



Preprocessing for Enhanced Face Recognition

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Team Members



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Principle



- Find a function which maps a given test (probe) image into the correct train (gallery) image

$$\overline{X_{train}} = f_{opt}(Y_{test})$$

- Approach

$$X_i = f_i(Y_{test}) \quad i = 1, 2, \dots, M$$

where M is the number of training images

- Select f_i that is **maximally bijective or isomorphic**

Recognition Principle



- A function ' f ' is found which maps points in the test (probe) to equivalent points in the train (gallery)

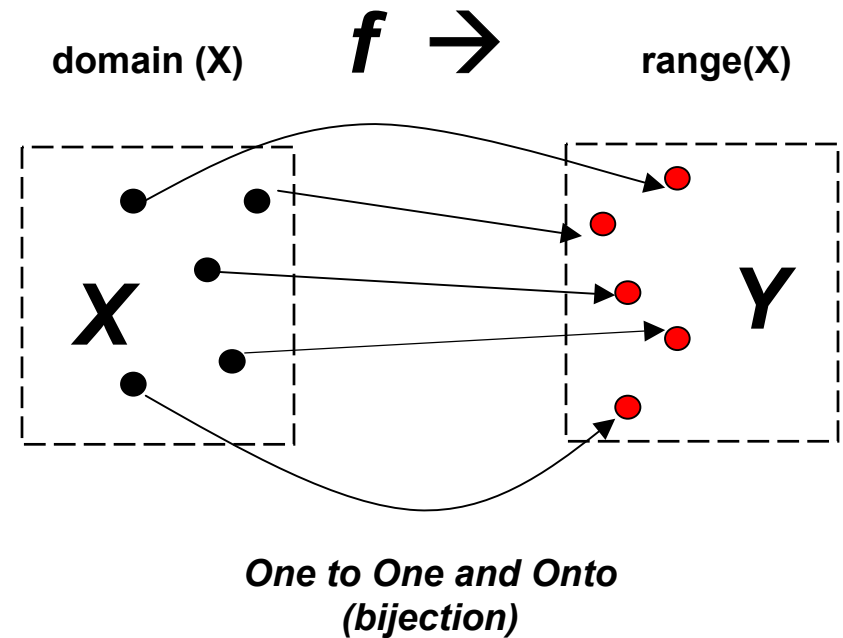
$$Y = f(X)$$

where

X = Test image (domain)

Y = Train image (co-domain)

f = Bijective function mapping $X \rightarrow Y$



Inverse Estimation



- A function 'g' is found which maps points in the train (gallery) to equivalent points in the test (probe)

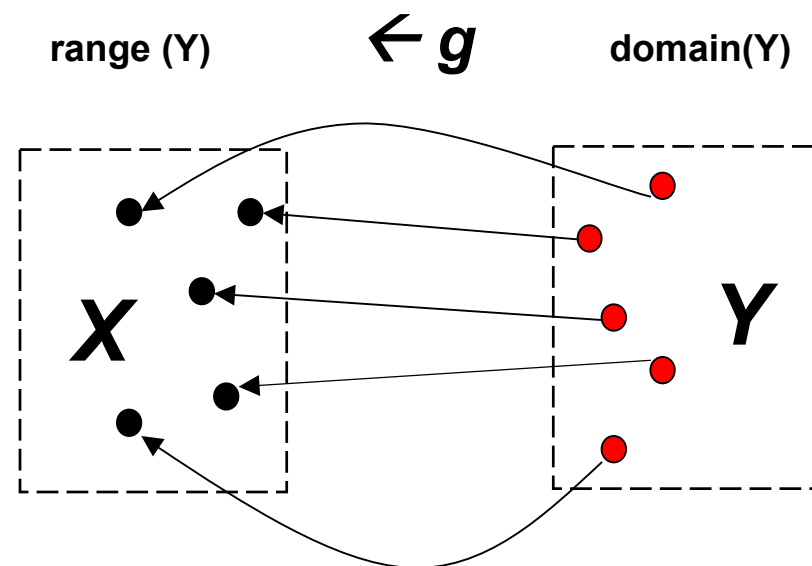
$$X = g(Y)$$

where

Y = Train image (domain)

X = Test image (co-domain)

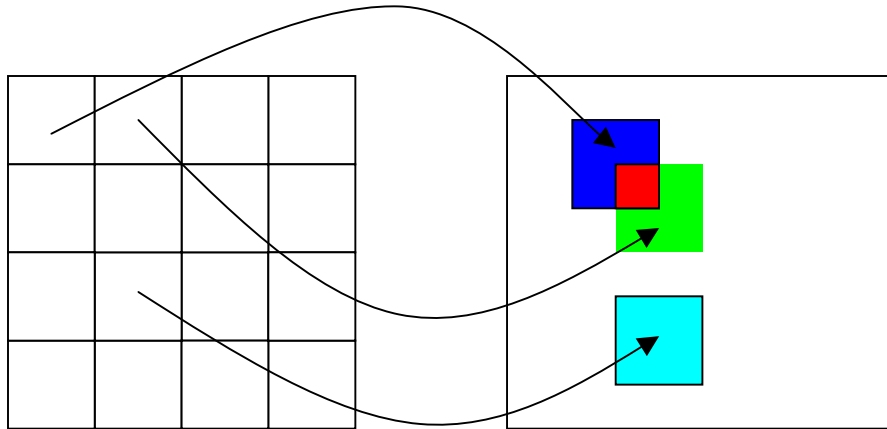
g = Bijective function mapping $Y \rightarrow X$



Measure of Bijectivity



$X \longrightarrow f \longrightarrow Y$



Blue, Green, Cyan \rightarrow

$$\{f(X_1) \cup f(X_2) \cup \dots \cup f(X_p)\}$$

Red $\rightarrow \{f(X_1) \cap f(X_2) \cap \dots \cap f(X_p)\}$

Partition X

Do not partition Y

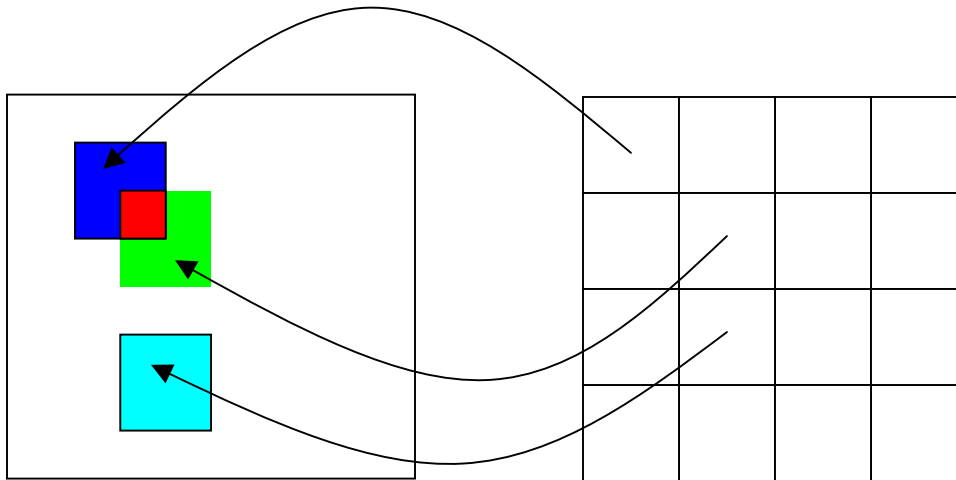
$$M_f = \frac{\eta[\{f(X_1) \cup f(X_2) \cup \dots \cup f(X_n)\}] - \eta[\{f(X_1) \cap f(X_2) \cap \dots \cap f(X_n)\}]}{\eta[X]}$$

where n is the total number of distinct blocks in X

Measure of Bijectivity



X ← g ← Y



Blue, Green, Cyan →

$$\{f(Y_1) \cup f(Y_2) \cup \dots \cup f(Y_p)\}$$

Red → $\{f(Y_1) \cap f(Y_2) \cap \dots \cap f(Y_p)\}$

Do not partition X

Partition Y

$$M_g = \frac{\eta[\{f(Y_1) \cup f(Y_2) \cup \dots \cup f(Y_p)\}] - \eta[\{f(Y_1) \cap f(Y_2) \cap \dots \cap f(Y_p)\}]}{\eta[Y]}$$

where p is the total number of distinct blocks in Y

Measure of Bijectivity



The Bijectivity score is given by:

$$S = \lambda_1 M_f + \lambda_2 M_g + \lambda_3 M_{f'} + \lambda_4 M_{g'}$$

M_f = Forward (test \rightarrow train)

M_g = Backward (train \rightarrow test)

$M_{f'}$ = Adaptive Forward (test \rightarrow train)

$M_{g'}$ = Adaptive Backward (train \rightarrow test)

$\lambda_1, \lambda_2, \lambda_3, \lambda_4$ = constants and $0 \leq \lambda \leq 1$

Matching Criteria



Matching Criteria

$$\min (\|y - a\mathbf{x}\|)$$

Where a is assumed to be a constant over each small region solved by least squares:

$$a = \frac{\langle \mathbf{x}, \mathbf{y} \rangle}{\langle \mathbf{x}, \mathbf{x} \rangle}$$

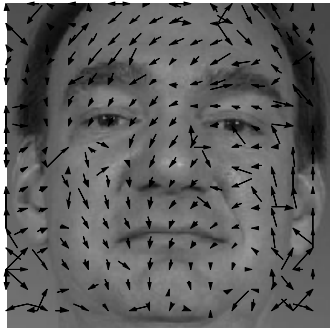
Preprocessing Example



train



test



Vector Field
Representation of f



Preprocessed Test
Image

Recognition Example



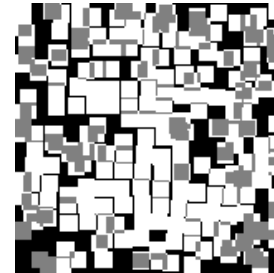
With the **correct** gallery



Gallery



Probe



Bijection
Mapping

White Region → measure of bijectivity (52.91%)

Recognition Example



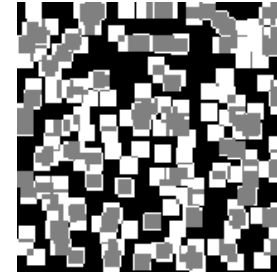
With **wrong** gallery



Gallery



Probe



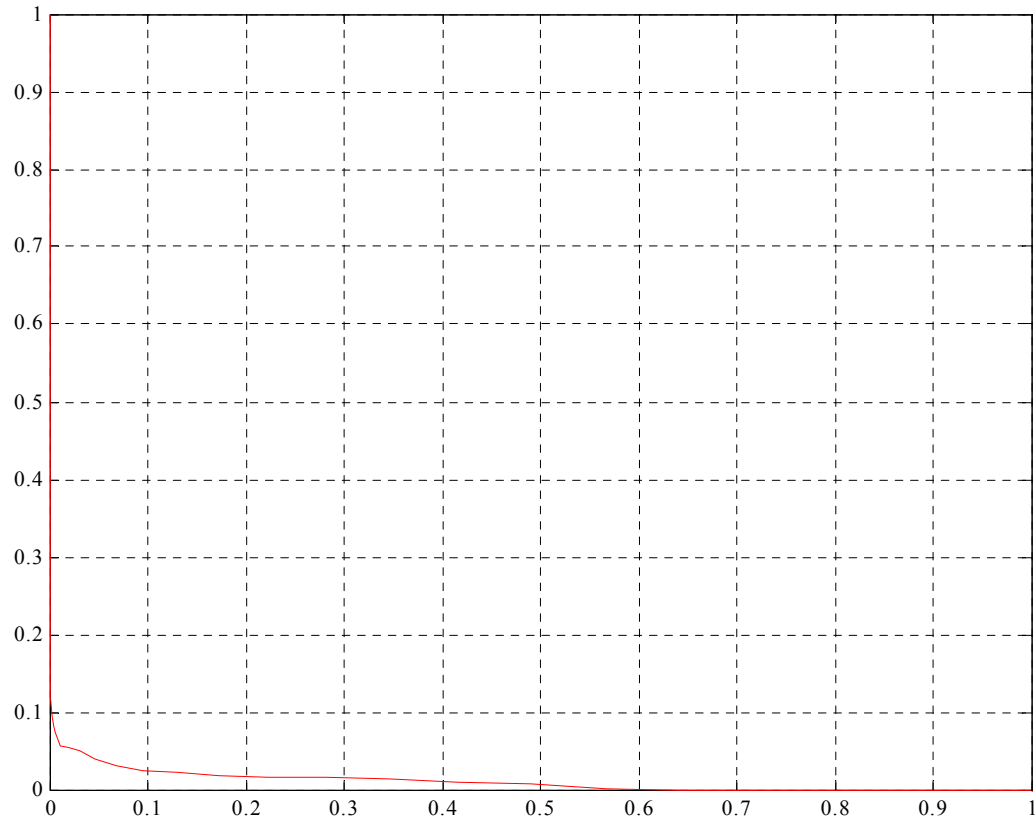
Bijection
Mapping

White Region → measure of bijectivity (33.94%)

ROC

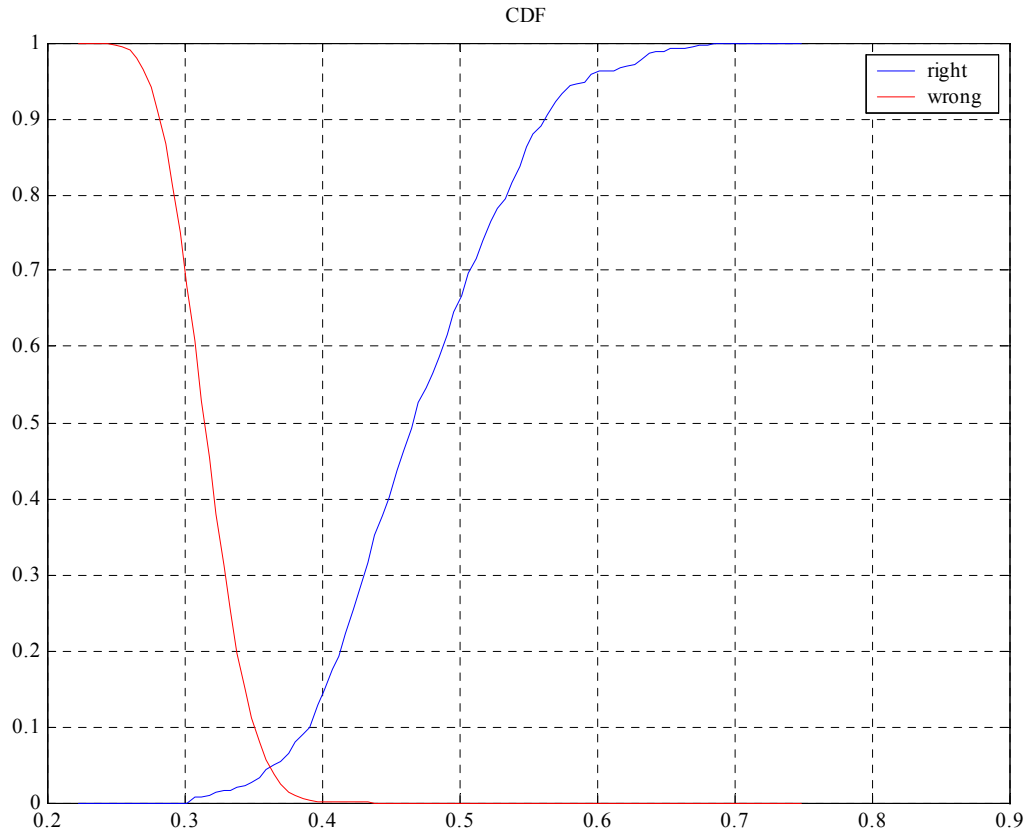


False Rejects



False Accepts

CDF



blue → CDF of right persons score

red → CDF of rest of the worlds score

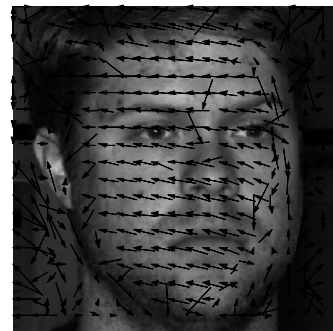
Preprocessing Example (Yale)



Train



Test



Vector field
representation of f



Preprocessed test
image

More Preprocessing Examples



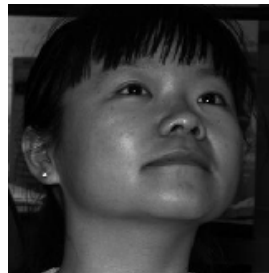
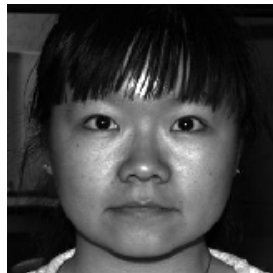
Train



Test



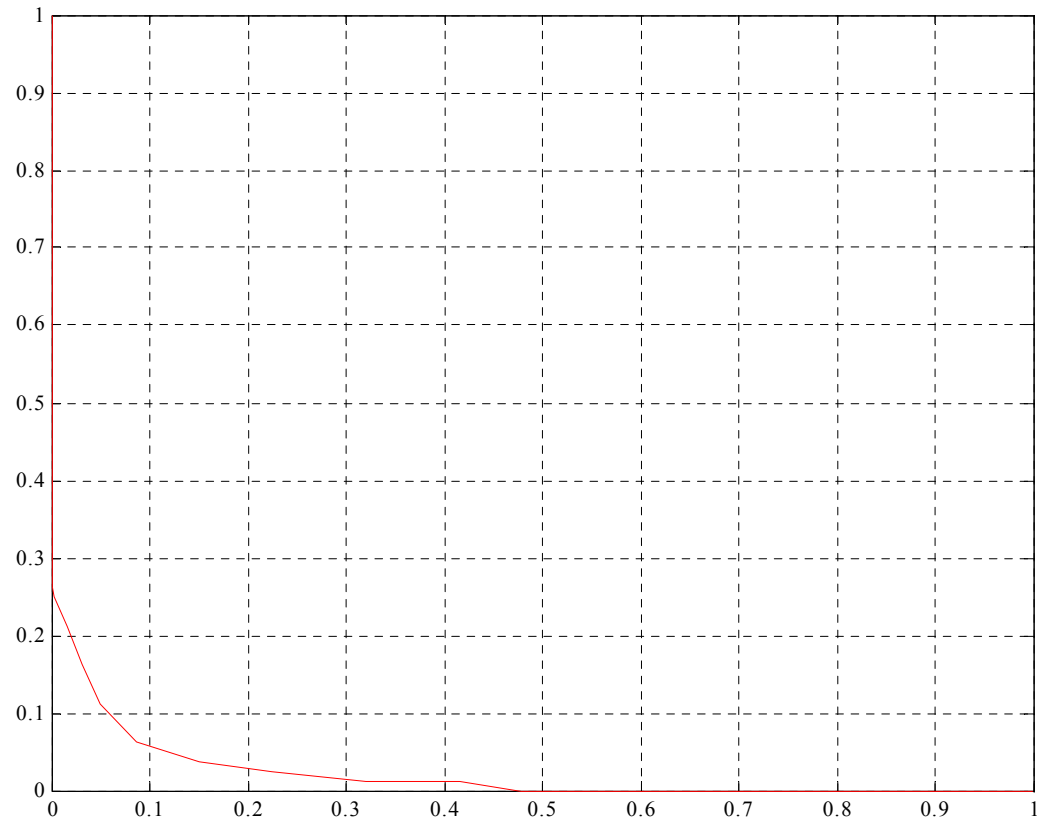
Preprocessed
test Image



ROC (Yale)



False Rejects



False Accepts

Summary and Conclusions



- A new method has been introduced for preprocessing as well as recognition.
- The new method is based on the measure of **bijection** or **isomorphism** between images.
- Preliminary results look encouraging for pose and illumination variations.



Thank You

Preprocessed Images are available . Please
contact mammone@caip.rutgers.edu