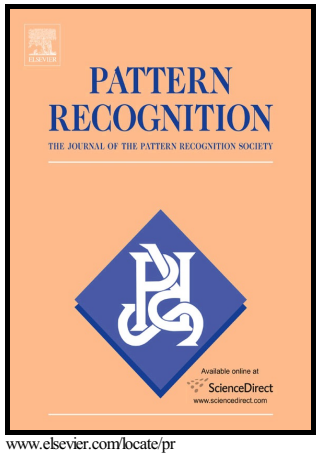
Maximum-Likelihood Approximate Nearest Neighbor Method in Real-time Image Recognition

A.V. Savchenko



www.elsevier.com/locate/pr

PII: S0031-3203(16)30228-X
DOI: http://dx.doi.org/10.1016/j.patcog.2016.08.015
Reference: PR5844

To appear in: *Pattern Recognition*

Received date: 19 August 2015
Revised date: 20 April 2016
Accepted date: 15 August 2016

Cite this article as: A.V. Savchenko, Maximum-Likelihood Approximate Nearest Neighbor Method in Real-time Image Recognition, *Pattern Recognition* http://dx.doi.org/10.1016/j.patcog.2016.08.015

Maximum-Likelihood Approximate Nearest Neighbor Method in Real-time Image Recognition

A. V. Savchenko

National Research University Higher School of Economics, Laboratory of Algorithms and Technologies for Network Analysis, 136 Rodionova St., Nizhny Novgorod 603093, Russia

avsavchenko@hse.ru

ABSTRACT

An exhaustive search of all classes in pattern recognition methods cannot be implemented in real-time, if the database contains a large number of classes. In this paper we introduce a novel probabilistic approximate nearest-neighbor (NN) method. Despite the most of known fast approximate NN algorithms, our method is not heuristic. The joint probabilistic densities (likelihoods) of the distances to previously checked reference objects are estimated for each class. The next reference instance is selected from the class with the maximal likelihood. To deal with the quadratic memory requirement of this approach, we propose its modification, which processes the distances from all instances to a small set of pivots chosen with the farthest-first traversal. Experimental study in face recognition with the histograms of oriented gradients and the deep neural network-based image features shows that the proposed method is much faster than the known approximate NN algorithms for medium databases.

KEYWORDS

Approximate nearest neighbor method; large database; maximum likelihood; real-time pattern recognition; image recognition; probabilistic neural network; HOG (histograms of oriented gradients); deep neural networks.

Abbreviations

AESA, Approximating and Eliminating Search Algorithm; ANN, approximate nearest neighbor; DEM, directed enumeration method; DNN, deep neural network; HOG, histograms of oriented gradients; HT-PNN, homogeneity testing probabilistic neural network; ML-ANN, maximal-likelihood approximate nearest neighbor; NN, nearest neighbor; P-ML-ANN, pivot-based maximal-likelihood approximate nearest neighbor; SVM, support vector machine

1. Introduction

Image recognition is a challenging problem due to the variability of either objects presented in images or conditions of observations, e.g., illumination, noise, etc. [1]. The input image and all reference images are usually processed to extract either local features, e.g., SIFT [2] and SURF [3], or a global descriptor, e.g., the histograms of oriented gradients (HOG) [4], the pyramid HOGs [5] and the features based on Deep Neural Network (DNN) [6]. After that, machine learning techniques can be applied, e.g., conventional Support Vector Machines (SVM) [4,7] or modern DNNs [8,9]. These image recognition methods have reached a certain level of maturity when the size of the training set is large with respect to the number of different classes. These methods proved to be very efficient in such tasks,