VISTO: A new CBIR system for vector images

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ARTICLE INFO

ABSTRACT

In this paper, we present the main features of VISTO (Vector Image Search TOol), a new content-based image retrieval (CBIR) system for vector images. Though unsuitable for photo-realistic imagery, vector graphics are continually becoming more advanced and diffused. Vector images are fully scalable, resolution independent, not restricted to rectangular shape, allowing layering and editable/searchable text. Notwithstanding this increasing interest, the research area concerning CBIR systems for vectorial images is quite new, and our research on a vector based CBIR system actually derives from a precise request of vector based application experts that did not find appropriate solutions to their retrieval problems in customary shape-based CBIR system. To the best of our knowledge, VISTO is the first CBIR system for vector images proposed in the literature, and it supports the retrieval of images in SVG (scalable vector graphics) format.

We discuss VISTO from both the engine and the interface points of view, and then evaluate its engine from an experimental point of view within an advanced high quality 2D animation environment supporting cartoon episodes management. To satisfy the requirements of stroke-based applications, in VISTO vector images are modelled as inertial systems and then associated with descriptors representing visual features invariant to translation, rotation, and scaling transformations. Furthermore, to efficiently serve different application domains, the engine offers a variety of moment sets as well as different distance functions for similarity computation. The graphical interface offers tools that help in the selection of criteria and parameters necessary to tune the system to a specific application domain.

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1. Introduction

Though unsuitable for photo-realistic imagery, vector graphics are continually becoming more advanced and diffused. Vector images are made up of individual, scalable objects defined by mathematical equations rather than pixels. This makes vector images fully scalable, resolution independent, not restricted to rectangular shape, allowing layering and editable/searchable text, in contrast to raster images.

Common vector formats include, among others, AI (Adobe Illustrator), CDR (CorelDraw), CGM (Computer Graphics Metafile), SWF (Shockwave Flash), and DXF (CAD software). It was maybe the wide variety of formats, along with their strong dependance on application programs, which discouraged research in content-based image retrieval (CBIR) systems dealing with vector images, although a number of application domains might have profited from results in this field. Furthermore it may be noticed that raster images has so far ruled the roost also on the World Wide Web, notwithstanding the convenience of vector images on the web, for their reduced size compared to raster images, as well as for the possibility of client-side scaling, which avoids new images to be sent.

The growing popularity of new vectorial-based web design programs, such as Macromedia Flash, along with the new standard format SVG (scalable vector graphic) [71] proposed by W3C, are now changing this trend, promising to bring vector graphics to ordinary web pages soon (popular browsers such as Internet Explorer have plug-ins that can allow readers to use SVGs). Notwithstanding this increasing interest, the great majority of content-based image retrieval (CBIR) systems proposed in the literature still deals with raster images, for a complete survey see e.g., [9]. As pointed out in [53] *"to the best of authors' knowledge, there are no proposals (neither theoretical, nor applicative) that try to solve CBIR when images are represented in a vectorial data model"*, whereas there is a recognized need to search vector image databases not only based on keywords or text annotations but also based on visual features (e.g., shape or color). Actually, this was exactly the problem we had to solve in order to satisfy the requirements coming from a 2D animation

production environment [69], which was our initial application domain. In such domain, application experts did not find appropriate solutions to their retrieval problems in customary shape-based CBIR system, and their request stimulated our research.

1.1. Requirements from the application domain

In a 2D animation production environment supporting cartoon episodes management, efficient searching of animation material is crucial for helping cartoonists in scene re-use. To offer an environment as close as possible to the natural one, the system in [69] supports an interactive slate composed of a digital display and an electronic, pressure sensitive, pen. This technology, based on new intelligent pen systems, protects every natural element of a paint realized in the traditional environment (thus supporting artistic signature).

Generally, to create an episode it is necessary to animate a large number of scenes, in turn composed of a number of frames. The traditional realization of a scene utilizes an appropriate device, called *rostrum* (see Fig. 1).
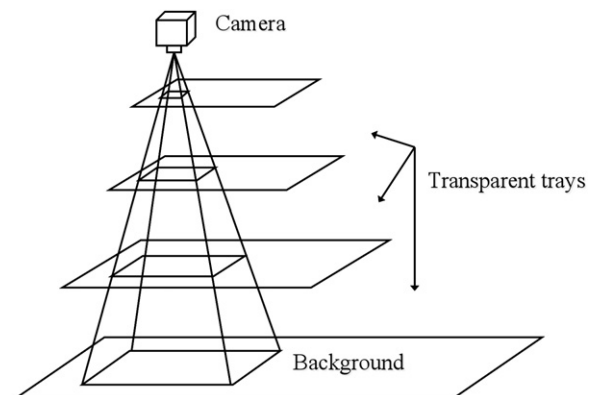

Fig. 1. The rostrum representation.