METHODS AND TECHNOLOGY OF MATHEMATICAL MODELING OF AUTOMATIC PROCESSING OF TELEVISION IMAGES IN THE RECOGNITION OF OBJECTS

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Annotation

Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different vie points, in many different sizes and scales or even when they are translated or rotated.

Key words: Technology in The Field Of Computer Vision, Objects in An Image or Video

Object recognition – technology in the field of computer vision for finding and identifying objects in an image or video sequence. Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different vie points, in many different sizes and scales or even when they are translated or rotated. Objects can even be recognized when they are partially obstructed from view. This task is still a challenge for computer vision systems. Many approaches to the task have been implemented over multiple decades.

Hypothesize and test

- General Idea:
  - Hypothesize a correspondence between a collection of image features and a collection of object features
  - Then use this to generate a hypothesis about the projection from the object coordinate frame to the image frame
  - Use this projection hypothesis to generate a rendering of the object. This step is usually known as backprojection
  - Compare the rendering to the image, and, if the two are sufficiently similar, accept the hypothesis
- Obtaining Hypothesis:
  - There are a variety of different ways of generating hypotheses.
  - When camera intrinsic parameters are known, the hypothesis is equivalent to a hypothetical position and orientation – pose – for the object.
  - Utilize geometric constraints
  - Construct a correspondence for small sets of object features to every correctly sized subset of image points. (These are the hypotheses)
- Three basic approaches:
  - Obtaining Hypotheses by Pose Consistency
  - Obtaining Hypotheses by Pose Clustering
  - Obtaining Hypotheses by Using Invariants
- Expense search that is also redundant, but can be improved using Randomization and/or Grouping
  - Randomization
    - Examining small sets of image features until likelihood of missing object becomes small
    - For each set of image features, all possible matching sets of model features must be considered.
    - Formula:

$$(1 - W^c)^k = Z$$

- W = the fraction of image points that are “good” (w ~ m/n)
- c = the number of correspondences necessary
- k = the number of trials
- Z = the probability of every trial using one (or more) incorrect correspondences

- Grouping
  - If we can determine groups of points that are likely to come from the same object, we can reduce the number of hypotheses that need to be examined

Pose consistency[edit]

- Also called Alignment, since the object is being aligned to the image
- Correspondences between image features and model features are not independent – Geometric constraints
- A small number of correspondences yields the object position – the others must be consistent with this
- General Idea:
  - If we hypothesize a match between a sufficiently large group of image features and a sufficiently large group of object features, then we can recover the missing camera parameters from this hypothesis (and so render the rest of the object)
- Strategy:
  - Generate hypotheses using small number of correspondences (e.g. triples of points for 3D recognition)
  - Project other model features into image (backproject) and verify additional correspondences
- Use the smallest number of correspondences necessary to achieve discrete object poses

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