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INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

**(PROJECT REPORT TITLE)**

By:

**(name(s) of students)**

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DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

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**ABSTRACT**

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**LIST OF SYMBOLS / ABBREVIATIONS**

θ Orientation Vector

p Position Vector

SIFT128 The 128-dimension SIFT descriptors

2D 2 Dimensional

3D 3 Dimensional

BoW Bag of Words

SIFT Scale Invariant Feature Transform

SMO Sequential Minimal Optimization

SURF Speeded Up Robust Features

SVM Support Vector Machine

**1. INTRODUCTION**

There are numerous applications for object recognition and classiﬁcation in images. The leading uses of object classiﬁcation are in the ﬁelds of robotics, photography, and security. Robots commonly take advantage of object classiﬁcation and localization in order to recognize certain objects within a scene. Photography and security both stand to beneﬁt from advancements in facial recognition techniques, a subset of object recognition.

Our method ﬁrst obtains salient features from an input image using a robust local feature extractor. The leading techniques for such a purpose include the SIFT and SURF. After extracting all keypoints and descriptors from the set of training images, our method clusters these descriptors into N centroids. This operation is performed using the standard K-means unsupervised learning algorithm. The key assumption in this paper is that the extracted descriptors are independent and hence can be treated as a BoW in the image. This BoW nomenclature is derived from text classiﬁcation algorithms in classical machine learning. For a query image, descriptors are extracted using the same robust local feature extractor. Each descriptor is mapped to its visual word equivalent by ﬁnding the nearest cluster centroid in the dictionary. An ensuing count of words for each image is passed into a learning algorithm to classify the image.

**2. LITERATURE REVIEW**

Computer vision (image understanding) is a discipline that studies how to reconstruct, interpret and understand a 3D scene from its 2D images in terms of the properties of the structures present in the scene. It has been studied since late 1970s and has lot more to go. Signiﬁcant eﬀorts have been paid to develop representation schemes and algorithms aiming at recognizing generic objects in images taken under diﬀerent imaging conditions (e.g., viewpoint, illumination, and occlusion). Within a limited scope of distinct objects, such as handwritten digits, ﬁngerprints, faces, and road signs, substantial success has been achieved. Object recognition is also related to content-based image retrieval and multimedia indexing as a number of generic objects can be recognized. In addition, signiﬁcant progress towards object categorization from images has been made in the recent years. Object recognition has also been studied extensively in psychology, computational neuroscience and cognitive science.

Geometry-based approaches

Early attempts on object recognition were focused on using geometric models of objects to account for their appearance variation due to viewpoint and illumination change. The main idea is that the geometric description of a 3D object allows the projected shape to be accurately predicted in a 2D image under projective projection, thereby facilitating recognition process using edge or boundary information (which is invariant to certain illumination change). Much attention was made to extract geometric primitives (e.g., lines, circles, etc.) that are invariant to viewpoint change. Nevertheless, it has been shown that such primitives can only be reliably extracted under limited conditions (controlled variation in lighting and viewpoint with certain occlusion).

Appearance-based approaches

In contrast to early eﬀorts on geometry-based object recognition works, most recent eﬀorts have been centered on appearance-based techniques as advanced feature descriptors and pattern recognition algorithms are developed. Most notably, the eigenface methods have attracted much attention as it is one of the ﬁrst face recognition systems that are computationally eﬃcient and relatively accurate. As the goal of object recognition is to tell one object from the others, discriminative classiﬁers have been used to exploit the class speciﬁc information. Classiﬁers such as k-nearest neighbor, neural networks with radial basis function (RBF), dynamic link architecture, Fisher linear discriminant, support vector machines (SVM), sparse network of Winnows (SNoW), and boosting algorithms have been applied to recognize 3D objects from 2D images. While appearance-based methods have shown promising results in object recognition under viewpoint and illumination change, they are less eﬀective in handling occlusion. A single exemplar is unlikely to succeed. As such approaches require pattern to be identified from the image and object looks different under varying conditions (illumination, viewing direction, change in shape/size), all possible appearances of an object is impossible to be represented from a single exemplar. Thus, use of multiple example images of the objects is used to perform recognition. In addition, a large set of exemplars needs to be segmented from images for generative or discriminative methods to learn the appearance characteristics. These problems are partially addressed with parts-based representation schemes.

Feature-based approaches

The central idea of feature-based object recognition algorithms lies in ﬁnding interest points, often occurred at intensity discontinuity, that are invariant to change due to scale, illumination and aﬃne transformation. It correctly classifies images of objects under perturbation by noise, rotation and scaling. FBR uses a set of feature detectors to build a representation vector for images. The feature detectors are learned from the dataset itself. The scale-invariant feature transform (SIFT) descriptor, proposed by Lowe, is arguably one of the most widely used feature representation schemes for vision applications. The SIFT approach uses extrema in scale space for automatic scale selection with a pyramid of diﬀerence of Gaussian ﬁlters, and keypoints with low contrast or poorly localized on an edge are removed. Next, a consistent orientation is assigned to each keypoint and its magnitude is computed based on the local image gradient histogram, thereby achieving invariance to image rotation. At each keypoint descriptor, the contribution of local image gradients are sampled and weighted by a Gaussian, and then represented by orientation histograms. For example, the 16×16 sample image region and 4×4 array of histograms with 8 orientation bins are often used, thereby providing a 128-dimensional feature vector for each keypoint. Objects can be indexed and recognized using the histograms of keypoints in images. Numerous applications have been developed using the SIFT descriptors, including object retrieval. Although the SIFT approach is able to extract features that are insensitive to certain scale and illumination change, vision applications with large base line change entail the need of aﬃne invariant point and region operators. Finally, SIFT-based methods are expected to perform better for objects with rich texture information as suﬃcient number of keypoints can be extracted. On the other hand, they also require sophisticated indexing and matching algorithms for eﬀective object recognition

RECENT DEVELOPMENT

With more reliable representation schemes and recognition algorithms being developed, tremendous progress has been made in the last decade towards recognizing objects under variation in viewpoint, illumination and under partial occlusion. Nevertheless, most working object recognition systems are still sensitive to large variation in illumination and heavy occlusion. In addition, most existing methods are developed to deal with rigid objects with limited intra-class variation. Future research will continue searching for robust representation schemes and recognition algorithms for recognizing generic objects. We can see major promising projects going on like ImageNet, Microsoft COCO and many more.

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**APPENDIX B: FORMAT OF DISKETTES/CD CONTAINING COMPUTER SOFTWARE**

Listings of software should be given in a diskette/CD. The diskette/CD should contain files containing the source code, one or more sample input and corresponding output separately. Other than there, there must be another file named “README”. In this ASCII text file, the following sections must appear:

* Files in the Disk: In this section, the names of the files together with their contents must be listed.
* Hardware Requirements: In this section, the equipment, graphics card, mouse, disk capacity, RAM capacity etc necessary to run the software must be noted.
* Software Requirements: In this section the operating system, the compiler, the linker and the libraries etc necessary to compile and link the software must be listed.

Please note that no copyrighted material file (compiler, library etc.) should be put on the disk without obtaining the necessary license from the copyright owner.