

Deep Learning-Based Real-Time Error Detection in Radiotherapy with EPID Images

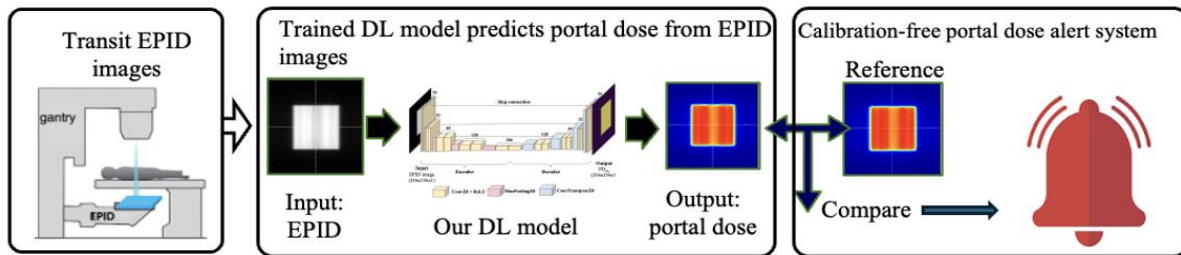
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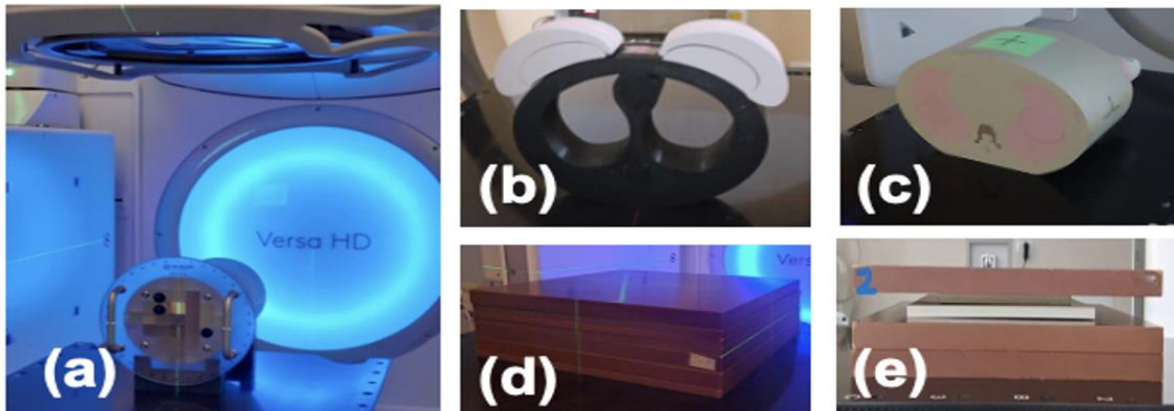
25-29 May, 2026

Introduction

- Electronic portal imaging devices (EPID) can be used for transit in vivo dosimetry (IVD).
- **Major limitation** of amorphous Silicon EPID detectors for usage IVD: non-linear detector response to water equivalent dose.
- **Possible solution:** deep learning (DL) model, to obtain portal dose (PD) from EPID images.
- **This work:** assess the sensitivity of our DL framework to detect different dose errors and to compare various metrics.
- Useful for the development of inhouse DL-based alert system.



The DL model maps a raw EPID image to its corresponding portal dose.



Irradiated phantoms: Multiplug (a), customized INFN breast phantom (b), CIRS (c), solid water (d), inhomogeneous phantom (e).

Materials and Methods

- We irradiated various commercial + non-commercial radiotherapy phantoms and fields, using the Elekta Versa HD Linac system at the Carreggi University Hospital, Florence, Italy.
- Acquired EPID images without errors (reference) and with controlled treatment errors and converted into portal dose (PD) images.
- Various alert metrics for 2D analysis: gamma index, relative peak dose difference (rePDD) and more.
- Systematic comparison of metrics.

$$\Gamma(\mathbf{r}_m, \mathbf{r}_c) = \sqrt{\frac{r^2(\mathbf{r}_m, \mathbf{r}_c)}{\Delta d_M^2} + \frac{\delta^2(\mathbf{r}_m, \mathbf{r}_c)}{\Delta D_M^2}}$$

$$\gamma(\mathbf{r}_m) = \min\{\Gamma(\mathbf{r}_m, \mathbf{r}_c)\} \forall \{\mathbf{r}_c\}$$

.....(1)

$$\gamma(\mathbf{r}_m) \leq 1, \text{ calculation passes}$$

$$\gamma(\mathbf{r}_m) > 1, \text{ calculation fails.}$$

$$\text{GPR} = \frac{\sum_{v, \text{pass}} \Gamma_v^{\text{pass}}}{\sum_{v, \text{tot}} \Gamma_v^{\text{valid}}}$$

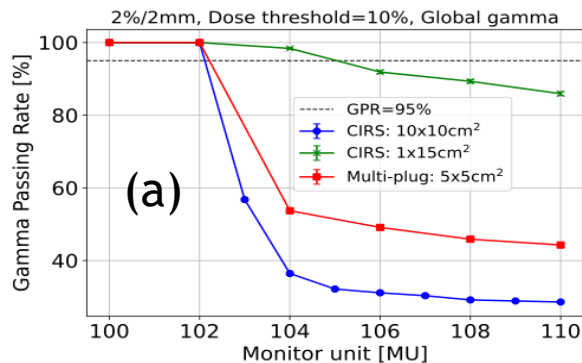
$$\text{rePDD} = \max\left(\frac{D_{e,i} - D_{r,i}}{D_{r,i}}\right)$$

.....(2)

Results

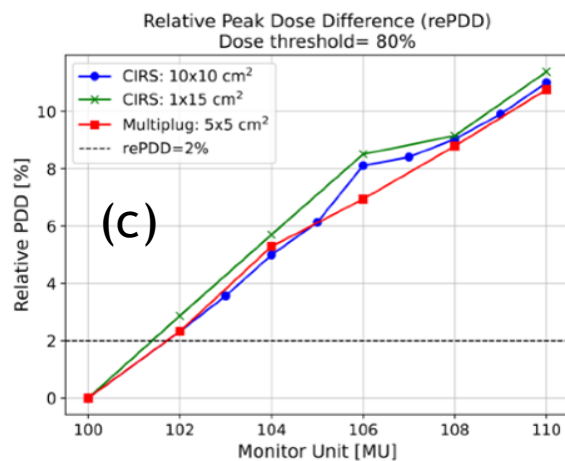
Data points represent comparisons between PD of reference with PD including errors

Monitor unit error



Warning ⚠ : GPR < 95%

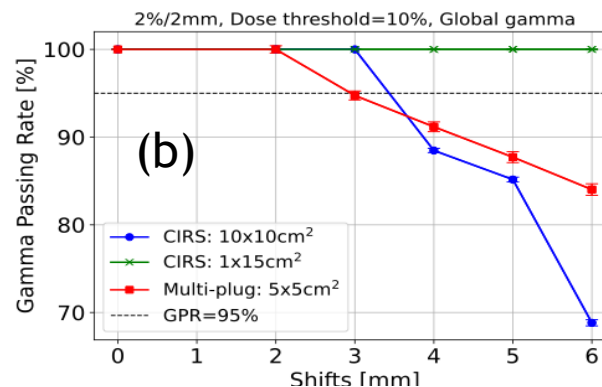
GPR less sensitive to MU error for narrow fields



Warning ⚠ : rePDD > 2%

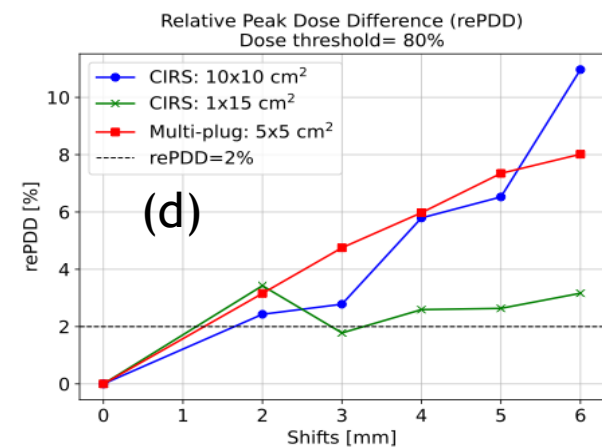
Reference: 100 MU
> 2% error in MU caught

Positioning error



Warning ⚠ : GPR < 95 %

GPR insensitive to positioning error for narrow fields



Warning ⚠ : rePDD > 2%

Reference: 0 mm
> 1.5 mm error caught

Using different metrics increases sensitivity

Conclusions

DL framework developed to transform EPID into dose images



Avoids complex EPID calibration and correction



Detection of errors with alert system including different metrics



Potential for real-time in-vivo dosimetry for increasing patient care quality

