# Entropy Projection Curved Gabor with Random Forest and SVM for Face Recognition

Eucássio Lima[1], Luis Vogado[1], Ricardo Rabelo[1], Cornélia Passarinho[2], Daniela Ushizima[3,4]

[1]Computer Science Department, Federal University of Piaui, Teresina
[2]Computer Science Department, State University of Piauí, Piripiri, Brazil
[3]Lawrence Berkeley National Laboratory, Berkeley, CA
[4]Berkeley Institute of Data Science, University of California, Berkeley, CA

## Abstract

This work investigates algorithms for face recognition under occlusion using the entropy projection from the curved Gabor filter, and create a representative and compact features vector that describes a face. Despite the reduced vector obtained by the entropy projection, we show how to explore further dimensionality reduction as it follows:

- Random Forest classifier as an attribute selector, providing a 97% reduction of the original vector while keeping suitable accuracy;
- Experiments using 3 public databases: AR Face, Extended Yale B with occlusion and FERET
- Evaluation with SVM classifier showing promising results when compared to the available approaches in the literature, obtaining 98.05% accuracy for the complete AR Face, 97.26% for FERET and 81.66% with Yale with 50% occlusion.

## Challenges to create an ideal face recognition system

- Effective differentiation of individuals (a large inter-class variation) while accepting variations between representations of the same individual (intra-class variation);
- Extraction of face images precisely through quick processing;
- Low dimensional space to reduce computational costs as part of the classification process.

## Contribution

**We deliver a set of algorithms to provide reduced feature vector face recognition that work on images with face occlusions. The Entropy Curved Gabor Random Forest extract features using the Curved Gabor Entropy Projection for compact and efficient representation.**

https://github.com/Eucassio/face-recognition

## General flowchart of the proposed methodology

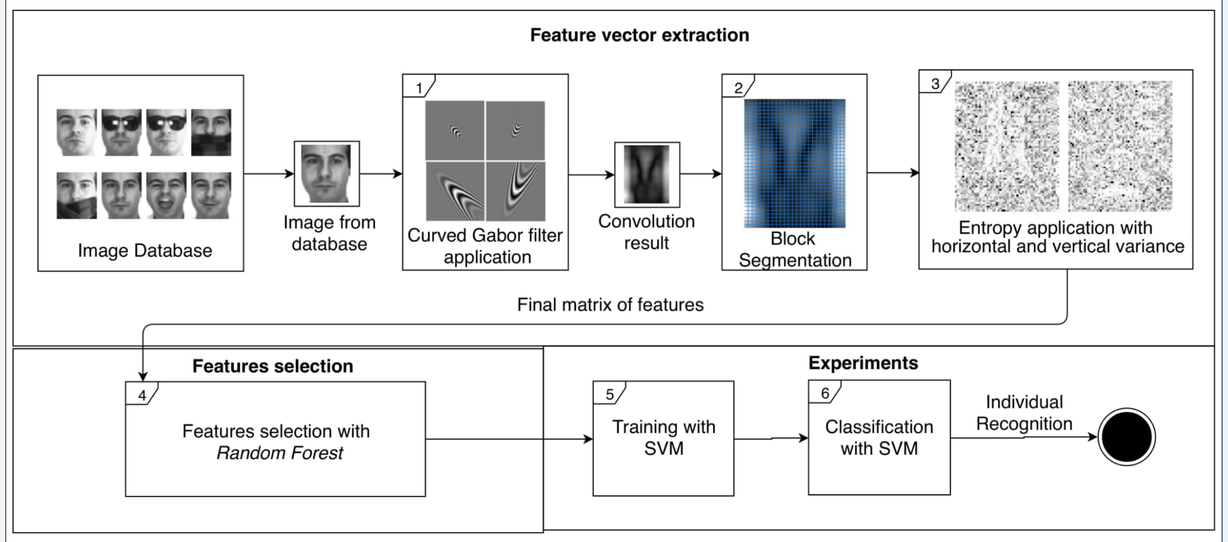


**Fig I. Image workflow and methodology outline.**

## Experimental Results

**Tab I. Comparisons between the results and state-of-the-art methodologies in AR Face database.**

| Database | LRC | SRC | CESR | FSS | SGLasso | DC | CC | DCC | Ghazi and Ekenel [8] | CGEP [14] | **Proposed methodology** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lighting variations | 31.37 | 45.80 | 48.74 | 44.96 | 38.24 | 45.24 | 79.83 | 71.01 | x | 100.00 | 99.50 |
| Occlusions by sunglasses | 25.21 | 28.99 | 68.49 | 28.99 | 21.85 | 74.79 | 3.78 | 72.69 | 35.45 | 76.00 | 96.00 |
| Occlusion by scarf | 94.96 | 95.38 | 96.64 | 95.38 | 93.28 | 97.06 | 68.49 | 97.06 | 89.09 | 84.50 | 96.50 |
| Illumination + sunglasses | 8.19 | 15.13 | 20.80 | 14.50 | 11.55 | 23.95 | 3.15 | 22.48 | x | 94.75 | 96.50 |
| Illumination + occlusion by scarf | 18.28 | 29.41 | 36.76 | 27.31 | 21.22 | 29.20 | 63.87 | 45.80 | x | 98.25 | 99.25 |
| Facial expressions variations | x | x | x | x | x | x | x | x | x | 98.25 | 99.00 |
| Complete basis | x | x | x | x | x | x | x | x | x | 99.14 | 98.05 |

**Tab II. Comparisons between the results and state-of-the-art methodologies in FERET database.**

| Methodology | LRC | SRC | CESR | FSS | SGLasso | DC | CC | DCC | Proposed |
|---|---|---|---|---|---|---|---|---|---|
| Accuracy | 79.22 | 86.37 | 92.35 | 86.27 | 82.35 | 92.55 | 64.02 | 92.84 | **97.26** |

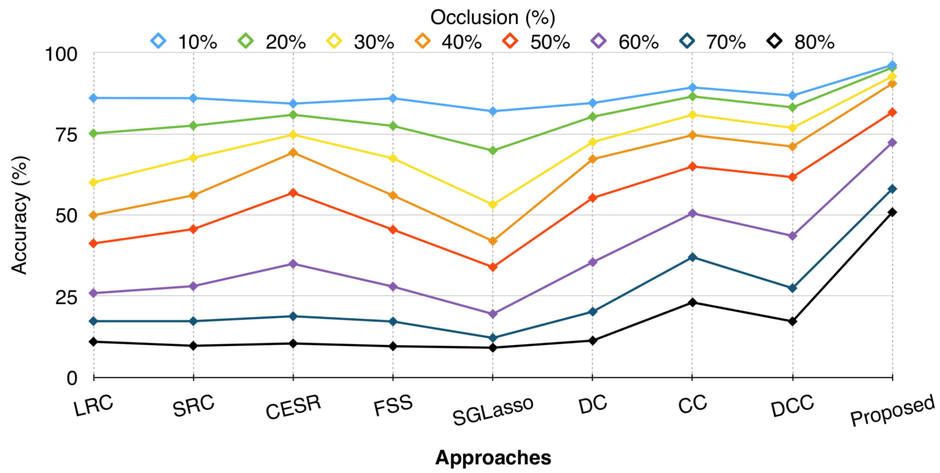


**Fig II. Comparison of the results of the proposed methodology with approaches on the Yale base with occlusion.**

## Discussion

The feature vector created after the extraction stage results in 94,080 elements for images of size 48x56 pixels. From this representation, we use Random Forest for feature selection in stage 4. As a result, the new generated vector has a smaller size than the initial one, with 2,800 elements. The reduction in size presented a percentage of 97.02%.

The results obtained by the methodology proposed for the AR Face base were superior in three of the four subsets that presented partial occlusion of the face. In FERET database the proposed approach obtains the best results with the accuracy of 97.26%, followed by DCC with 92.84%.

The experiments with occlusion performed at the Yale database have the objective of creating conditions of uncontrolled environments in a controlled database. These experiments were performed with the random overlap of the baboon in each image. Among the state-of-the-art methodologies, CC achieved the best results, followed by DCC. The proposed methodology exceeded the accuracy values of all state-of-the-art approaches for the tested image sets.

## Conclusion

The methodology based on the entropy Curved Gabor Random Forest enabled identification of facial traits that are accurate enough to identify faces, even under occlusion.

## Acknowledgements

This research is funded in part by the Gordon and Betty Moore Foundation through Grant GBMF3834 and by the Alfred P. Sloan Foundation through Grant 2013-10-27 to the University of California, Berkeley. Algorithmic work is partially supported by the Office of Science of the US Department of Energy (DOE) under Contract No. DE-AC02-05CH11231, Advanced Scientific Computing Research (ASCR) Early Career Award. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and they do not necessarily reflect the views of DOE or the University of California.

### AR-Face Database

This database consists of over 4,000 colored images of 126 people (70 men and 56 women) in total. This database was partitioned into 6 different subsets in order to group different features in the tests.

### FERET Database

The FERET database consists of 1,400 face images. This database has as main feature the occlusion of the face through changes in lighting.

### Yale Database

Extended Yale B database corresponds to 2,496 frontal facial images of 38 people, photographed in gray-scale on 64 controlled variations of illumination.