Indexing of Technical Line Drawings Based on $\mathcal{F}$-Signatures

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Context

- Large quantity of technical documentation but few studies

  $\longrightarrow$ difficult to deal with a huge variety of symbols

- Method to index technical line drawings based on the notion of $\mathcal{F}$-signature

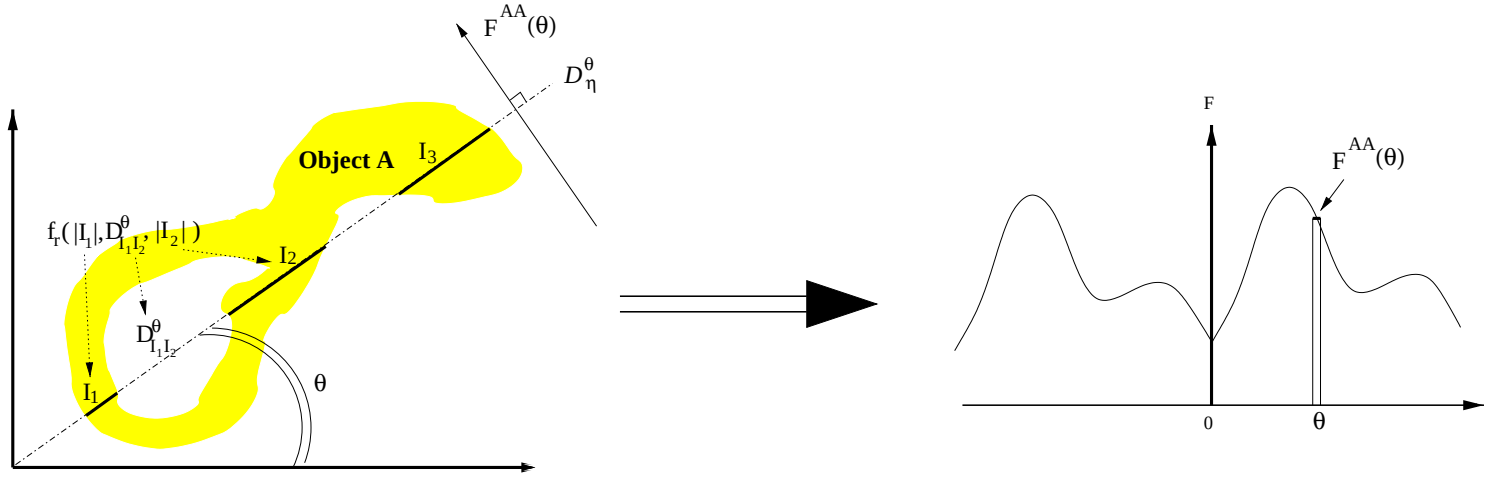
  $\longrightarrow$ low time complexity

  $\longrightarrow$ invariant to fundamental geometric transformations

  $\longrightarrow$ deals easily with complex shapes

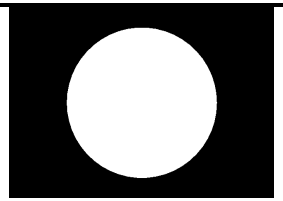
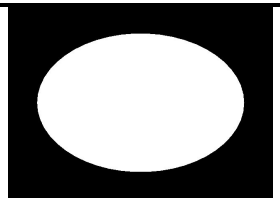
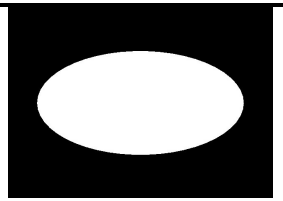
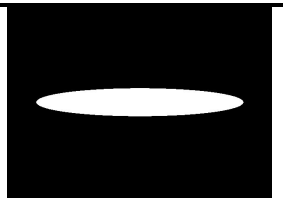
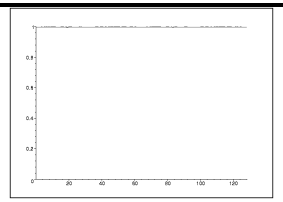
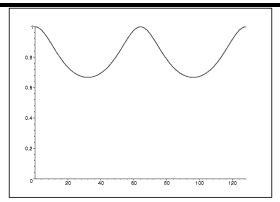
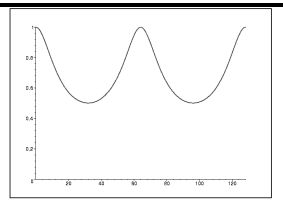
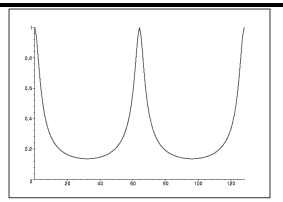
$\mathcal{F}$-signatures

Representation of the attraction forces exerted between the parts of an object following a set of directions



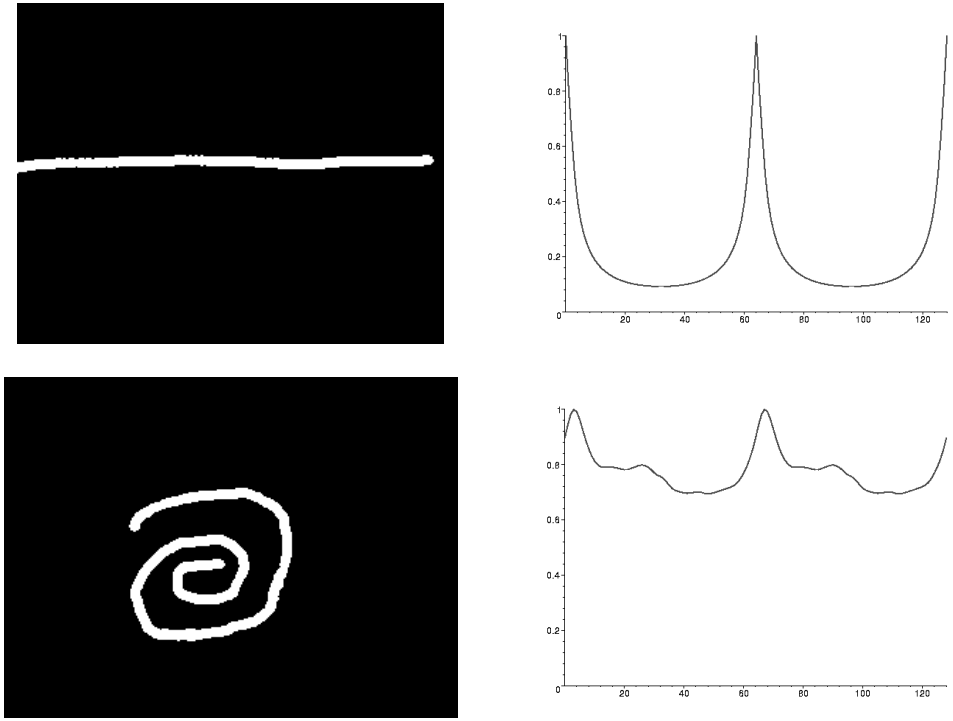
Properties

➥ Shape discrimination

				
C	1	$\frac{4}{5}$	$\frac{8}{17}$	$\frac{16}{65}$
$2D$-S				

Comparison between $\mathcal{F}$-signature and compactness degree of elliptical shapes

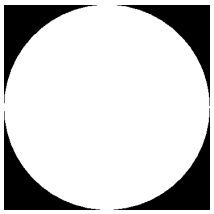
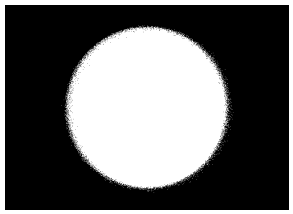
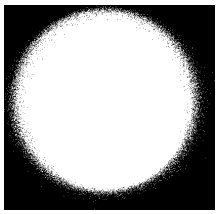
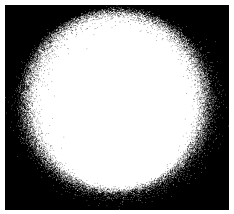
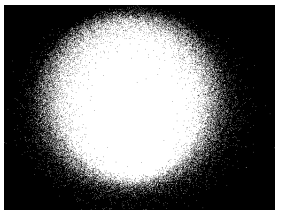
➥ More substantial information than the compactness degree



$\mathcal{F}$-signature (between $[0, 2\pi[$) and spatial representation

- Invariance properties
  - ✓ Translation: the object is processed independently of its location in the frame of the image
  - ✓ Scaling: use normalized $\mathcal{F}$-signatures
  - ✓ Rotation (after shifts): the approach is isotropic
  - ✓ Symmetry: the forces are the same following two opposite directions

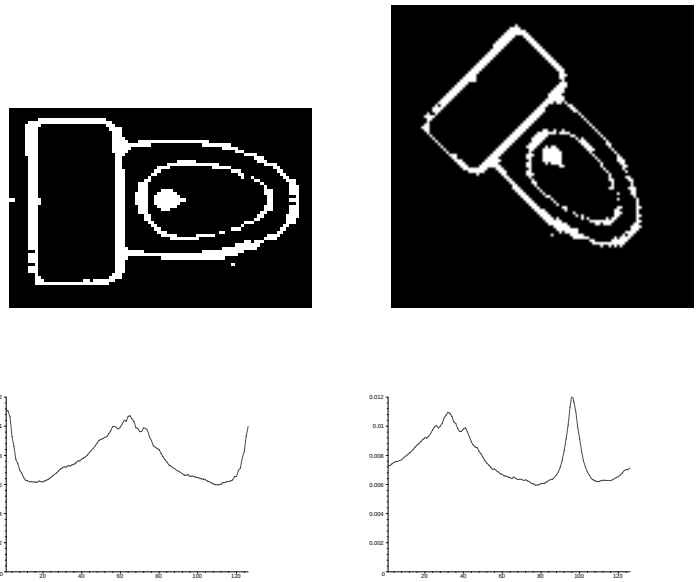
➥ Robustness to deformation

I	I_{5s}	I_{10s}	I_{15s}	I_{30s}
				
max	0.069	0.237	0.659	2.383
$\bar{\mu}$	0.043	0.13	0.315	1.185
RMS	$1.8 \cdot 6^{-5}$	$6 \cdot 10^{-5}$	$2 \cdot 10^{-4}$	$7.6 \cdot 10^{-4}$

Differences between original and degraded $\mathcal{F}$-signatures

Experimental results

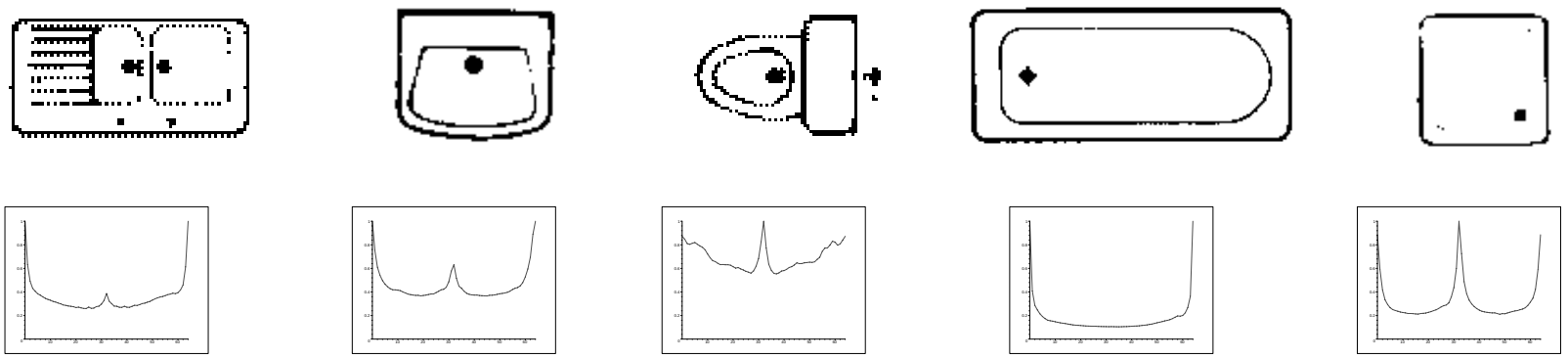
- Matching between signatures of technical symbols needs to define the angle of rotation $\Rightarrow$ optimization (similarity ratio) on the circular shifts between two histograms to be matched



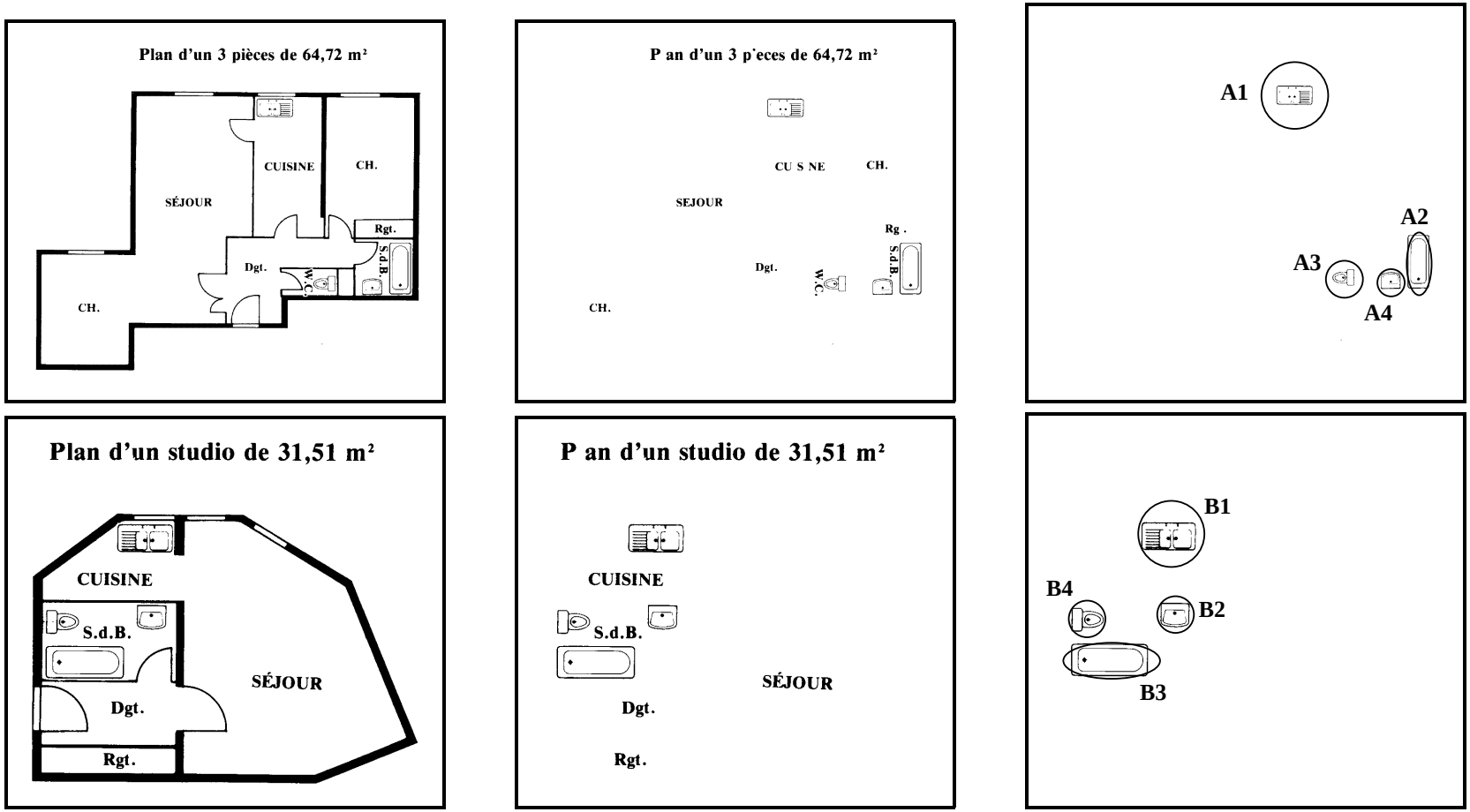
Signatures of a same object in two orientations

➥ Classification using preset clusters

Sink | Washbasin | WC | Bath | Shower



Samples used and $\mathcal{F}$-signatures ($[0, \pi[$)



Document Segmentation Result

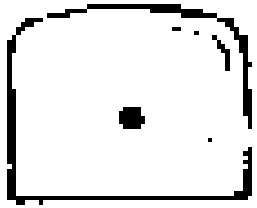
Object	A1	A2	A3	A4	B1	B2	B3	B4
Sink	**0.926**	0.427	0.505	0.707	**0.947**	0.765	0.430	0.483
Wash.	0.714	0.326	0.655	**0.915**	0.846	**0.995**	0.328	0.633
WC	0.465	0.212	**0.959**	0.697	0.550	0.647	0.213	**0.961**
Bath	0.505	**0.870**	0.239	0.334	0.427	0.362	**0.881**	0.229
Shower	0.821	0.430	0.457	0.636	0.717	0.672	0.475	0.438

Similarity ratio between samples and main graphic objects

Dealing with degraded symbols $\longrightarrow$ clusters of $\mathcal{F}$-signatures

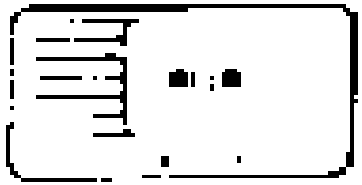
Bath

0.815



Washbasin

0.858



Sink

0.909

Similarity ratios of degraded objects which are rightly classified

Conclusion and perspectives

- A powerful signature to index complex symbols with low time complexity and nice geometric properties
- Interesting preliminary results
- Perspectives
  - ✓ processing much larger databases of technical drawings
  - ✓ construction of a binary search tree