Learning Where to Position Parts in 3D

Marco Pedersoli1,2; Tinne Tuytelaars1
1ESAT-PSI / iMinds, KU Leuven
2LEAR team, Inria Grenoble Rhone-Alpes, Lab. Jean Kuntzmann, CNRS, Univ. Grenoble Alpes, France.

Introduction

Task: Learn a 3D representation of an object category for object detection and pose/viewpoint estimation.

Motivation: Previous work uses 3D CAD models or other sources of 3D information to estimate the shape of the object. We want to learn a 3D model representation without any explicit 3D info, just from the object location and viewpoint. Our method achieves almost 14X as in [6]!

Contribution: We show that in the context of deformable models it is possible to augment the latent variables to estimate also the 3D location of the object parts. This produces a coarse estimation of the 3D of the object that improves recognition results in terms of both object detection and pose estimation.

Related work

[1] explicitly associates each part to a 3D landmark from 3D CAD samples. [2] models the 3D shape as a composition of planar surfaces that are learned from 3D CAD models. [3] synthesizes a view of an object in the HOG space based on 3D CAD models. [4] uses annotated 3D landmarks to build a model to estimate the 3D viewpoint of cars. [5] assumes the object to fit a cuboid representation, while for us that assumption is used only for initialization.

Scoring Function

Objective

Part Orientations:
Object Center:
Object Rotation:

\[ C: \text{Score of a part relative to camera} \]
\[ O: \text{Score of the entire object with respect to} \ O. \]

Orthographic Projection

HOG features from Image I at location (x,y) \[ H(I, x, y) \]
Distortion assuming orthogonal projection \[ T_p(i) = (y, x, y) \]

\[ \text{Camera Distortion at pixel level:} \]
\[ \phi(I, i) = H(T_p(I), i, x, y) \]
\[ \text{Camera Distortion at HOG level:} \]
\[ H(T_p(I), c, x, y) \]

3D Deformation

Quadratic deformation cost in 3D defined by \( (d_x, d_y, d_z) \) for each part i with location \( l_i \) and part displacement \( m_i = (m_x, m_y, m_z) \)

\[ \text{Speed Up} \]


References