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Landmark Aquisition and Environment Identification for Visual Urban Navigation

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Motivation

Landmark and Environment Recognition in Outdoor Scenes:

- Localization:Compute vehicle location from landmarks.
- Mapping: Build map by collecting models of distinctive landmarks.
- Change Detection: Compare appearance of observed landmark with model.
- Cueing: Identify subsets of images from raw training set.

Issues:

- No a-priori knowledge of the discriminating landmarks.
- No a-priori geometric models.
- Considerable variation in appearance of objects.

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Approach

Visual Model Acquisition: Models are collections of images with similar feature distributions.

- **Model:**
  - Group images from a training sequence into groups.
  - Represent each group with prototype distributions.
- **Filter:**
  - Low-confidence groups.
  - Non-discriminating groups.
- **Recognize:**
  - Register image with models.
  - Match image with models using distance between distributions.

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Feature Distributions

Feature Distributions for 16 subimages

Segments

density, length, orientation, angles 18 dim for each

Parallel segments

density, length, orientation 18 dim for each

Contour

density, length, orientation 18 dim for each

Color

histogram 8 dim

TOTAL 992 dim ((18+18+18+8)x16)

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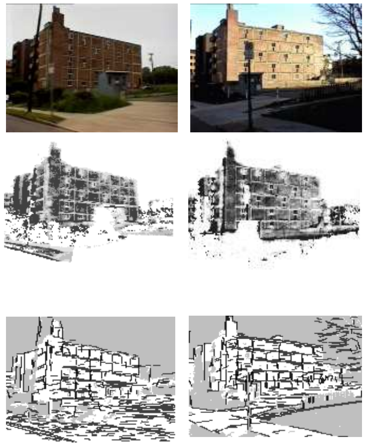
Feature Distribution: Typical Examples

Color after histogram quantization and normalization:

Edges:



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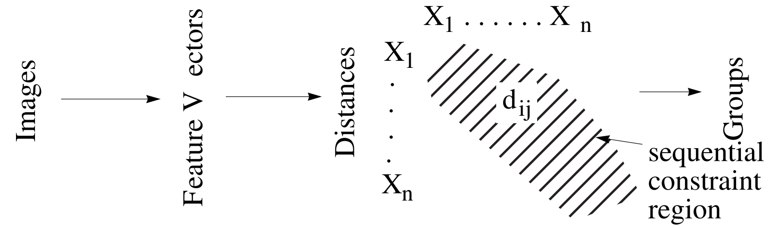
Grouping



- Compute mutual distances of feature distributions d_{ij}.
- Use relative weights between features.
- Use sequential constraints to limit search.

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Grouping Example

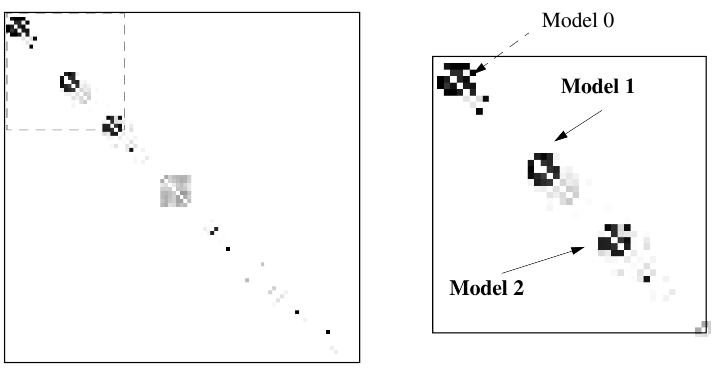

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Image Transformations

- Features not invariant with respect to geometric transformations.

⇒ Approximate registration.

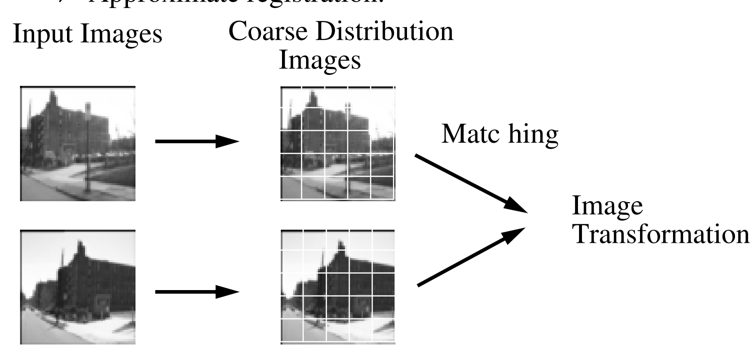
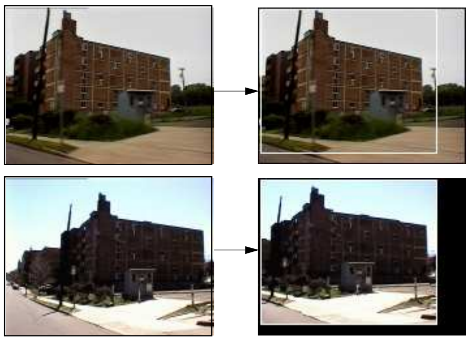


Image Registration

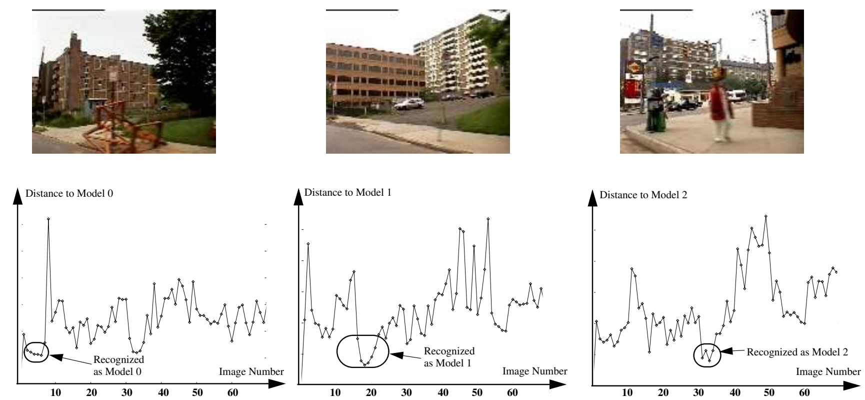
1. Registration of upper part of image using reduced set of parameters .
2. Registration of larger region using affi ne parameters .



original images registered image

Matching

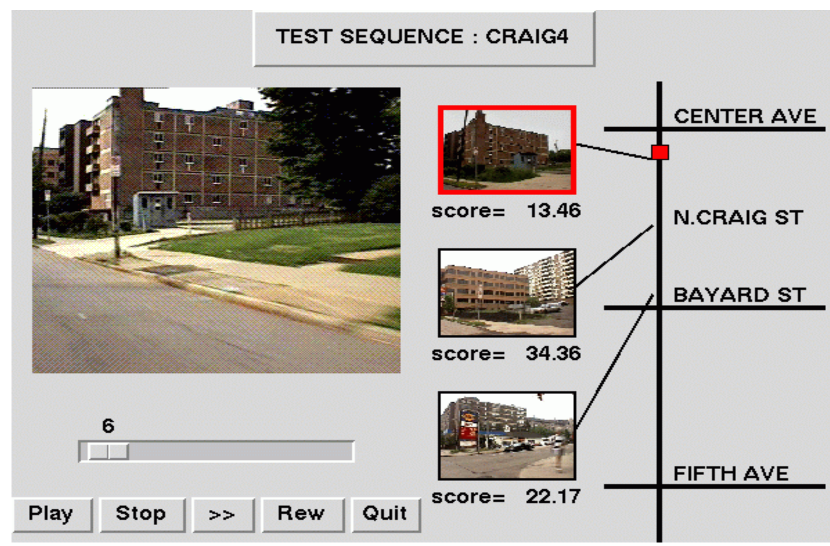
- 3 Models + 70-image sequence:



On-Vehicle Experimentation

- Tested on over ten sequences from vehic le
- Algorithms exercised under diffi cult test conditions:
  - Non-modeled sequences
  - Large variations in illumination
  - Large variations in viewpoint
- Tuned to minimize mis-c lassifi cation
- Sample statistics:
  - Matching performance in 12 sequences:

	Recognized	Rejected	Mis-Classified
Model Images	77.4%	22.6%	0%
Non-Model Images		99.7%	0.3%



Variation in Images

- Images from model group:

- Images Recognized under large variations in viewpoint and illumination:

Future Developments

1. Integration to vehic le system and demonstration
2. Optimization of time performance for practical operation
3. Optimization of time performance for practical operation
4. Exploration of use of Omnicamera