Improving Object Classification in X-ray Luggage Inspection

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(ABSTRACT)

X-ray detection methods have increasingly been used as an effective means for the automatic detection of explosives. While a number of devices are now commercially available, most of these technologies are not yet mature. The purpose of this research has been to investigate methods for using x-ray dual-energy transmission and scatter imaging technologies more effectively.

Followed by an introduction and brief overview of x-ray detection technologies, a model for a prototype x-ray scanning system, which was built at Virginia Tech, is given. This model has primarily been used for the purpose of system analysis, design and simulations. Then, an algorithm is developed to correct the non-uniformity of transmission detectors in the prototype scanning system.

The x-ray source output energy in the prototype scanning system is not monochromatic, resulting in two problems: spectrum overlap and output signal unbalance between high and low energy levels, which will degrade the performance of dual-energy x-ray sensing. A copper filter has been introduced and a numerical optimization method to remove thickness effect of objects has been developed to improve the system performance.
The back scattering and forward scattering signals are functions of solid angles between the object and detectors. A given object may be randomly placed anywhere on the conveyor belt, resulting in a variation in the detected signals. Both an adaptive modeling technique and least squares method are used to decrease this distance effect.

Finally, discriminate function methods have been studied experimentally, and classification rules have been obtained to separate explosives from other types of materials. In some laboratory tests on various scenarios by inserting six explosive simulants, we observed improvements in classification accuracy from 60% to 80%, depending on the complexity of luggage bags.