Birdlets: Subordinate Categorization Using Volumetric Primitives and Pose-Normalized Appearance

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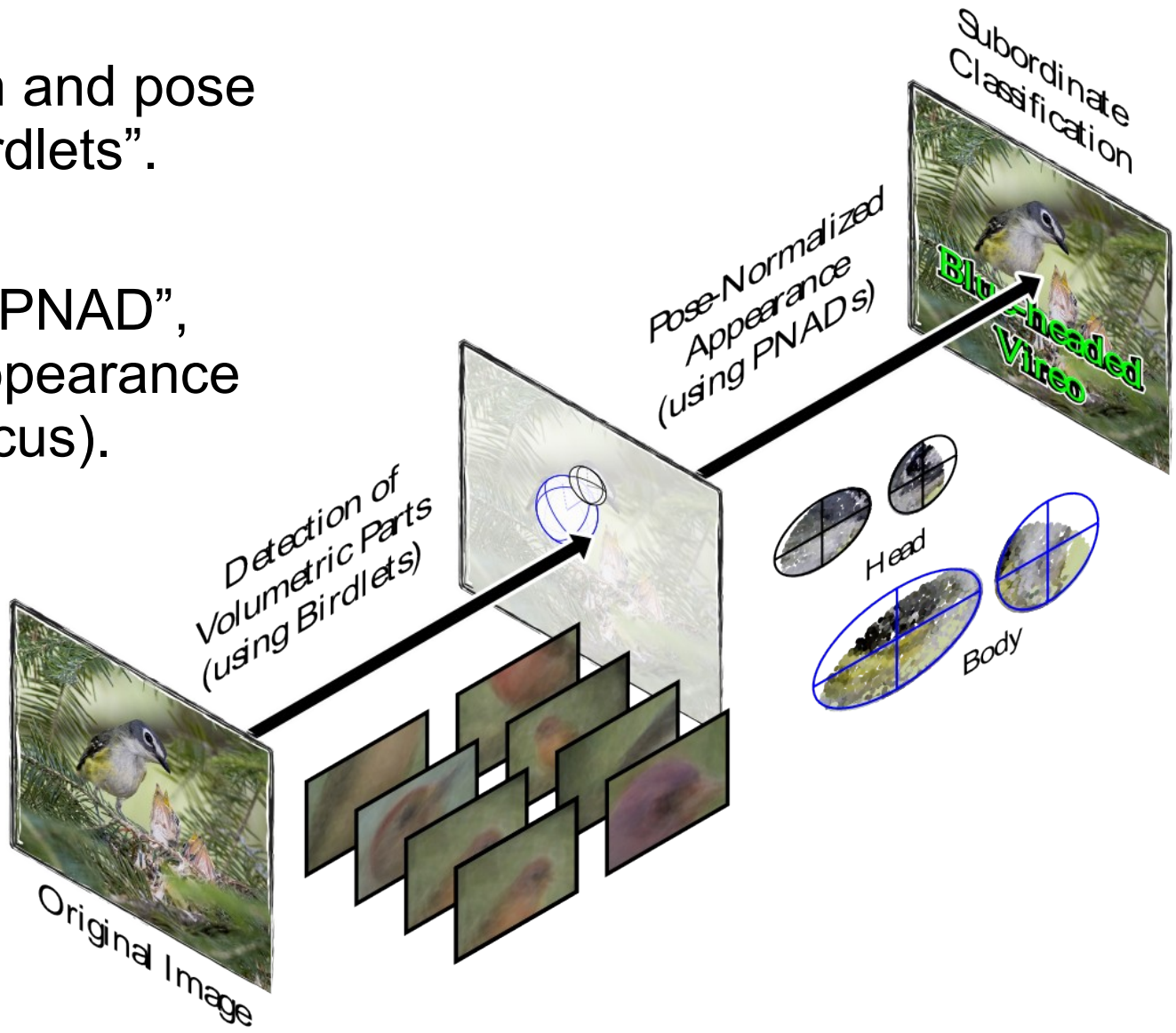
1. Basic level detection and pose estimation using “Birdlets”.
2. Subordinate level classification using “PNAD”, Pose Normalized Appearance Descriptor. (Their focus).



Basic Geometric Assumption

- Use two ellipsoids to describe the animal.
- Use ellipsoids that are stretched along a single axis.
- Assume scaled orthographic projection.
- The pose of an ellipsoid is defined by its 2D-location, 3D-rotation, stretch & scale (7 parameters).

1. Basic level detection

Detect the parts of the object, i.e. the ellipsoids (using Birdlets).

2. Subordinate level classification

Look at differing properties of these parts: appearance, shape, size, etc (using PNAD).

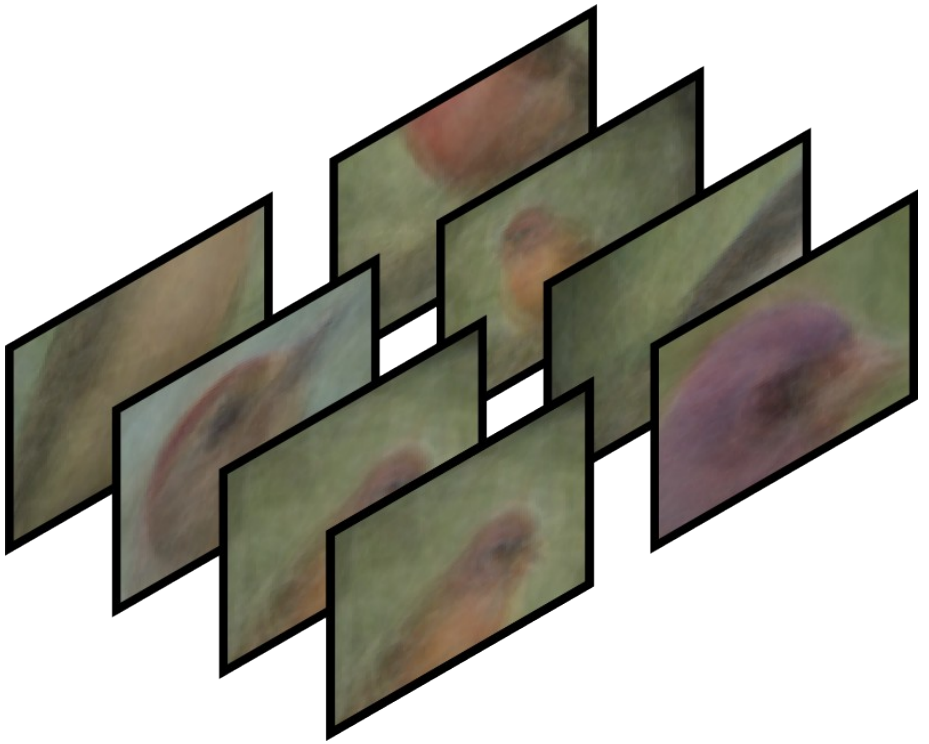
Basic level detection and pose estimation using Birdlets - Annotation

Annotate training data with pose: 2D-location, 3D-rotation, stretch & scale for each ellipsoid.

2*7=14 parameters. Or 14-1=13?

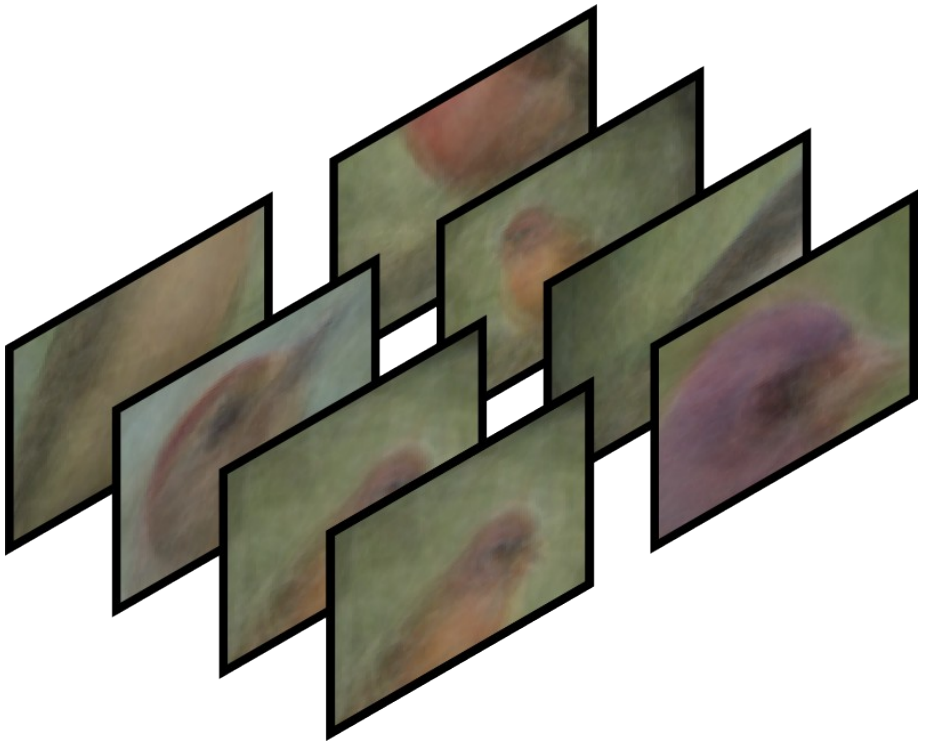
Basic level detection and pose estimation using Birdlets - Training 1

- Define a distance function for poses, taking rotation and scale into account.
- Group training images with similar poses. These groups are called Birdlets (based on the Poselet framework).
- Within each group the images are aligned by computing a 2D similarity transformation and the pixels are warped to a canonical rectangle.



Basic level detection and pose estimation using Birdlets - Training 2

- They use rectangles of 96x64 pixels.
- For each 8x8 region a HOG is computed and concatenated into a feature vector.
- For each Birdlet a classifier is learnt using SVM.
- Use a retraining stage, where false positives of the initial classifier are collected before the final classifier is learnt.

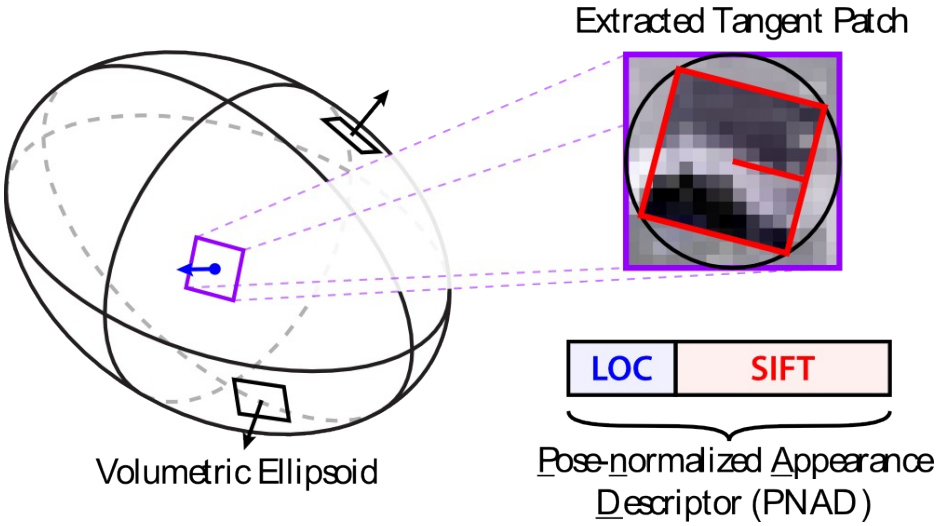


Basic level detection and pose estimation using Birdlets - Runtime

- Use a sliding window approach and apply the classifier of each Birdlet over the image.
- Record high responses and their pose. Each response votes for a pose.
- Finally cluster the recorded responses into one or more final responses (a bit tricky).

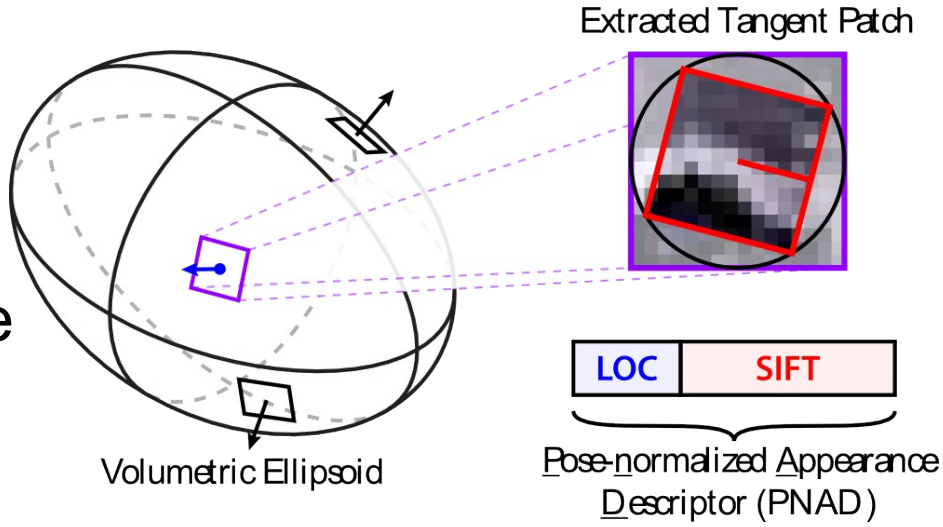
Subordinate level classification using PNAD (Their main focus)

- PNAD - Pose Normalized Appearance Descriptor
- Assume that we have an image and a known ellipsoid pose.
- Sample (visible) points on the ellipsoid randomly.



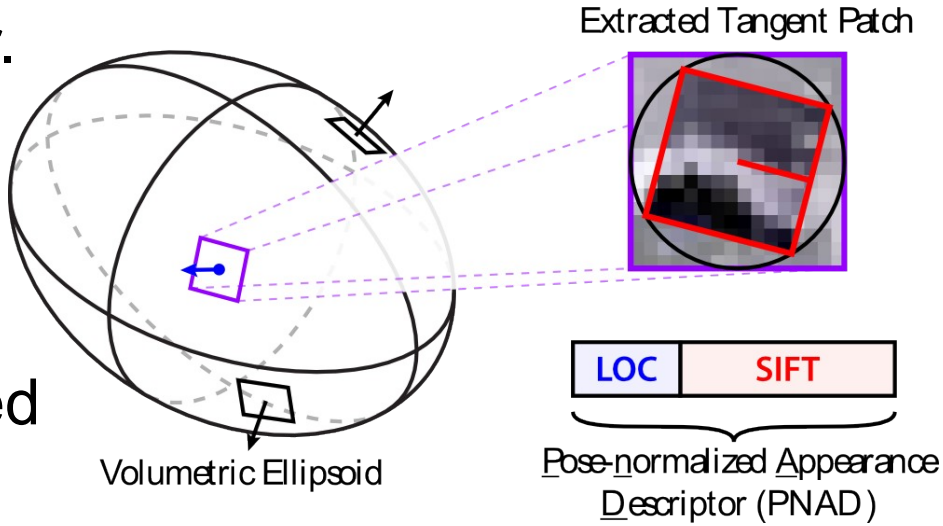
Subordinate level classification using PNAD

- Consider a small square patch in the tangent plane of the sampled point.
- To get the pixel content of the tangent patch it is projected to the image.
- This gives a parallelogram which can be warped to a square.



Subordinate level classification using PNAD

- A color-SIFT descriptor of this patch is computed.
- The surface position and the SIFT is concatenated to a single vector.
- Can also concatenate extra information like, ellipsoid stretch and size.
- This vector is the Pose Normalized Appearance Descriptor PNAD, which couples the pose and appearance of a patch.
- For each image several PNADs are computed as a description of the visible region of the ellipsoid.



Subordinate level classification

- They train a classifier based on Stacked Evidence Trees.
- These rely on a Random Forrest constructed such that all leaves are required to have a specified minimum number of training samples (they use 20).
- When a query (PNAD) is passed through the forest and reaches a leaf, the classifier returns the distribution of class labels that reached that leaf during training.
- The resulting class distribution for each query are aggregated into a single evidence vector (each PNAD votes for several class labels).

Subordinate level classification

- A second-stage (“stacked”) multi-class adaboost classifier is then applied to the class distribution evidence vector, producing the final category prediction. Why?

- The Stacked Evidence Tree model was selected for the way it complements the Pose Normalized Appearance model, providing a way to handle the occlusion.
(Compare Bag of Words)

Experimental Results?

Successful detections

Unsuccessful detections