Visualization Tool for Environmental Modeling

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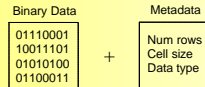carr@tiem.utk.edu, gross@tiem.utk.edu*

Problem

The Institute for Environmental Modeling (TIEM) performs large-scale environmental modeling on geo-referenced maps and needs to visualize the complex model output.
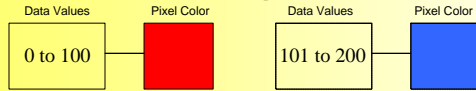
Objectives

• Create and manipulate images for landscape data models
• Embed geo-referencing metadata within image files
• Provide compatibility with standard image-viewers
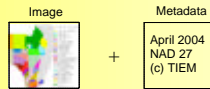
Primary Data Formats

Landscape Data

Binary Data

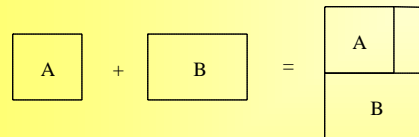| 01110001 |
| 10011101 |
| 01010100 |
| 01100011 |

+

Metadata

Num rows
Cell size
Data type

Color Map File

Data Values	Pixel Color
0 to 100	

Data Values	Pixel Color
101 to 200	

GeoTIFF Image

Image

+

Metadata

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(c) TIEM

Basic Image Operations

Horizontal Concatenation of Two Equal-sized Images

A + B = A B

Vertical Concatenation of Two Unequal-sized Images
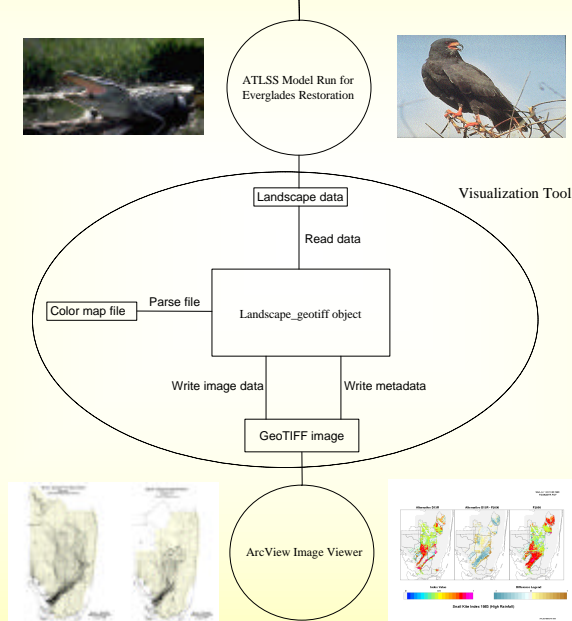
A + B = A / B

Solution

Image library was written in C++ programming language to translate landscape data files into GeoTIFF images.

• C++ template library used for efficient data structures and algorithms
• libtiff and libgeotiff libraries imported to simplify image file manipulation
• Modularized design by defining several C++ classes

Code Structure

ATLSS Model Run for Everglades Restoration

Visualization Tool

Landscape data

Read data

Color map file — Parse file — Landscape_geotiff object

Write image data   Write metadata

GeoTIFF image

ArcView Image Viewer

Secondary Problems Overcome

• Integrating procedural-style C libraries with object-oriented C++ code
• Parsing color map file for errors
• Porting across different operating systems and compilers

Results

• Succeeded in objective of generating images with geo-referenced metadata based on landscape data
• Implemented vertical and horizontal concatenation functions for basic image manipulation
• Documented all open-source code to allow easy use and modification by users
• Provided alternative software to PV-Wave, an expensive, commercial product, by forming a simpler connection to ArcView, a popular Geographic Information System (GIS) program
• Supplied additional tool for TIEM to present users interested in modeling
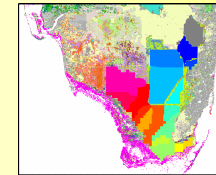
Sample Florida Image Map

GeoTIFF Image   **ArcView Map of Florida**

Overlap of GeoTIFF over ArcView image

Future Work

• Produce difference images—images based on color value differences in two images
• Create default color maps
• Specify separate border colors and fill-in colors during concatenation
• Provide graphical user interface for setting geoTIFF tags

References

• Gross, Louis J. *ATLSS Home Page frame - Everglades Restoration - Across Trophic Level System Simulation* . ATLSS. 21 March 2004. <http://www.atlss.org>

• Warmerdam, Frank, et al. *GeoTIFF*. Remote Sensing. 21 March 2004. <http://www.remotesensing.org/geotiff/geotiff.html>

• Warmerdam, Frank, et al. *TIFF Software*. Remote Sensing. 21 March 2004. <http://www.libtiff.org>