor and surrounding. Tumor motion can be studied with the LOI, while the ROI option allows the clinician and physicist to highlight the tumor region for changing the contrast between the tumor and surrounding organs.

Conclusions:

We developed a PR-Creator toolkit that can be used for in-room patient imaging with proton beams. It generates proton radiography images that can be used in real-time to perform tumor tracking during a proton therapy course.