Local Descriptor Based on Texture of Projections

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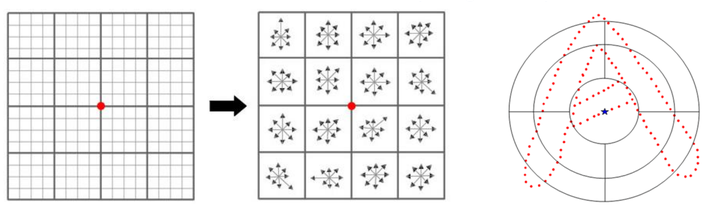
Introduction

Objective : Investigate an alternative to spatial domain histograms for developing an image descriptor.

- Gray-scale image descriptor using local Radon transform.

Grids Used for Computing Descriptors



Background

Shape/appearance information of a given region can be captured by computing histograms of features over pre-defined grids.

- Descriptors like SIFT,GLOH, Shape-Context etc.

Spatial distribution information captured is regulated by the grid used for computing histograms.

- Finer Grids → More Information. But, we tend to lose invariance

Solution: Alternate way to encode spatial distribution information based on Radon transform.

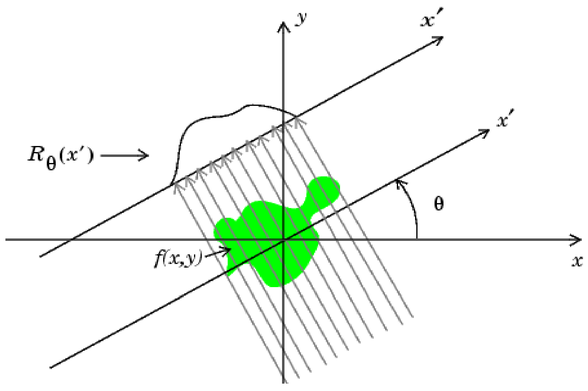
Inspiration

Separation between hands determines the appearance

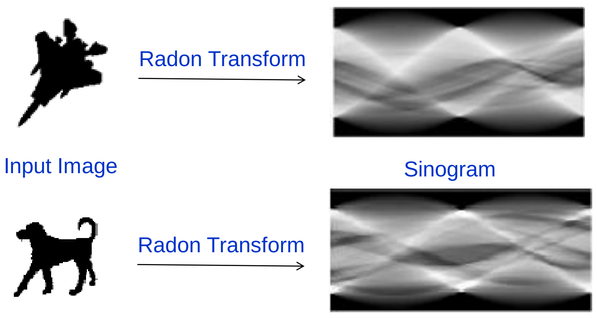
In absence of vision, separation between our hands aids our perception of shape.

How can this be mathematically modeled?

Binary Case : Radon Transform (RT) + Texture



$$R(r,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)\,\delta(x\cos\theta + y\sin\theta - r)\,dx\,dy$$



Radon transform ($R(r,\theta)$) of the image ($f(x,y)$)

- equivalent to probing the given object along its boundary.

How do we infer the shape of the object from RT?

- typically by comparing and analyzing how the value of the RT changes for different views

Earlier attempts to use Radon transform for description focused on using histogram of intensities.

- Issue: Quantization and binning

Our Idea: Texture information in projection space can capture changes in RT across views.

In our work we make use of Local Binary Patterns for capturing texture information.

Extension to Gray Scale

In RT representation ,

- For a binary image f(x,y), $R(r,\theta)$ indicates separation information between the boundaries
- For a gray Scale image f(x,y), $R(r,\theta)$ indicates the mean intensity along a line.

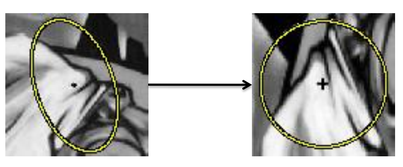
Observation : LBP over RT representation alone is not adequate for distinctive description.

To achieve the distinctiveness required,

- Descriptor is derived by concatenating texture descriptor in spatial domain along with texture descriptor computed in RT domain.

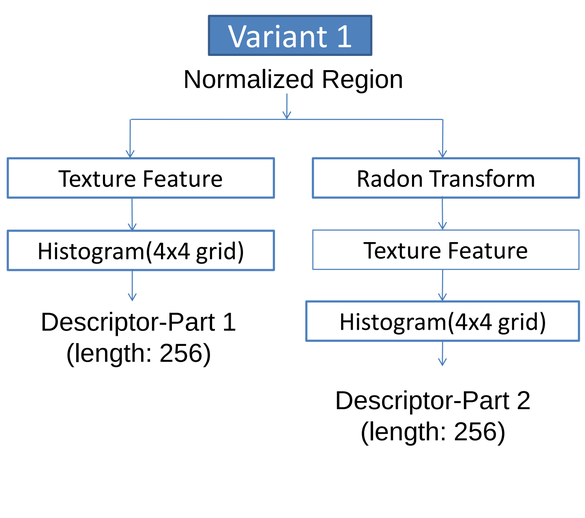
We have tested two ways to incorporate spatial distribution information using RT.

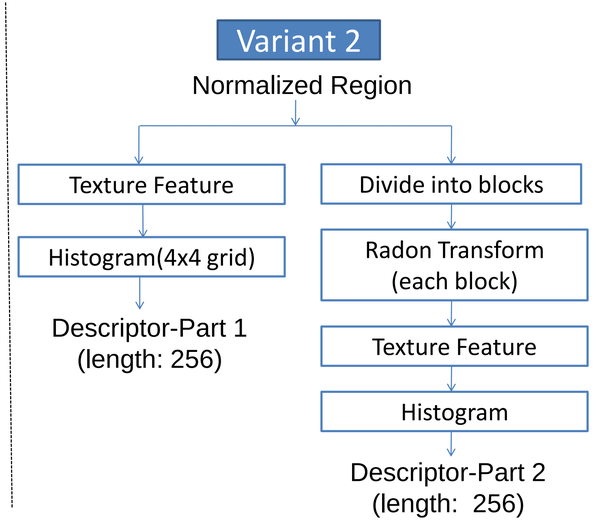
Descriptor Computation



Detected Region — Normalized Region

Detected regions are normalized to a standard size.



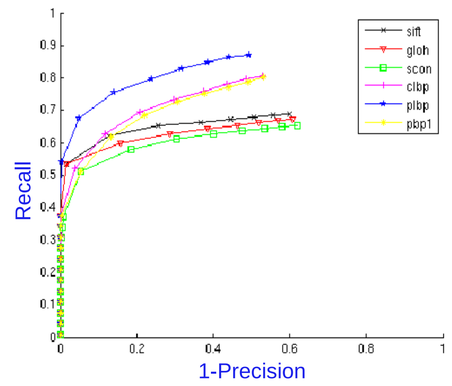


Descriptor = {Descriptor-Part1, Descriptor-Part 2}

Performance Evaluation

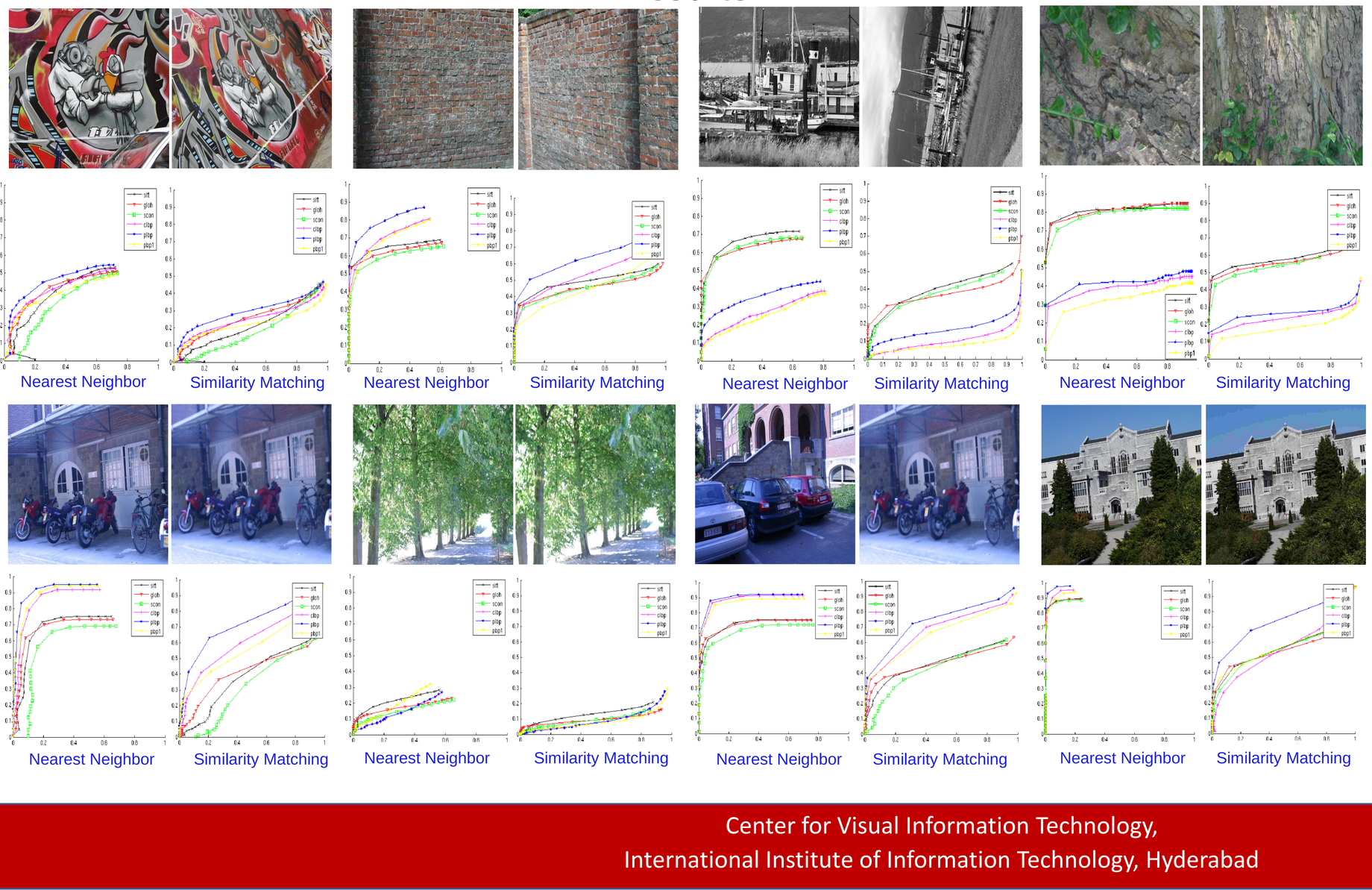
The performance of the descriptors is evaluated using recall-precision curve.

Sample Result



A comparison of affine region detectors and descriptors, K. Mikolajczyk, T.Tuytelaars, C. Schmid, Zisserman, J. Matas, F. Schaffalitzky, T. Kadir, L. Van Gool

Results



Conclusion

- Matching accuracy has improved compared to earlier descriptors.
- Results indicates that, it is possible to incorporate spatial distribution information using geometric transformations like Radon transform even in gray scale images.
- Computing texture information in Radon transform domain is a potential direction for its use in gray-scale images.

Issues to be addressed

Compactness : size of the descriptor is high, experiments with varying binning parameters or dimensionality reduction techniques like PCA have to be explored.

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