Rotation Invariant Template Matching

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PhD Thesis, Series of Publications A, Report A-2001-3
Helsinki, November 2001, 139 pages
ISSN 1238-8645, ISBN 952-10-0009-0

Abstract

In *rotation invariant template matching* one wants to find finding from the given input image the locations that are similar to the given pattern template, so that the pattern may have any orientation. Template matching is an old but important problem in computer vision and pattern recognition, and thus there have also been many attempts to solve it. Most of the most successful solutions so far come from the signal processing community, based on fast computation of *cross correlation* or *correlation coefficient*. The existing combinatorial approaches have ignored the template rotations. This thesis fills in this gap by presenting the first rotation invariant combinatorial template matching algorithms.

The thesis begins by giving the definition, from the combinatorial point of view, of a rotated approximate occurrence of a pattern template in an image. The accuracy of the approximation can be measured by several different distance functions. The consequences of this definition to the problem complexity are then analyzed.

We present several algorithms for solving the problem. There is a trade–off of complexity, efficiency and generality between the algorithms. The simplest one of the algorithms is also the most general one, in terms of distance functions allowed. It evaluates the distance between the pattern and all image positions and pattern rotations in

an optimal time. The subsequent algorithms assume that there is a certain limit (threshold) to the maximum allowed distance between the pattern and the image. We give several different algorithms for this thresholded matching, varying in complexity and generality. For the exact matching we give also an algorithm that is optimal on the expected case.

We consider also *indexing*. The image is preprocessed to build an index structure that can be used for fast queries of the pattern occurrences.

Finally, we compare the performance of our algorithms against the traditional FFT–based correlation approach. It turns oout that the new methods can be orders of magnitude faster for the thresholded matching. Preliminary results of a biological application are reported.

Computing Reviews (1998) Categories and Subject Descriptors:

E.1 Data Structures—trees

F.2.2 Analysis of Algorithms and Problem Complexity: Nonnumerical Algorithms and Problems—pattern matching, sorting and searching, geometrical problems and computations

H.3.1 Information Storage and Retrieval: Content Analysis and Indexing

H.3.3 Information Storage and Retrieval: Information Search and Retrieval

General Terms:

Algorithms, Theory

Additional Key Words and Phrases:

Template matching, rotation invariance, indexing