Multi-view Object Detection Using Epipolar Constraints within Cluttered X-Ray Security Imagery

Brian K. S. Isaac-Medina*, Chris G. Willcocks*, Toby P. Breckon†
Department of {*Computer Science, †Engineering}, Durham University, UK

**Issue:** The use of information from multiple views in X-ray security object detection

**Approach:** Epipolar constraints are imposed to improve object detection in uncalibrated multi-view X-ray baggage imagery (i-iv).

(i) **Fundamental matrix** is estimated using ground truth object-level bounding box centroids as point correspondences.

\[ x = \hat{x} + \Delta x + \Psi_b \]
\[ \Delta x \sim N(\mu, \sigma^2) \]

(ii) **Detection distance to the epipolar line.** Given a detection \( \mathcal{B} \) in one view, the distance \( d' \) of the centroid \( \mathbf{x}' \) of \( \mathcal{B}' \) in the second view is modeled as \( d'(\mathbf{x}', \mathbf{f}) \sim N(\mu_e, \sigma^2_e) \).

(iii) **Epipolar detection confidence.** The distance to the epipolar line is used to get an epipolar detection confidence.

\[ p(d') = 
\text{erfc} \left( \frac{d' - \mu_e}{\sqrt{2}\sigma_e} \right) \]

(iv) **Multi-view Filtering.** The detection confidence is multiplied by \( p(d') \) and filtered by a threshold before Non Maximum Suppression (NMS).

**Results**
- **Detector:** YOLOv3\(^{[1]}\). **Metric:** MS COCO\(^{[2]}\).
- AP increased +2.2% and AP\(_{0.5}\) increased +2.8%, without affecting the recall.
- Precision improvement is due to elimination of false positives.

**Conclusions**
- Fundamental matrix estimation using bounding box centroids.
- Epipolar confidence reduces false positives.
- Improved benchmark against single-view
  - AP increased +2.2% and AP\(_{0.5}\) increased +2.8%
  - Recall was unaffected

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