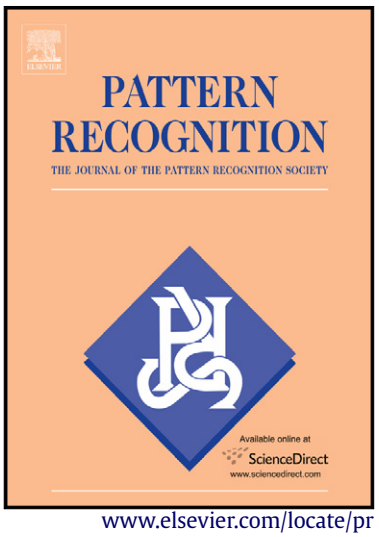

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Object Classification in 3D Baggage Security Computed Tomography Imagery using Visual Codebooks

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Abstract

We investigate the performance of a Bag of (Visual) Words (BoW) object classification model as an approach for automated threat object detection within 3D Computed Tomography (CT) imagery from a baggage security context. This poses a novel and unique challenge for rigid object classification within complex and cluttered volumetric imagery. Within this context it extends the BoW model to 3D transmission imagery (X-ray CT) from its conventional application in 2D reflectance (photographic) imagery. We explore combinations of four 3D feature descriptors (Density Histogram (DH), Density Gradient Histogram (DGH), Scale Invariant Feature Transform (SIFT) and Rotation Invariant Feature Transform (RIFT)), three codebook assignment methodologies (hard, kernel and uncertainty) and seven codebook sizes. Optimal performance is achieved using the DH and DGH descriptors in conjunction with an uncertainty assignment methodology. Successful detection rates in excess of 97% for handguns and 89% for bottles and false-positive rates of approximately 2-3% are achieved. We demonstrate that the underlying imaging modality and the irrelevance of illumination and scale invariance within the transmission imagery context considered here, result in the favourable performance of simpler density histogram descriptors (DH, DGH) over 3D extensions of the well-established SIFT and RIFT feature descriptor approaches.

Keywords: 3D Object classification, Bag of (Visual) Words, 3D descriptors, SIFT, RIFT, baggage-CT

1. Introduction

Baggage screening plays a central role within the aviation security domain [1]. Recent advances in airport-security regulations (European Civil Aviation Conference (ECAC) Standard 3 screening regulations [2]) will see high-speed variants of 3D X-ray Computed Tomog-

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