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Chapter IV

Quadtree-Based Image Representation and Retrieval

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Abstract

This chapter is a survey of quadtree uses in the image domain, from image representation to image storage and content-based retrieval. A quadtree is a spatial data structure built by a recursive decomposition of space into quadrants. Applied to images, it allows representing image content, compacting or compressing image information, and querying images. For 13 years, numerous image-based approaches have used this structure. In this chapter, the authors underline the contribution of quadtree in image applications.

Introduction

A *quadtree* (Finkel & Bentley, 1974; Klinger, 1971) is a well-known unbalanced spatial data structure built by recursive divisions of space in four equal-size disjoint quadrants. This chapter focuses on image domain. A quadtree has been used frequently to represent an image or picture in various applications. For example, Ahmad and Grosky (1997, 2003), Albuz, Kocalar and Khokhar (2000), Kim and Kim (2000), Lin, Tamer Özsu M, Oria and Ng (2001), Lu, Ooi and Tan (1994), Malki, Boujemaa, Nastar and Winter (1999) and Rukoz, Manouvrier and Jomier (2002) exploit it in the purpose of content-based image retrieval. Baligar, Patnaik and Nagabhushana (2003), Cheng and Li (1996), Jackson, Mahmoud, Stapleton and Gaughan (1997), Kim and Lee (2002), Li, Knipe and Cheng (1997), Shusterman and Feder (1994) and Strobach (1991) compress images using quadtrees. The quadtree is also used in computer graphics by Samet and Webber (1988); in image processing by Lin (1997a, 1997b), Smith and Chang (1994) and Yang, Chung and Tsai (2000); in Geographical Information Systems (GIS) by Aref and Samet (1997) and Shaffer, Samet and Nelson (1990); and in image databases by Jomier, Manouvrier and Rukoz (2000), Manouvrier, Rukoz and Jomier (2002), Tzouramanis, Vassilakopoulos and Manolopoulos (1998-2001) and Vassilakopoulos, Manolopoulos and Economou (1993-1995).

This chapter surveys the different applications of quadtree in the image domain. In the first part, the principles of quadtree representation are recalled. The second part presents several approaches minimizing the memory space used by encoding image quadtrees in a linear form or by compressing images using quadtrees. The third part gives an overview of the different approaches proposed for the storage and manipulation of clusters of images. Finally, the last part deals with the Content-Based Image Retrieval approaches using quadtrees.

Quadtree-Based Image Representation

Different types of data, like curves, surfaces or volumes, can be represented by quadtrees. A survey of the different quadtree types is presented by Samet (1984, 1990) and online demos are proposed by Brabec and Samet (2003). The most widely known quadtree, called *region quadtree*, allows cutting an image in regions or quadrants according to a given split criterion (for example, color homogeneity). As explained by Shusterman and Feder (1994), a quadtree allows representing images at different levels of resolution. This section recalls the general principles of quadtree and presents approaches using it to store image feature vectors.