8th INMM/ESARDA Joint Workshop: Position Paper

Arms Control: Balancing transparency vs. protection of sensitive information
Arms Control: Novel Technologies for Arms Control Verification

Cooperative Verification Using Radiography Behind an Information Barrier

Charles Little, Tom Weber, Chris Wilson: ***Sandia National Laboratories, Albuquerque, NM***

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Position Statement

Treaty inspectors must verify the authenticity or identity of items that contain sensitive features without actually revealing the sensitive data. Sandia National Laboratories has developed a technology utilizing radiography, combined with automated image processing algorithms, to create a novel method of verification that does not process or store sensitive information.

Radiography is a powerful inspection tool. Direct image comparisons can be used to verify the existence or absence of parts. It can also be used to authenticate that a current part matches a previously imaged part. However, it also reveals a great deal of detail about an item, some of which is sensitive data that may not be revealed by a verification agreement.

Our technique utilizes feature matching in radiographic images of complex items. The SURF (Speeded Up Robust Features) method is used to extract features from the images. FLANN (Fast Learning Artificial Neural Network) is used in the matching process. The feature list becomes the template. The SURF features are somewhat rotation, scale, and translation invariant, which means the reference and target images need not be taken from the exact same position for the source and film, making data collection easier. A significant discovery is that we can discard the position, size, and orientation information of the features and still perform the matching adequately. Without this information, geometry cannot be recovered; we believe it is impossible to reconstruct the image in this case, creating an irreversible transform that creates non-sensitive feature lists, or templates. This method is analogous to using a paper shredder to prevent reconstruction of an original while still being able to match features from the individual shredded pieces.

We propose a non-recording radiography system, combined with our image processing technologies to create non-sensitive template data, which can be used behind an information barrier. The matching process, which uses non-sensitive data, can be completed outside the information barrier; this enables a trusted verification system, reducing the complexity of the system within the information barrier.

Results of these image processing techniques on radiography simulations are promising, showing high correlation between features from identical items, even at slightly different measurement angles. Items not matching the original have significantly lower correlation with the feature set, enabling an automated decision process. These results are shown in figures 1 and 2 below.

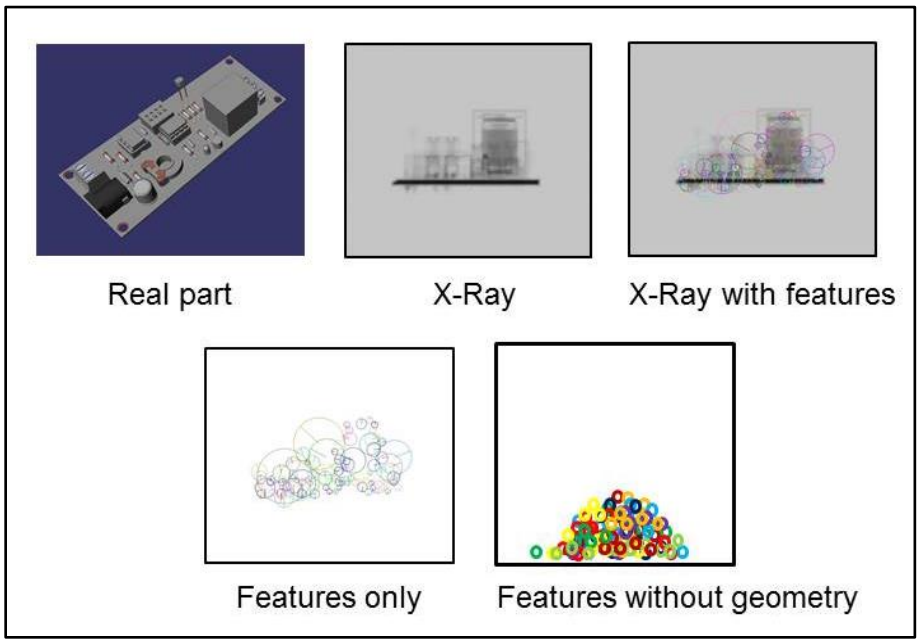

Figure 1: Radiograph to non-sensitive feature template

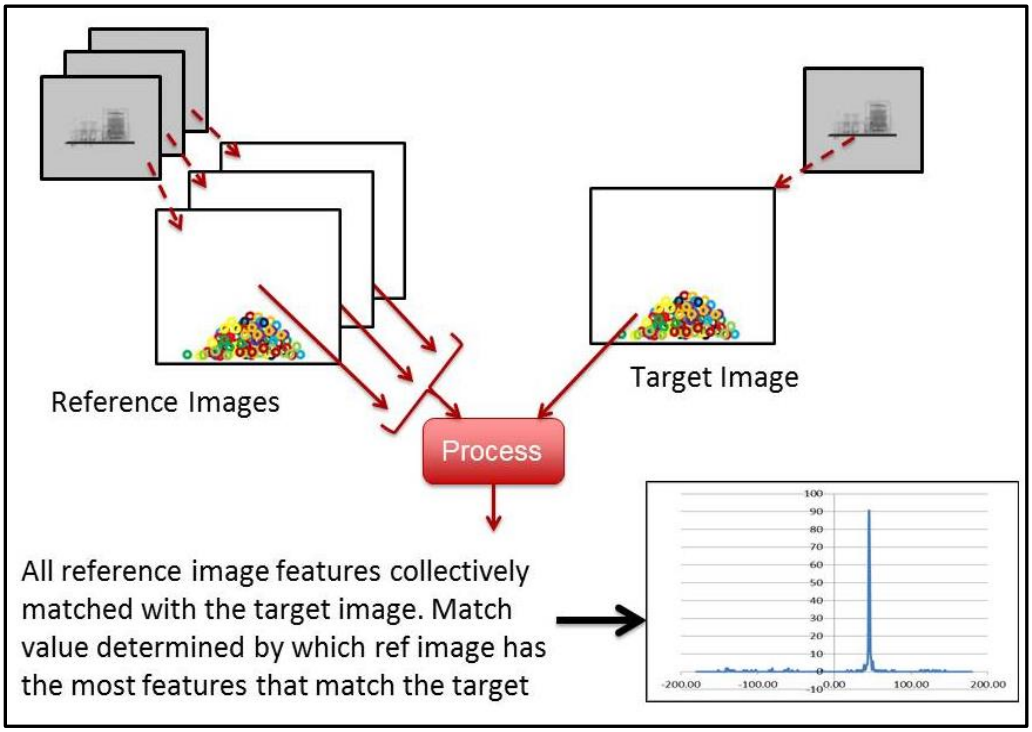

Figure 2: Feature matching for verification

We have also matched real radiography images against our CAD model based reference sets and verified good performance. This is important, since it may be difficult to obtain full reference sets by real-world radiography due to cost, safety, or security constraints. Instead, reference feature sets can be constructed through simulation only using CAD models of the real world objects. Building reference feature sets from simulated radiography based on CAD models could be provide an alternative to taking large numbers of radiographic images to generate reference feature sets.