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Evaluation of an Imager-Based Automatic Exposure Control System for Mobile Radiography

Thomas Jefferson University

Trevor Vent, PhD[1]; Eric Gingold, PhD[1]

[1]Thomas Jefferson University, Philadelphia PA

ABSTRACT

Purpose: To evaluate the performance of a digital, imager-based automatic exposure control (AEC) system for bedside radiography that uses a low-dose scout image to adaptively select x-ray technique, and to compare its exposure control and image quality performance with conventional ion-chamber AEC.

Methods: Phantom-based experiments were performed to evaluate S-AEC, a detector-based AEC feature of the Samsung GM85 Elite mobile x-ray unit. This system acquires a low-dose scout image, segments the image to identify anatomical regions of interest, and computes the exposure time for the diagnostic acquisition. Polymethyl methacrylate (PMMA) slabs from 0–30 cm thickness in 5 cm increments were imaged using an Abdomen AP Supine processing protocol. Additional acquisitions were performed using quality assurance phantoms (Leeds TOR-18FG, Fuji OneShot) and an anthropomorphic pelvis phantom. Matched measurements were obtained on a conventional radiographic system using ionization chamber–based AEC. For each acquisition, exposure index (EI) relative to a target receptor dose of 2.5 µGy (EI = 250) was recorded. Image quality was quantified using contrast-to-noise ratio (CNR) measurements from standardized regions of interest.

Results: Across PMMA thicknesses and phantom types, S-AEC exposures were within 25% of the target EI for all but the lowest-attenuation conditions. DI values closer to zero indicate EI consistency was superior to that achieved using conventional ion-chamber AEC. For abdomen protocol on each system with 20 cm of PMMA above the Leeds phantom, CNR values were slightly higher for S-AEC compared with the conventional AEC system.

Conclusion: A scout-based, fully digital AEC system for mobile radiography achieved reliable target exposure control and demonstrated improved contrast-to-noise performance relative to conventional ion-chamber AEC. These results suggest that algorithm-driven exposure control may provide a clinically meaningful advantage for portable radiography.

INTRODUCTION

Automatic Exposure Control (AEC) is a feature of radiography that automatically terminates the radiation exposure once a preset amount of radiation reaches the image receptor. The primary goal is to ensure consistent diagnostic image quality using the amount of radiation necessary to achieve a desired average detector air kerma, corresponding to a target signal-to-noise ratio (SNR). The most common implementation of AEC uses thin, low-attenuation ionization chambers placed just in front of the image receptor. These ionization chambers produce a time-integrated electrical signal that terminates the exposure when that signal reaches a predetermined reference voltage. This implementation works very well in radiographic rooms with Bucky assemblies. This approach has not been practical in bedside/mobile radiography settings.

Recently, an equipment manufacturer (Samsung) introduced a method to achieve AEC using a signal obtained directly from an electronic flat-panel image receptor to terminate the radiographic exposure[1,2]. The purpose of this study was to evaluate this novel AEC system, known commercially as "s-AEC". The exposure time is determined using a brief low dose "scout" image. An algorithm segments the scout image, identifies the anatomy of interest, and prospectively calculates an exposure time to achieve the target SNR. A fixed time exposure is then performed. This approach is driven by image-based analysis rather than in-beam feedback.

In this work we compare traditional ion chamber AEC with scout-image based AEC under matched imaging conditions, using Exposure Index (EI) and Contrast to Noise Ratio (CNR) as endpoints.

METHODS AND MATERIALS

- Matched radiographic image sets were acquired using two automatic exposure control approaches:
  - A conventional radiographic system with ion chamber–based AEC (**IC AEC**)
  - A mobile digital radiography system using image-derived smart AEC (**s-AEC**)
- AEC consistency was assessed using polymethyl methacrylate (PMMA) blocks of increasing thickness in 5 cm increments (from 0-30 cm).
- Images were acquired using a target detector dose of 2.5 µGy, and the exposure index (EI) was recorded for each PMMA thickness.
- AEC performance was evaluated based on each system's ability to maintain a consistent EI across the tested range of attenuation conditions (**Fig. 1**).
- Contrast-to-noise ratio (CNR) was evaluated using a Leeds TOR-18FG phantom containing 18 contrast-detail targets ranging from 0.9% to 16.7% contrast within a uniform background (**Figs. 2** and **3**).
- The Leeds phantom was radiographed using both AEC systems, and CNR was measured for each contrast target (**Fig. 4**).
- Additional images of an anthropomorphic pelvis phantom were acquired on both systems to support qualitative image quality comparison (**Figs. 5** and **6**).

RESULTS

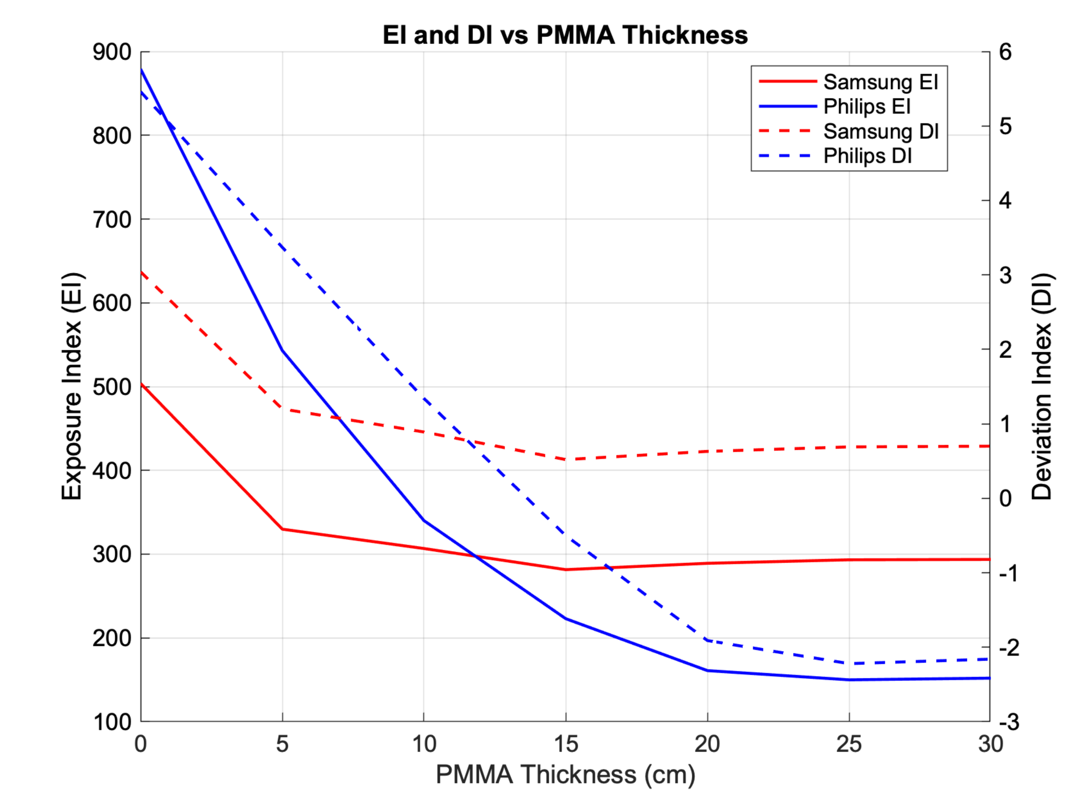
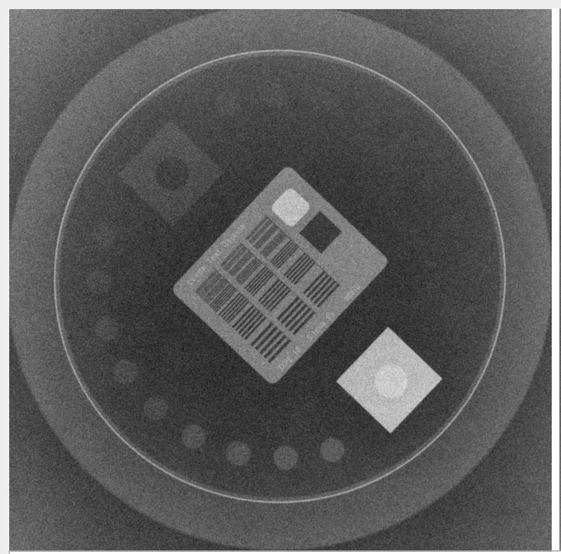


Figure 1. Exposure Index (and corresponding Deviation Index DI) for varying PMMA thicknesses.



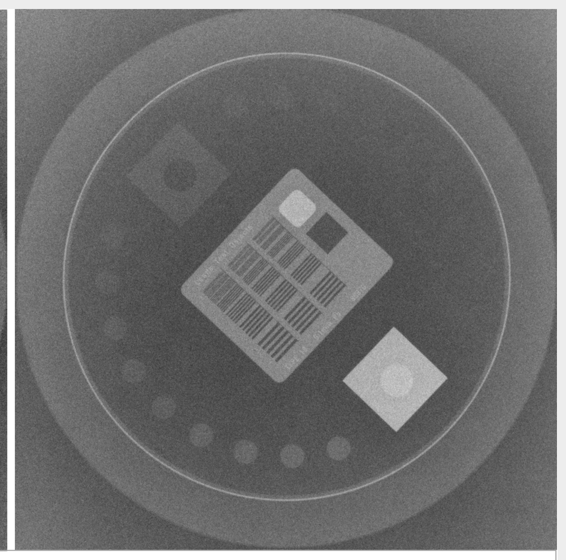


Figure 2. Samsung DR with s-AEC

Figure 3. Philips DR with conventional IC AEC

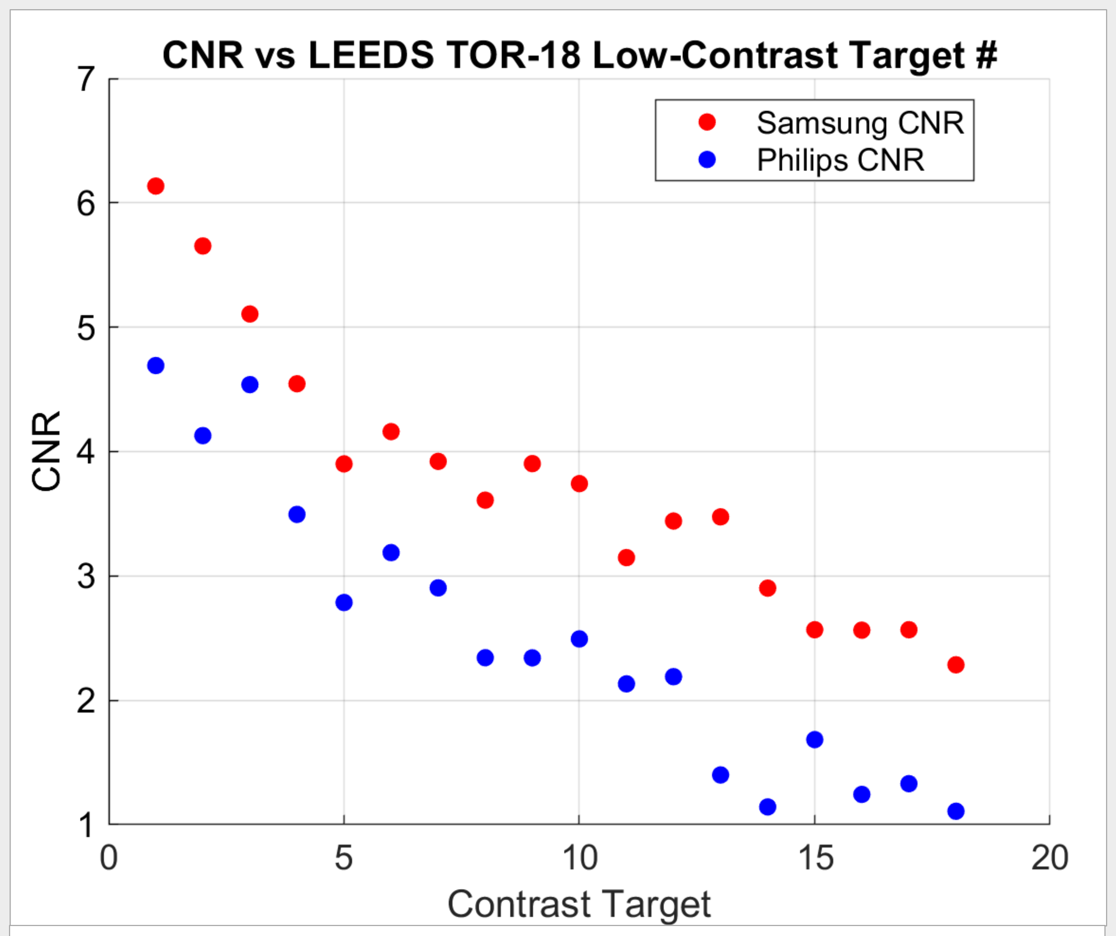


Figure 4. CNR vs contrast for 18 targets in Leeds TOR-18FG phantom for 2 different DR systems. Exposures were matched.

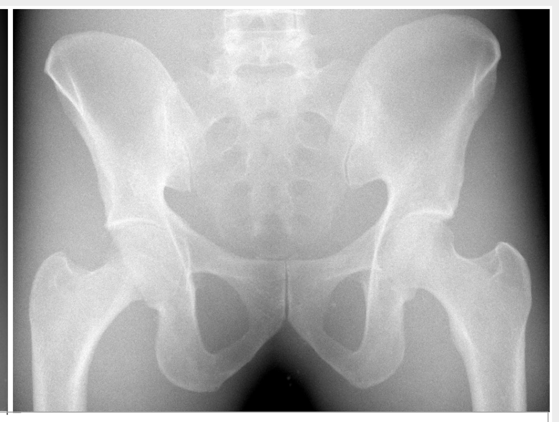


Figure 5. Samsung DR with s-AEC

Figure 6. Philips DR with conventional IC AEC

DISCUSSION

- Across clinically relevant attenuation conditions, S-AEC produced EI values nearer to the target EI and less dependent on phantom thickness than those obtained using conventional IC AEC.
- The largest deviations from the target EI occurred at the lowest attenuation conditions, where both AEC methods produced extremely short exposure times of less than 100 ms.
- CNR values were consistently higher for S-AEC than for IC AEC.
- Given the similar CsI indirect detection technologies of both systems, the observed differences are attributed primarily to differences in exposure modulation strategy and image processing rather than detector performance.
- These findings demonstrate that an image-based, algorithm-driven AEC system can provide consistent and reliable exposure control while maintaining image quality commensurate with, and in some cases superior to, conventional ion chamber–based AEC.

CONCLUSIONS

This work demonstrates a quantitative, physics-based framework for comparing fundamentally different AEC strategies under matched imaging conditions. By evaluating EI consistency alongside CNR, the method separates exposure control accuracy from downstream image quality effects. This approach is broadly applicable to emerging digital and algorithm-driven AEC implementations and provides physicists with a practical evaluation strategy that extends beyond simple detector air kerma verification.

REFERENCES

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2. Cha YK et al. Efficacy of a new detector automatic exposure control in portable anteroposterior chest radiography: a retrospective examination of radiation dose optimization and image quality. Acta Radiologica 67(1) 60-66, 2026.

For more information contact:

Trevor.Vent@jefferson.edu

Eric.Gingold@jefferson.edu