

Assignment: 2D + 3D face recognition

Biometrics

Introduction

Faces are probably the most common biometric identifier that is used by humans to recognize people. Research in automatic face recognition started in the 1960s and has resulted in commercially available systems with acceptable performance using 2D images. However, these systems impose a number of restrictions (fixed pose, controlled illumination). In order to lift these restrictions, recent research has shifted from 2D to 3D and even 2D+3D face representations.

This assignment involves the implementation of a face recognition system that makes use of 2D and 3D face representations.

Recognition system

The purpose is to build a system for

- 2D face recognition
- 3D face recognition
- fusing the results of these two systems

For the two face recognition systems, you will be able to make use of external libraries.

The systems then need to be combined, called fusion, as it has been proven to clearly boost the recognition performance [1].

Face recognition systems

Generally speaking, there are two different approaches for face recognition systems:

- holistic approaches, considering the face as a whole, e.g. eigenfaces. Some holistic approaches can be used on 2D as well as on 3D (e.g. [2]).
- feature based approaches, performing recognition on a (sparse) set of discriminating features, e.g. SIFT [3]/meshSIFT [4].

In this assignment, you should read and summarize at least one paper of each category, and point out some possible advantages and disadvantages of both approaches.

Implement a 2D AND 3D face recognition system.

Fusion

After having implemented the two recognition systems (one for 2D, one for 3D), these need to be combined. Read reference [1], and implement a way of combining the results. Explain the obtained results. Before that read [5].

Optionally, you could also implement different approaches (holistic / feature-based) per modality (2D or 3D) and combine these.

Data

The dataset that is available is a subset of the Bosphorus database (<http://bosphorus.ee.boun.edu.tr/default.aspx>) and contains 2D and 3D images of 10 subjects (bs000 to bs009). The dataset also has anatomical landmarks. Half of the dataset (bs000 to bs004) can be used for training. The other images will be used for testing.

Testing

When your system is implemented and trained, you can apply it on the test set where you select the neutral faces bs00x_N_N as gallery images. All other images are the probe images. Show the recognition results of the 2D system, the 3D system and the combined system.

Toolboxes

MATLAB

ASM and AAM: <http://www.mathworks.com/matlabcentral/fileexchange/26706>

Eigenfaces: <http://www.mathworks.com/matlabcentral/fileexchange/17032>

SIFT: <http://www.vlfeat.org/~vedaldi/code/sift.html>

meshSIFT: <https://mirc.uzleuven.be/MedicalImageComputing/downloads/meshSIFT.php>

Python

OpenCV: FaceRecognizer

OpenCV: SIFT

Report

Write a (+- 10 pages) report containing:

- discussion (main method, advantages/disadvantages) of the (at least) two papers you read
- description of the methods you implemented
- presentation of results
- discussion of obtained results

This report should be handed in, together with your code at least 2 days prior to your examination. The examination will further consist of a Powerpoint-like presentation.

References

- [1] K. I. Chang, K. W. Bowyer, P. J. Flynn, An Evaluation of Multimodal 2D+3D face biometrics. IEEE Transactions on Pattern Recognition and Face Biometrics, 27:4 (2005) 619-624.
- [2] F. Tsalakanidou, D. Tzovaras, M.G. Strintzis, Use of depth and colour eigenfaces for face recognition, Pattern Recognition Letters 24 (2003) 1427-1435.

- [3] D. G. Lowe, Distinctive Image Features from Scale-Invariant Keypoints" International Journal of Computer Vision, 60:2, (2004) 91-110, 2004.
- [4] D. Smeets, J. Keustermans, D. Vandermeulen, P. Suetens, meshSIFT: Local surface features for 3D face recognition under expression variations and partial data," Computer Vision and Image Understanding 117:2 (2013) 158-169.
- [5] J. Daugman, Combining multiple biometrics, online document
[<http://www.cl.cam.ac.uk/~jgd1000/combine/>].