

# Study of Different Object Recognition Approaches

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**Abstract** - Object recognition is an essential area in the field of computer vision. It requires dealing with view point variations, illumination changes, partial occlusion and background clutter and hence is considered as a difficult task. To overcome the above challenges and achieve nearly optimal results, various object recognition approaches are discussed here. Each approach considers various constraints like evaluation time, accuracy, recognition reliability and invariance and based on this, suitable recognition techniques can be evaluated.

**Keywords** –geometry-based, appearance-based, eigenvectors, feature-based, contour.

## I. INTRODUCTION

Object recognition has been one of the challenging problems in the field of image processing and automation world. It is a task of finding objects in an image or a video sequence. In other words it can be considered as a labeling problem which is based on model consisting of known objects. Consider any given image which contains one or more objects (and background) and a set of labels which corresponds to a set of models which are known to the system, then the system should be able to assign correct labels to the regions or a set of regions, in the image.

Object recognition is a difficult task because of the factors like relative pose of an object to a camera, illumination changes, occluded or obscured images which reduce the level of accuracy.

## II. BASIC IDEA

Object recognition system usually consists of the following components.

### 1. Model database:

It consists of all the models which are known to the system. The information in a model database can vary from qualitative or functional description to precise geometric surface information and it depends on the approach which is used for recognition.

### 2. Feature detector:

The features which are used in any object recognition system depend on how model database is organized and also depend on the types of objects to be recognized.

The feature detector then applies operators to the images. It also identifies the locations of the features which help in formation of object hypotheses.

### 3. Hypothesizer:

Once the features are detected in the image, the hypothesizer assigns likelihoods to the objects which are present in the

scene. This step is uses certain features and thus reduces the search space for the recognizer.

### 4. Hypothesis verifier:

The model database is organized with some type of indexing scheme which helps to eliminate unlikely object candidates from possible consideration. The hypothesis verifier then uses the object models to verify the hypotheses. It also refines the likelihood of objects. Based on all the evidence, the object recognition system selects the object with the highest likelihood as the correct object.

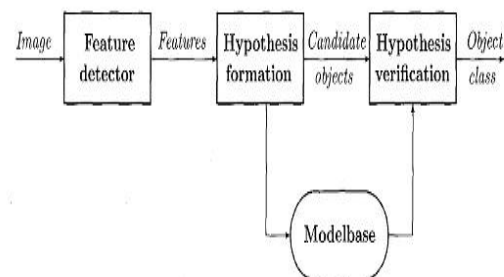


Fig. 1. Different components of an object recognition system

Fig. 1 shows the interactions and flow of information among different components of the object recognition system.[1]

## III. APPROACHES for OBJECT RECOGNITION

There are many techniques used for recognizing objects. Among those we focus on the following three identification techniques.

### A. Geometry based (Model based)

The main idea is, the geometric description of a 3D object allows the projected shape to be accurately predicted in the form of a 2D image under projective projection, thereby facilitating recognition process using edge or boundary information which is invariant to a certain illumination change. [2]

This method includes the extraction of basic geometric shapes like line, circle which are independent of any changes in viewpoint. The information about the object is represented explicitly by the user as computer aided design(CAD) like model. This model describes the 3D shape of an object and does not include properties like color and texture.

Advantages [3] –

1. It predicts accurate shape of an object irrespective of any viewpoint.
2. Edge detection and geometric boundary segmentation are used to provide geometric descriptions from images without considering illumination changes.
3. Geometry is a well-developed theory in mathematics that includes various algorithms which run efficiently in identifying geometric shapes
4. Complex geometric shapes can be represented with simple geometric shapes such as triangle, spheres using CAD models.

Disadvantages [4] –

1. This method is dependent on reliable extraction of basic geometric shapes like lines and circles.
2. Presence of primitives that are not modeled causes ambiguity in interpretation of the detected primitives.
3. It requires models to be created manually.

### B. Appearance based

The appearance of an object is the combined effect of its shape, surface reflectance, pose in the scene and illumination conditions. Appearance based approach explicitly considers these factors for object recognition. In this method the objects are represented from all possible viewpoints and all possible illumination directions.

It involves computation of eigenvectors from a set of vectors. Each vector of that set represents one face image as a raster scan vector of gray-scale pixel values. Variance among all the vectors is captured by an eigenvector and the appearance variation of face images in the training set is captured by a small set of eigenvectors. Each face image can be represented by a linear combination of eigenfaces with minimum error and this linear combination constitutes a compact reorientation.[5]

In this approach there is no need of user-provided model. Automatic learning agent updates the representations of an object that depends on the reflectance properties of the surface of that object.

A set of correlated reference images that includes the object appearance under different views, varying lighting conditions and multiple instances is used for the construction of a model in the first step of this approach. Principal Component Algorithm (PCA) can be used for efficient compression of these images. The second step (recall) includes extraction of parts of input image having same size as the reference images. Extraction can be carried out using segmentation based on color, motion and texture or by exhaustive enumeration of image windows over a whole image. This extracted part is compared with the reference images by the recognition system. [6]

Appearance based approach does not consider detection and matching of image features or geometric primitives.

Disadvantages:

1. The object of interest needs to be completely separated from the background.
2. This method is sensitive to occlusion.

### C. Feature based

A feature is some attribute of the object that is considered important in describing and recognizing the object in relation to other objects. Feature-based object recognition identifies objects by extracting features and relationships represented in the database from the image contours. Database objects are thus selected that have high probability of being contained in the captured image.

The three main steps are as follows-

1. The image is translated into a set of contours which follow the outlines and significant grey level edges. The image with superimposed contours can be represented graphically where the sharp corners with the heightened peaks and straight lines denote successive points near x-axis. This makes the endpoint formulation very easy and gives accurate results.(Refer Fig. 2)

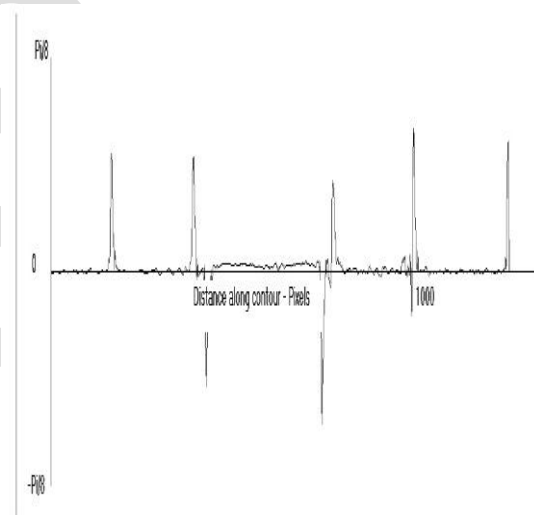


Fig. 2. Example: Graphical representation of a contour

2. The contours are reduced into a set of simple geometric features that represent significant part of the original image. As there are many contours for each image, they need to be examined properly for relevant extraction of the feature and the rest is discarded. The features are stored with associated contours in the program. Feature range may vary from thousand to ten thousands.

All features are combined and reduced (generally minor features are combined into larger one based on their redundancy).

There are three types of main features –

- (i) Line – It is represented by midpoint, length, tangent angle. It can be retrieved from flat spots with zero amplitude in the contour graph.

(ii) Arc –It is represented by midpoint, length, tangent angle and radius. It can be retrieved from flat spots with comparatively higher amplitude in the contour graph.

(iii)Lobe – It is represented by midpoint, length, tangent angle, two endpoints and the angle the contour changes from start to finish. It is fitted to the heightened peaks of the contour graph.

These lines are combined with different lines of variable length that are generally parallel. Similarly arcs are combined by considering radius and intersection points as parameters. Lobes are combined based on the vectors between each of the three sets of points.

As a result a new set of line, arc and lobe is calculated that represent the average feature attributes. This helps in representing the image by using a handful of features known as “Super-features”. This makes the further processing easier.

3. The processed features are converted in the word form to search and compared with the database entries to find which objects are likely to be in the image. This is done by using the “Super-features” to find relationships in the image. The relationships in the image are stored using array of Boolean variables. Using one bit of each relationship means the object is obscured, only few relationships are not present, giving reliable results in this condition.

The array of bits can be converted to a search word that compares the database entries. The comparison is done by bitwise AND operation between the two words and a count of matched bits is examined. The count with maximum hits gives the resultant match.[7]

Advantages –

1. Can be used to identify objects that are partially occluded or viewed from different angles.
2. Is applicable to the system efficient enough to hold larger database.

#### IV. CONCLUSION

Feature based methods are generally used where objects of fixed view are to be recognized and features from them are then extracted. These methods with local features are quite useful to recognize generic objects as well. This approach is applicable to objects with distinctive features. Appearance-based methods are mostly exploited in the recognition of specific objects, especially faces. Geometry based approach can be applied in order to achieve pose and illumination invariance.

Thus we have studied the above three approaches used for recognizing objects from an image sequence.

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