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A deep neural network approach for enhancing signal-to-noise ratio of MV EPID images

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INTRODUCTION

Megavoltage Electronic Portal Imaging Devices (EPIDs), of linear accelerators, have been increasingly used in radiation oncology clinics for patient positioning and treatment planning quality assurance. An EPID flat-panel consists of metal and phosphorous layers for energy deposition and an amorphous silicon array of diode detectors for photon collection. The EPID detection efficiency of the incident x-ray photons does not exceed 2% in the current clinical EPID setups. Thus, images measured by available EPID devices have low signal-to-noise ratio.

AIM

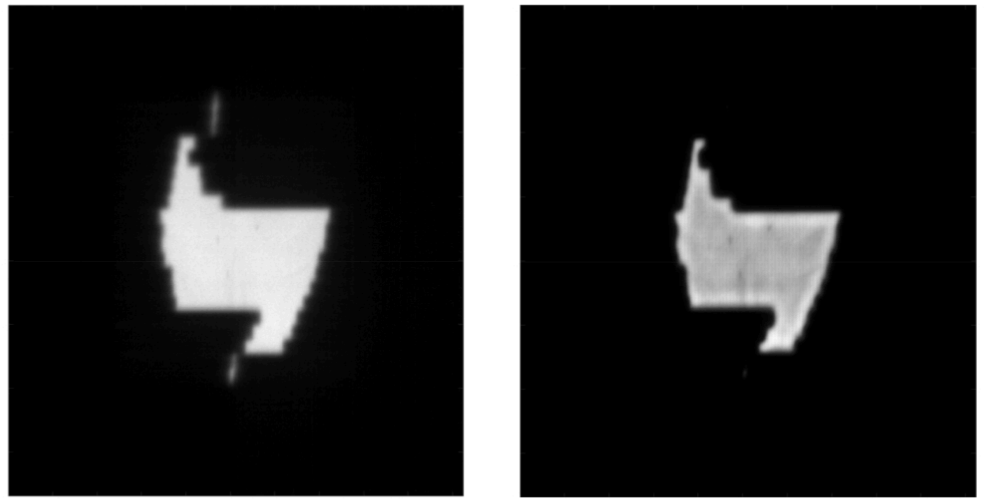
The MV electronic portal imaging device (EPID) signal is known to have low signal contrast. Here, we developed a deep convolutional neural network to enhance the SNR for exit-fluence signal measurements for prostate patients

METHOD

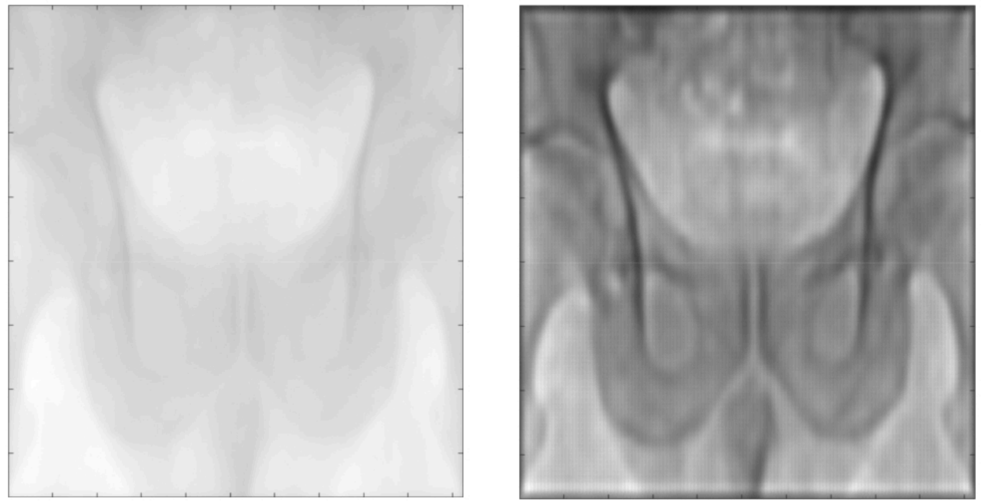
Two training datasets were prepared for UNet-based neural networks. The first dataset was trained on 12000 exit-fluence EPID images predicted through 22 manually aligned prostate patient CTs. The second network used 2400 EPID images computed through a specific patient CT. Unique projections are created by permuting the gantry angle, source-to-imager distance, and isocenter position of the CT during the prediction. The output training examples are computed by replacing the MV energy spectrum by a kV energy spectrum in the prediction model to obtain kV images at the same MV-image projections. During the prediction, limiting devices were removed from the beam pathway to generate full 1024X768 pixel aS1000 EPID images. White noise was superimposed on the predicted MV signal to emulate the noise in the measured EPID images. Quantitative testing is performed on calculated datasets, while qualitative testing is performed on actual EPID measurements.

RESULTS

The normalized root mean square error for the testing dataset with the general population network is 1.1±0.28, whereas for the patient-specific network is 0.61±0.11. Applying both networks to actual EPID measurements shows that the patient-specific network was more efficient. Networks were trained in less than 3 hours on a single NVIDIA P6000 GPU device.



Actual EPID measurement on the left panel. Enhanced EPID image by the DCNN on the right panel.



Simulated MV EPID image on the left panel. Enhanced MV EPID image by the DCNN on the right panel.

CONCLUSIONS

In this study, we demonstrated the feasibility of using calculated MV exit-fluence images in improving the SNR of measured EPID signals. The trained networks efficiently emphasize the in-aperture features for better anatomical detectability.

REFERENCES

- Antonuk L E 2002 Electronic portal imaging devices: a review and historical perspective of contemporary technologies and research Phys. Med. Biol. 47 R31–65
- El-Mohri, Y., Antonuk, L.E., Yorkston, J., Jee, K.-W., Maolinbay, M., Lam, K.L. and Siewerdsen, J.H. (1999), Relative dosimetry using active matrix flat-panel imager (AMFPI) technology. Med. Phys., 26: 1530-1541.
- Munro, P. and Bouius, D.C. (1998), X-ray quantum limited portal imaging using amorphous silicon flat-panel arrays. Med. Phys., 25: 689-702.

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