DESIGN and EXPERIENCE
with a
GENERALIZED RASTER TOOLKIT

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ABSTRACT

Raster manipulation software is often viewed as an *ad hoc* means to fine-tune the appearance of digital images, or as a means to reformat them to conform to specific hardware requirements. A universally accepted, machine readable, device-independent specification of a raster image is seldom employed. This stands in contrast to the variety of "standards" for higher-level scene representation. We define a general raster "type", which unifies the design of a toolkit of raster-based software. Operations performed by the tools are closed in the sense that operators map objects having the raster type onto new objects having the raster type. This closure encourages a synthesis of function by allowing composition of operators. Sequences of these operators are surprisingly powerful and have wide application.

RÉSUMÉ

Les logiciels de manipulation d'images "raster" sont souvent considérés comme un moyen *ad hoc* d'améliorer l'apparence d'images digitales, ou comme un moyen de les modifier de façon à ce qu'elles se conforment à un appareil spécifique. La représentation universelle d'une image "raster", ne dépendant pas d'une machine particulière, est rarement utilisée; ce qui contraste avec le grand nombre de normes qui existent pour représenter des images de plus haut niveau. Nous définissons un type "raster" qui permet la création d'une série d'outils opérant sur celui-ci. Les outils en question forment un ensemble fermé dans le sens qu'ils opèrent sur des images de type "raster" pour produire des images de type "raster". Cette fermeture permet la création de fonctions par la simple juxtaposition d'opérateurs plus simple. Ces compositions de fonctions se révèlent étonnament puissantes et ont un vaste domaine d'applications.

Keywords: *bitmap, digital compositing, imaging, raster.*

INTRODUCTION

The ultimate goal of any software system should be the creation of a harmonious set of tools in which each tool embodies a conceptually simple operation. This is true for the case of raster image manipulation, but such a set is not in widespread use. To have generic utility, each tool must operate on an abstract raster type. For instance, a "cropping" tool should trim rasters regardless of their dimension or pixel attributes. Additionally, the tool's output should be, in all cases, a valid raster file so that tools may be composed arbitrarily.

To achieve this, we define a universal file format and implement general raster access routines. With these, the creation and coding of each new tool is greatly simplied, and the proliferation of disposable software can be alleviated. This scenario is also a boon to the user: generic tools imply a simple conceptual model. In some cases, they even suggest new ways of "plumbing" together raster operators. This approach is appealing in an academic/research environment, where creative experimentation is encouraged, but where software maintenance remains on a tight budget.

This paper discusses the design and implementation of a comprehensive raster manipulation system, based on the raster file format, that has been operational for over a year and is the mainstay of raster-based activities within the Computer Graphics Laboratory at the University of Waterloo. In that time, it has completely subsumed the various *ad hoc* raster file formats previously in use and has provided a unifying framework for new research.

OVERVIEW

The toolkit contains programs to support abstract operations (rotation and scaling), as well as interfaces to a number of hardware devices and software systems. These include I/O tools for Adage/Ikonas and Raster Technologies frame buffers, the Apple/Macintosh, and Versatec and Imagen hardcopy printers. In this usual setting, tools model the UNIX text/filter paradigm, whereby the output of any one tool may be piped