On the Development of Computational Methods Which Aid in Performing the Winston-Lutz Test

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Introduction

The Winston-Lutz test is the standard method to check for the isocenter stability of the linear accelerator prior to performing stereotactic radiosurgery (SRS) or stereotactic body radiosurgery SBRT (1) (2). The purpose of this project is to develop software that can programmatically analyze dosimteric images, taken when performing the Winston-Lutz test, and reduce the QA time when performing the Winston-Lutz test and to determine isocenter wobble of the linear accelerator (Varian True Beam).

Methods

Dosimetric images, with known shifts, were taken at 4 gantry angles (0, 90, 180 and 270 degrees) using a 17.5 mm Conical Collimator delimited field with 100 MU per dosimetric image at a dose rate of 300 Gy/MU and 6X photon energy. The images were acquired on a TrueBeam STx utilizing the dosimetry image type. The images were programmatically analyzed and the shift was calculated between the center of the cone position and center of the ball position. A known shift from central axis was applied unknown to the user and the calculated shift was then compared. The use can analyze the image by superimposing two ellipses on the ball and the cone. The program then calculates the distance between the centers of these ellipses. The program can also analyze the image pixel by pixel and finding he steep gradients in the image corresponding the cone and the ball. Then the program calculates the center of the cone and the ball, After this step is completed the software calculates the distance between the center of the cone and the center of the ball, determining the shift.

The software leverages the Eclipse Scripting Application Programing Interface (ESAPI), of Varian Medical Systems. The Portal Dosimetry Application of Eclipse is used to collect the image pixels. The pixels, are then displayed in a Windows Presentation Foundation application using Microsoft Visual Studio and C#. Two canvas are created on the Windows Presentation Foundation. The canvas on the left displays the image imported from the Portal Dosimetry Application of Eclipse,. Displays the shifts from the center of all the images analyzed. When the user hovers the mouse over a certain shift the program displays the shift values as well as the Field Id, gantry angle, collimator angle and couch rotation angle

Results

Image analysis indicates that the software program calculates the shifts with an error less than 0.5 mm. This error is due to discrepancies in the positioning of the ellipses by the uses. When the image is analyzed pixel by pixel there is no difference between the known shifts and the calculated shifts. Table 1 shows the difference between the actual shifts and the calculated shifts.

Field	X (mm) Known	Y (mm) Known	X (mm) Calculated	Y (mm) Calculated
test1	50	0	50	-0.1
test2	50	50	50.1	50.2
test3	-25	-50	-24.9	-50.1
test4	-10	25	-10	-25
test5	16	-17	-16.3	-17.1

Table 1: Comparison between the known and calculated shifts.

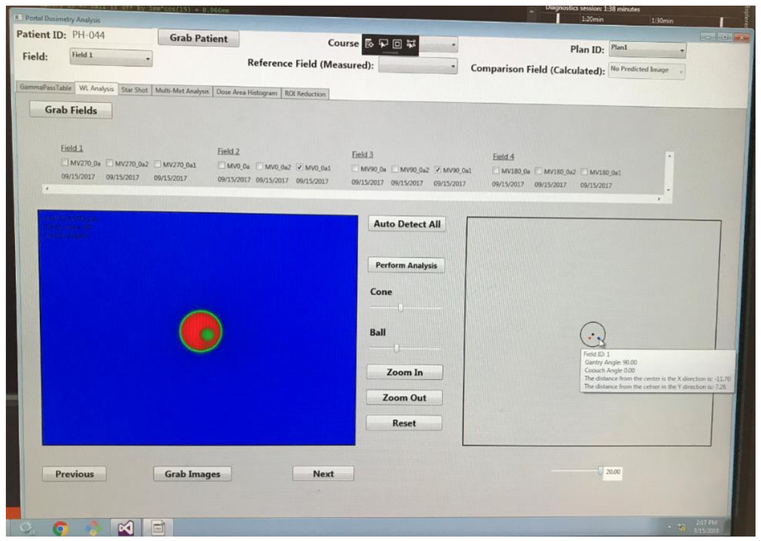

Figure 1: Tooltip results

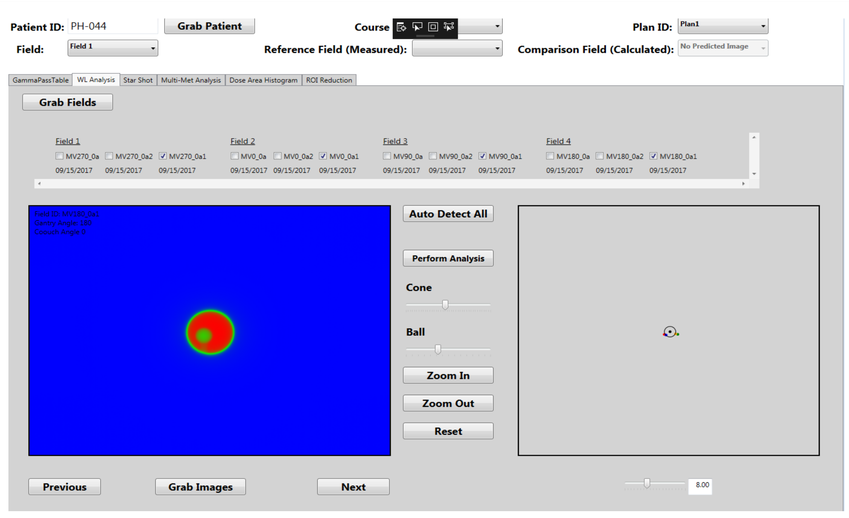

Figure 1: Graphics user interface

Conclusion

This work indicates that computer software can be of significant importance when performing QA to check for the mechanical stability of the rotation axes of the linac. The program provides the user with the exact information ,for each image, on the QA setup. This information includes the gantry rotation, collimator rotation and couch rotation. This allows for the user to easily determine the isocenter wobble and make the necessary adjustments.

References

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