An Iterative Method for Flat-Field Correction of Digital Radiography When Detector is at Any Position

Department of Biomedical Engineering, College of Medicine, Catholic University of Korea

Do-Il Kim, Hyoung-Koo Lee, Sung-Hyeon Kim, Daesop-Park,
Bo-Young Choe, Tae-Suk Suh

When examing patients with DRs it is necessary to remove bad pixels and lines and to correct non-uniform offsets and x-ray field. For non-uniformity correction a flat field x-ray image is needed, and to obtain it the center of detector is usually aligned with the focal spot of the x-ray tube, which is conserved when examing patients to preserve the flat field. In some of radiographic techniques, however, it is necessary to move the x-ray tube off the center position of detector or tilt the detector. We investigated the effect of detector tilting on the non-uniformity correction, and propose a method to reduce the effect using a new algorithm. The flat field of X-ray in the DR detector could be guaranteed with this result.

Key Words: digital radiography, CsI(Tl), pixel value, flat field correction

1. INTRODUCTION

For non-uniformity correction a flat field x-ray image is needed, and to obtain it the center of detector is usually aligned with the focal spot of the x-ray tube, which is conserved when examining patients to preserve the flat field. In some of radiographic techniques, however, it is necessary to move the x-ray tube off the center position of detector or tilt the detector. We investigated the effect of detector tilting on the non-uniformity correction, and propose a method to reduce the effect using a new algorithm.

2. MATERIALS AND METHODS

We used Trixell detector (pixium 4600) which has a pixel size of 143 micrometers, X-ray tube (Eureka), and dosimetry equipment (Radcal, 2026C: 20X6-60). The sensor array of the detector was made of hydrogenated amorphous silicon (a-Si:H) and the scintillating layer was CsI(Tl). Gain images were taken with the exposure condition of 70 kVp and 3 mAs in two SIDs. Pixel values at second SID was calculated using the pixel values at first SID, gain coefficient that represents pixels own unique radiation sensitivity characteristics and the formula based on the solid angle of each detector pixel facing to the x-ray source. Gain coefficient was adjusted using the difference between calculated and real pixel values. Calculation was repeated with new gain coefficient until the gain coefficient was converged into prescribed range. Non-uniformity of blank x-ray images taken with the detector tilted by 0 to 45 degrees was corrected and five ROIs across the image were defined and analyzed.

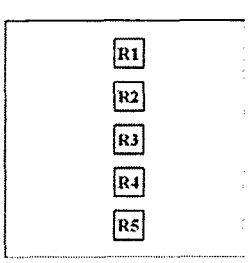
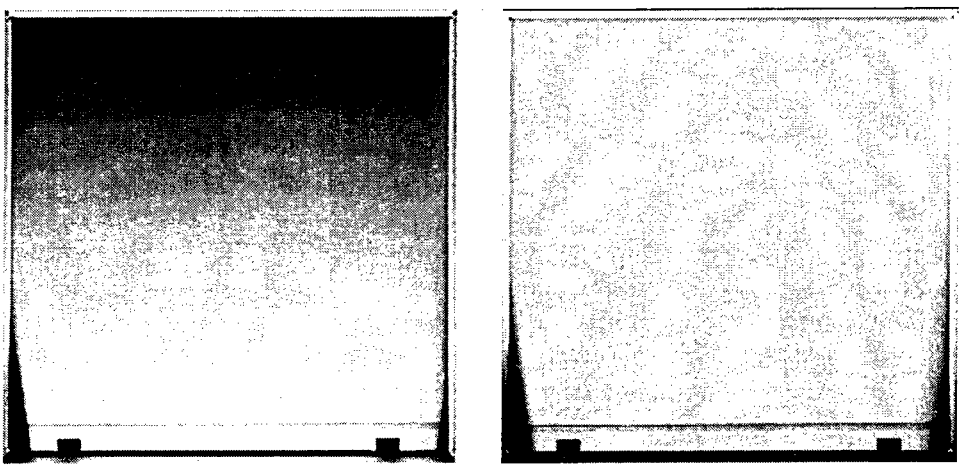


Fig. 1. ROIs for analyzing image

3. RESULT AND CONCLUSION

With a blank image obtained with the detector tilting angle of 45 degrees the lowest ROI mean value was 53% less than the highest ROI mean value when usual non-uniformity correction was performed. When the proposed algorithm was used for the flat field correction standard deviations of pixel values in the ROIs were reduce to 10% of the cases of usual flat field correction.



(a) (b)

Fig. 2. Images taken with the detector tilted by 45 degrees.
(a) raw image, (b) corrected image using the method supposed in this study.

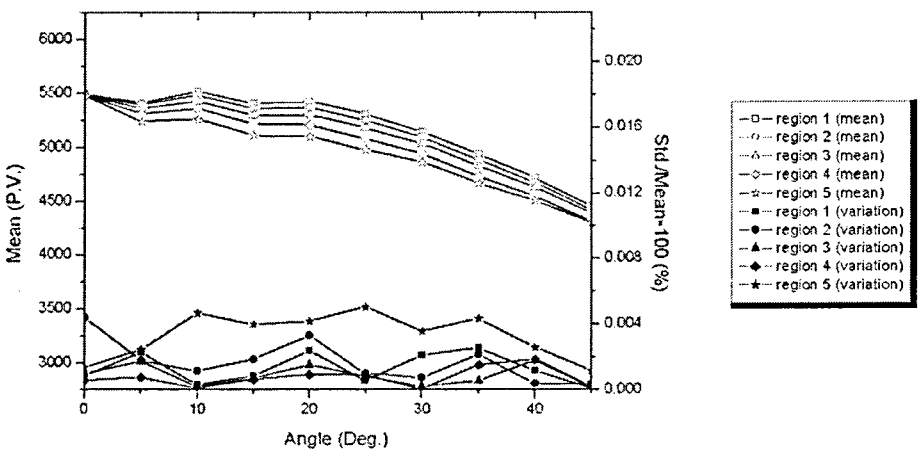


Fig. 3. Mean pixel values and standard deviations of each ROIs according to the tilting angle

반복적인 방법을 이용한 임의의 DR detector 위치에서의 flat field correction 방법 연구

가톨릭대학교 의공학교실

김도일 · 이형구 · 김성현 · 박대섭 · 최보영 · 서태석

디지털 래디오그래피 시스템을 이용하여 환자를 진료하기 위해서는 전처리 과정을 통해 DR 디텍터의 불량화소와 선을 제거하고 offset과 X선의 불균질성을 제거해야만 한다. 불균질성을 제거하기 위해 X-선의 flat field 영상이 필요하며 이는 X선관의 focal spot과 디텍터의 중심과 일치시켜 X선을 디텍터에 수직으로 입사시켜 얻는다. 이러한 영상 촬영구조는 환자를 촬영할 때에도 그대로 유지된다. 하지만 방사선 촬영 기법 중 여러 가지 요인으로 디텍터의 중심과 X선관의 중심을 일치시키지 않거나 디텍터를 기울여 촬영하는 방법들이 있다. 본 연구에서는 디텍터가 기울어져 있거나 또는 임의의 위치에서의 flat field correction 방법의 영향을 분석하고, 새로운 알고리즘을 이용하여 그 영향을 줄이고자 하였다. 본 연구의 결과로 DR 디텍터에서 X선의 flat field를 최대한 보장할 수 있을 것이다.

중심단어: 디지털 래디오그래피, CsI(Tl), 화소값, flat field correction