# Detecting Regions from Single Scale Edges

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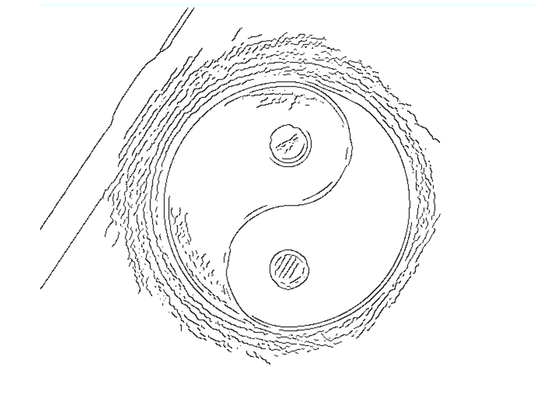
## Motivation & Approach

Detect blob-like regions of arbitrary shape from single scale edges.

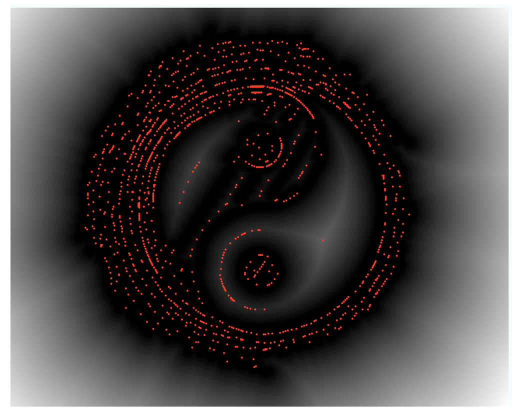
- Detect edges using relaxed thresholds
- Compute binary distance transform
- Use Delaunay triangulation of local maxima to capture underlying structure
- Use various criteria to detect salient features

## The algorithm

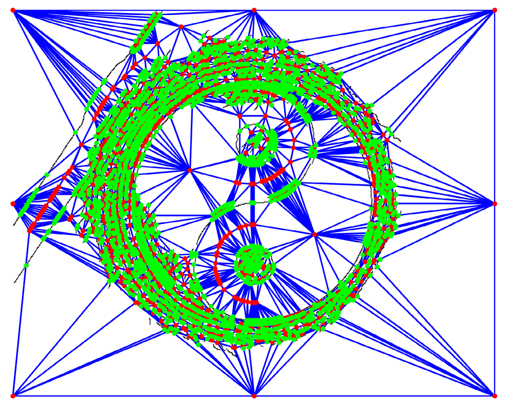


1. Edge map $F$

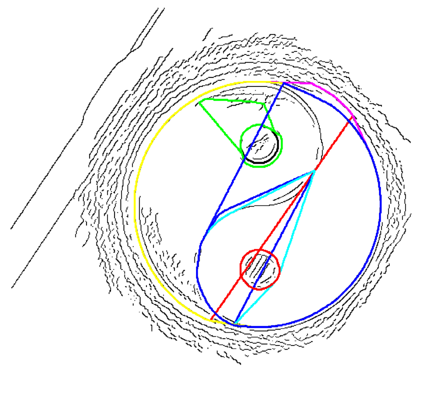
2. Distance map $D$



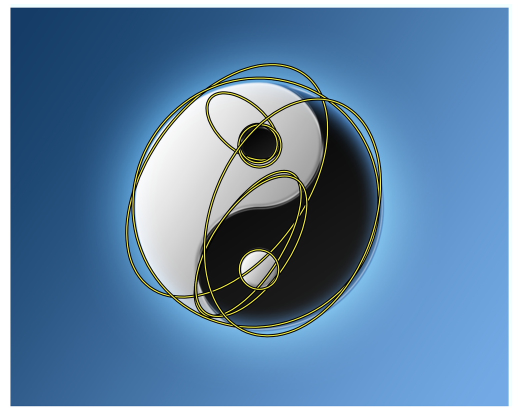
3. Local maxima $V$



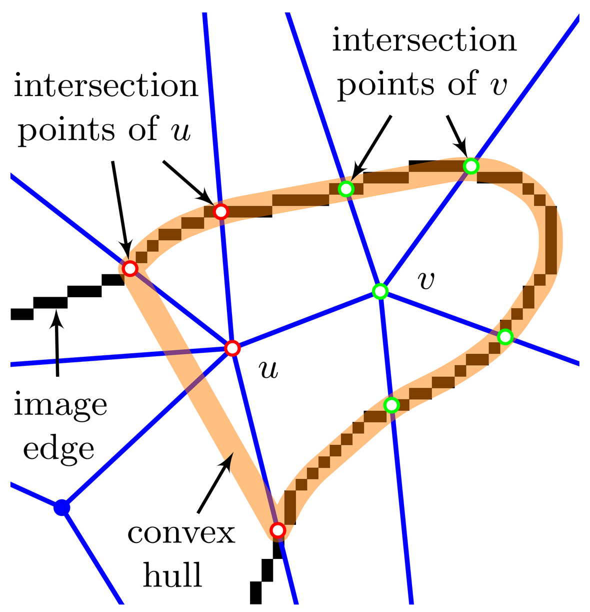
4. Delaunay triangulation $G$

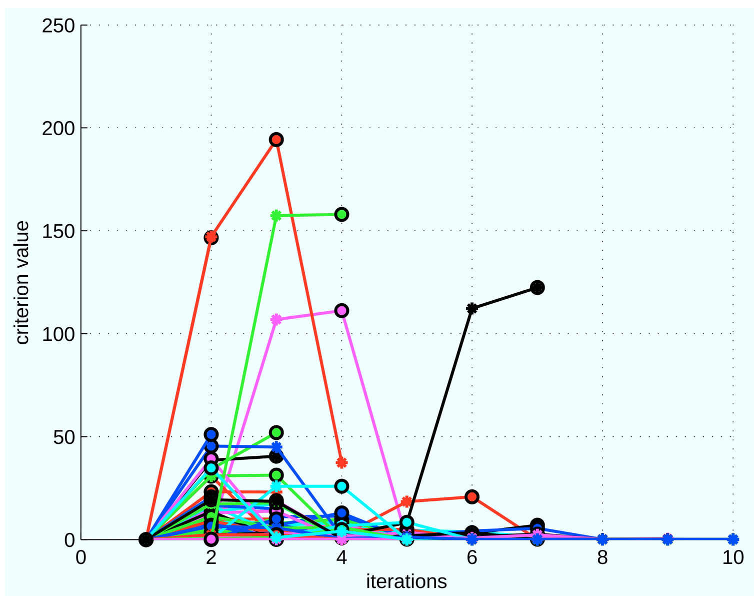


5. Convex hulls



6. Detected features



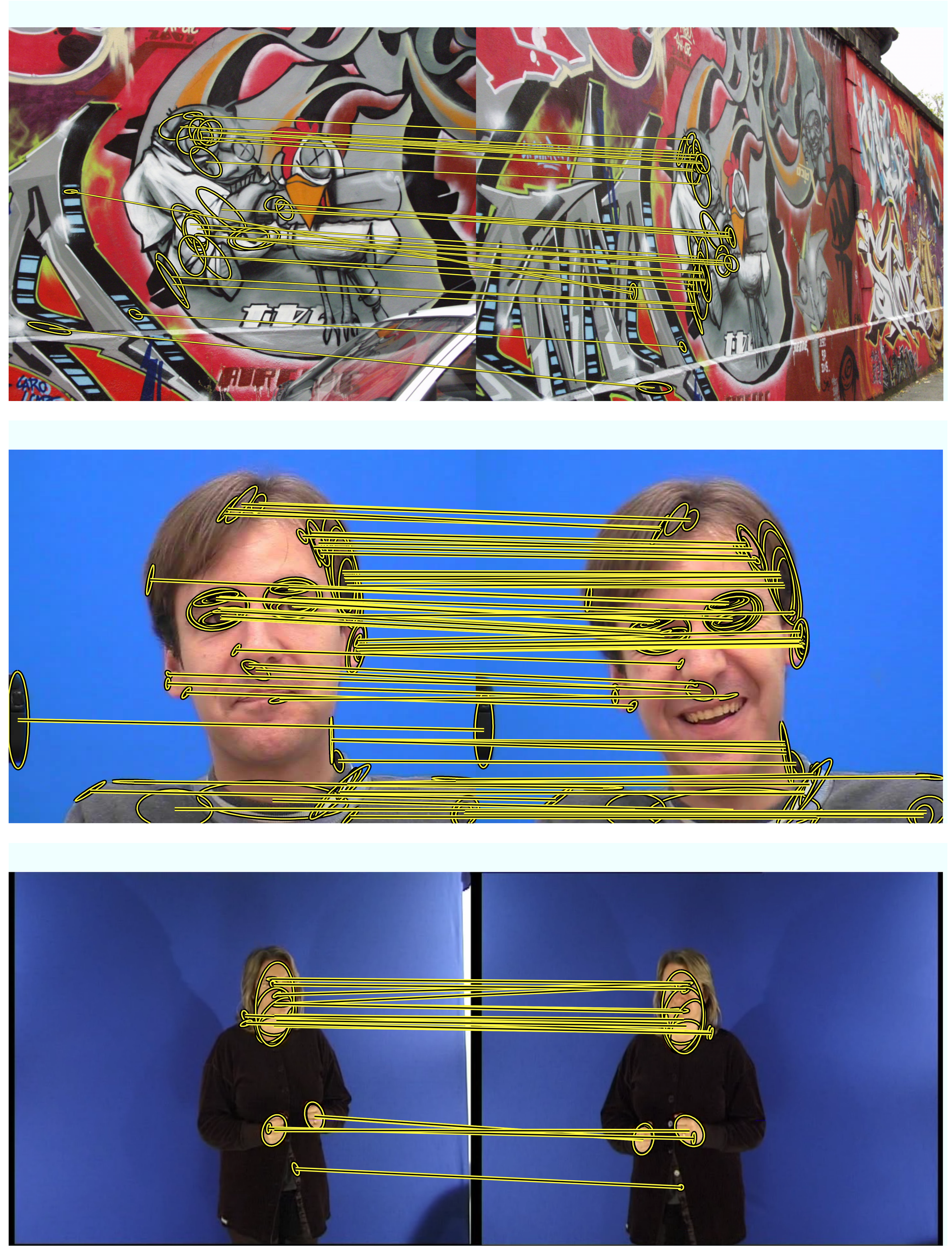

- Adjacent vertices $u, v$ correspond to neighboring local maxima of $D$.
- If there is no edge fragment lying between $u, v$, then $u$ and $v$ are likely to lie within the same region or along a ridge.
- If there is an edge fragment, then the gradient at the intersection point will determine at which iteration $u$ and $v$ will be merged, which would be equivalent to removing the fragment.
- A change in the component evolution indicates a significant change in the topology.
- The spatial extent of a region is computed from the edge fragments surrounding the vertices of the component.

## Feature detection

**Algorithm 1** Distance Transform Detector

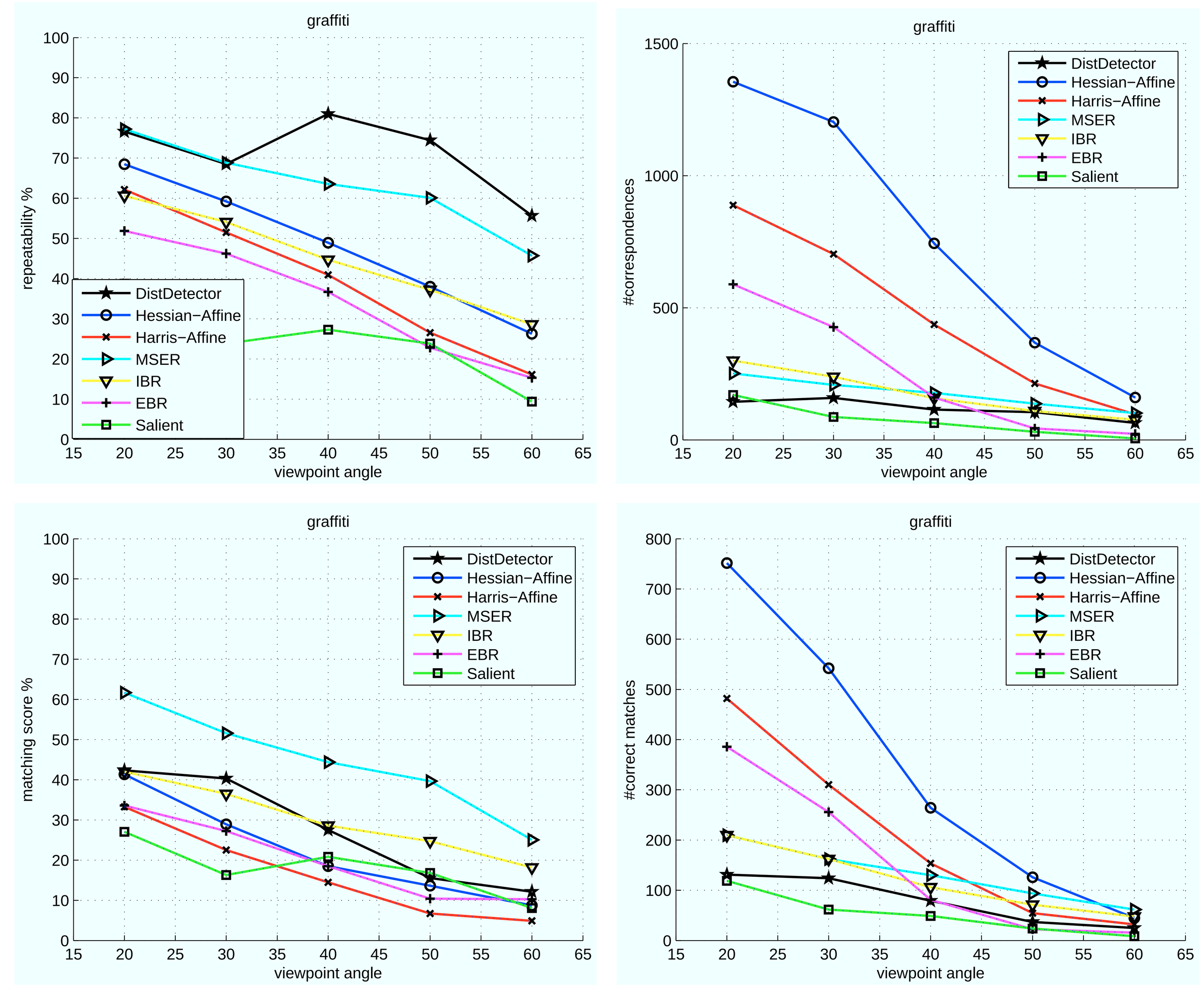
**procedure** DTD(image $I$, regions $\mathcal{R}$)
  $g \leftarrow \|\nabla G_\sigma \star I\|$ ▷ gradient magnitude at scale $\sigma$
  $F \leftarrow$ EdgeMap($I$)
  $D \leftarrow$ DistanceTransform($F$)
  $V \leftarrow$ LocalMaxima($D$)
  $G \leftarrow$ DelaunayTriangulation($V$)
  Sort($E$,$w$) ▷ sort edges by non-decreasing weight
  $t \leftarrow 0$
  $\mathcal{C} \leftarrow V$
  **for all** $e = (u, v) \in E(G)$ **do**
    $t \leftarrow t + 1$
    **if** $w(e) \leqslant \min\{\rho(C^{t-1}(u)), \rho(C^{t-1}(v))\}$ **then** ▷ check penalty
      $C^t \leftarrow$ Merge($C^{t-1}(u)$, $C^{t-1}(v)$) ▷ merge comp. of $v$ into comp. of $u$
      $\rho(C^t) \leftarrow w(e) + k/|C^t|$ ▷ update penalty
    **end if**
  **end for**
  $\mathcal{R} \leftarrow \emptyset$
  **for all** $C \in \mathcal{C}$ **do**
    $t \leftarrow \arg\max_s(\Delta\mu(C^s))$ ▷ iteration where measure change is maximized
    $H \leftarrow$ ConvexHull($N(C^t)$) ▷ neighborhood $N(C)$ defined in (5)
    $R \leftarrow$ FitEllipse($H$)
    $\mathcal{R} \leftarrow \mathcal{R} \cup R$
  **end for**
  **return** $\mathcal{R}$
**end procedure**

## Results

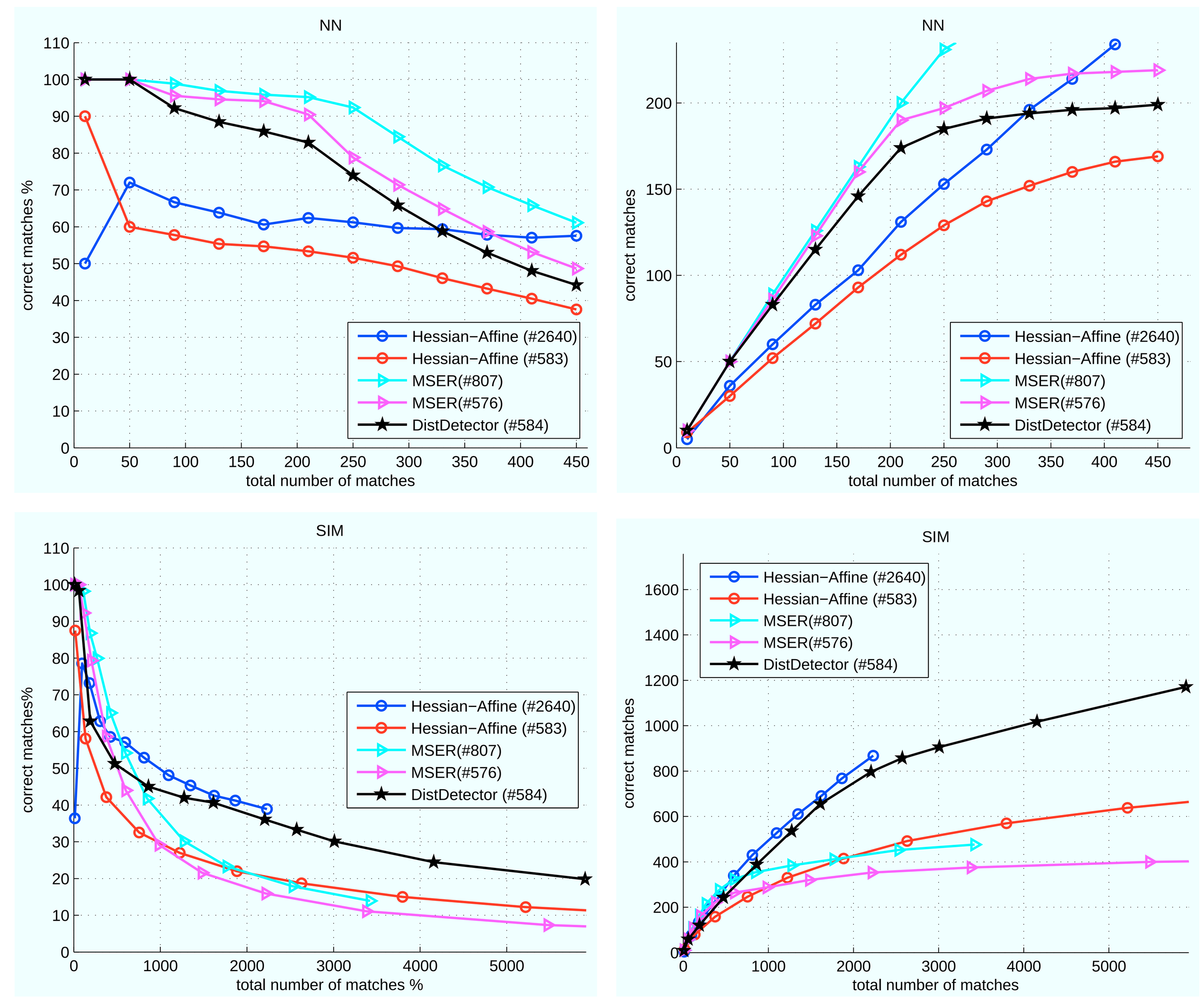


RANSAC inliers for three different pairs of images.

## Performance




Achieves a good trade-off between performance and number of features.




Performs quite well for a small number of total matches and ranks second after the MSER for the NN strategy. Outperforms both Hessian-Affine and MSER for approximately the same number of detected features under the similarity threshold strategy.

## Conclusions

- A novel feature detector based on single-scale edges.
- Compares well to state-of-the-art detectors and produces a compact set of interpretable and repeatable features.
- Potential application to wide-baseline matching and feature detection in sequences involving human activity.
- Straightforward extension to spatiotemporal data.

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