HP²IFS: Head Pose estimation exploiting Partitioned Iterated Function Systems

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Introduction

Estimating the actual **head orientation** from **2D images**, with regard to its three degrees of freedom, is a well-known problem that is highly significant for a large number of applications involving head pose knowledge.

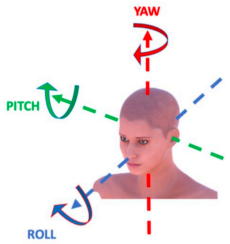


Image 1: The rotations of the head in terms of Pitch, Yaw and Roll angles.

Fractal Image Coding Approach

In this paper we take a different approach to this topic by using fractal coding theory and particularly **Partitioned Iterated Function Systems** (PIFS). The basic principle is that an image can be reconstructed by using the **self-similarities** in the image itself. When encoding an image, the algorithm partitions the original image into non-overlapping *domain regions*; after this, a new partition into smaller blocks (*range blocks*) is applied.

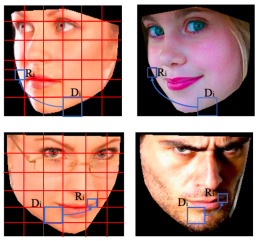


Image 2: The transformations between the domain blocks (D) and the range blocks (R), on image pairs featuring similar angular values.

For every range block, the best matching domain block is searched among all domain blocks by performing a set of **isometric transformations** on the blocks. The compression is obtained by storing only the descriptions of these transformations.

Self-similarities and HPE

Due to the self-similarity induced by the fractal codec, we obtain that the same blocks of *Domain* will go in the same blocks of *Range* for both images within an acceptable margin of error.

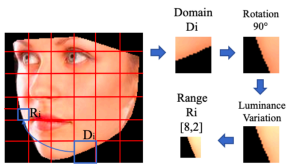


Image 3: A detail of the fractal coding process, in particular the rotation and the lighting variation leading to the range located in row 8 and column 2.

Proposed Method

1. Face detection and extraction.
2. Fractal image coding algorithm to obtain a matrix representing the fractal codes.
3. Pose estimation, transforming the fractal parameters in an array and comparing it to the angular array references obtaining in the same way (fractal codes) through Hamming distance metric.

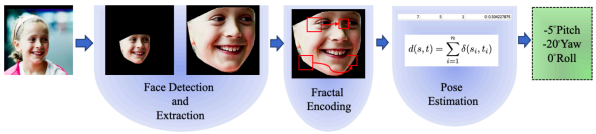
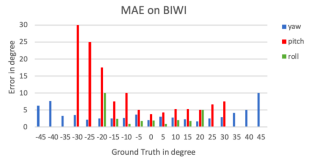


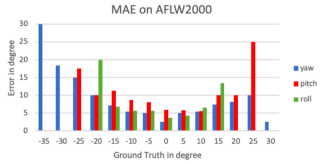
Image 4: Workflow of the proposed method.

Results

We relied on **BIWI** and **AFLW2000** datasets to perform the experiments. Our method based on fractal coding achieves results comparable with recent techniques though they are based on machine learning approaches.
We tested HP²IFS using a well-known performance index for pose estimation, the *Mean Absolute Error* (MAE).



Graphic 1: Errors on BIWI in terms of angular poses.



Graphic 2: Errors on AFLW2000 in terms of angular poses.

Conclusions

We presented **HP²IFS**, a novel method for head pose estimation based on Partitioned Iterated Function Systems to extract a fractal image code from input face to be matched against a reference array through Hamming distance. According to the results of experiments carried out on both BIWI and AFLW2000 reference datasets, the reported pose estimation error is comparable to that of state-of-the-art methods based on machine learning and often inferior to that reported by the best performing non-training based methods.

Contact

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