A Close Assessment of X-ray Image Enhancement Techniques for Contraband Detection

Sajid Ullah Khan
Department of Computer Science,
CECOS University,
Peshawar, Pakistan
Sajdi786@yahoo.com

Wang Yin Chai
Faculty of Computer Science and Information Technology,
Universiti Malaysia Sarawak,
Kuching, Malaysia
ycwang@fit.unimas.my

Najeeb Ullah
Department of Computer Science, CECOS University,
Peshawar, Pakistan
Najeebullah1984@gmail.com

Engr. Abdul Rauf
DCS, USTB, Bannu,
Pkaistan
engr_rauf_khan@hotmail.com

***Abstract*-X-ray image enhancement plays a vital role in the detection of explosive or illicit objects. X-ray image viewability is still a challenging task. To overcome this task, in this paper, we compare both new and old techniques of X-ray image enhancement for baggage inspection system on the basis of nine statistical measures of X-ray image viewability. From the experiments, it is concluded that some new techniques outclass the recent X-ray image enhancement methods that are regularly used at airports. From the viewability measurements, it is concluded that airport security baggage inspection system must be updated with our suggested enhancement approaches.**

Keywords: Deep Boost, Histogram Equalization, Crystal Clear, Viewability measures, X-ray Image Enhancements

I. INTRODUCTION

Baggage Inspection system used at airport uses only Deep Boost (DB), Histogram Equalization (HE) and Crystal Clear (CC) techniques for X-ray image enhancement. Our experience with airport screener's, it is well understood that these approaches only deliver a minimal benefit over the real X-ray images of airport baggage. These applications can degrade X-ray image quality in some cases. In this paper, we compare these state of the art techniques with some newly developed techniques on real and simulated X-ray images. We compare both new and old techniques of X-ray image enhancement for baggage inspection system on the basis of nine statistical measures of X-ray image viewability.

Below are the following reasons which must be known before going to improve the X-ray image quality.

i) Baggage inspection system provides X-ray images in 3 different colors on the basis of the atomic composition of the image being imaged. I.e. orange for organic material, blue for inorganic and green for mixed.

ii) The X-ray inspection systems have many image manipulation options and approximately screeners are not familiar with all functionality to allow them to use the accurate choice/techniques.

iii) The human judgment of X-ray images thru different operators is not identical. The performance of different screeners can be same with respect to their ability of pointing out illicit objects. However, it must be different in term of X-ray image quality grading. For the said reason, viewability measures remain a challenging task. The resulting image is very much close to a given original image. It is difficult to develop objective metrics that assess image quality without a reference image [1].

iv) Most screeners normally enhance the X-ray image once using HE approach and work with it. Since each screener take a decision on each bag within a 6 second, therefore, most of the functions never get used. "Fig. 1" shows X-ray baggage inspection system images.

II. X-RAY IMAGE ENHANCEMENT APPROACHES

In this paper, we take a close assessment of two commercially used approaches Histogram equalization and Crystal clear with 13 enhancement techniques from the literature. These enhancement techniques include:

High-boost Filter (HBF) [2], High-pass filter (HPF) [3], Adaptive Contrast Enhancement (ACE) [5], Adaptive Un-sharp masking (AUM) [3-4-6], Extreme Value Sharpening (EVS) [5], Cubic Un-sharp Masking-Un-separable (CUMN) [7], Product of Linear Operators (PLO) [8], Local Adaptive Scaling (LAS) [5], Fuzzy Contrast Enhancement (FCE) [9], Cubic Un-sharp Masking- Separable (CUMS) [7-3], Potential Functions (PF) [10], Gray Level Slicing (GLS) [11-12], Histogram Matching (HM) [13].