Jordan River Fly-by
Animation
Using Arcview

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Jordan River Fly-by Animation
Using Arcview

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The Department of Civil and Environmental Engineering of Brigham Young University accepts this project, completed by Christopher Michael Lynn, in its present form as satisfying the project requirements for the degree of Master of Science in Civil and Environmental Engineering.

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Executive Summary

Develop a three-dimensional computer generated fly-by of the Salt Lake Valley emphasizing the path and position of the Jordan River and it's inflows. The animation includes the rivers, highways, lakes, water treatment plants, and the land uses in the valley.
# Table of Contents

1.0 Overview ........................................................................................................ 1
   1.1 Background ................................................................................................ 1
   1.2 Scope ......................................................................................................... 1
   1.3 Process Outline ......................................................................................... 1

2.0 Data ............................................................................................................. 2
   2.1 Formats and Sources ............................................................................... 2
   2.2 Volume ..................................................................................................... 2
   2.3 Manipulation ............................................................................................ 3

3.0 Hardware ..................................................................................................... 3
   3.1 General ................................................................................................... 3
   3.2 Memory .................................................................................................. 4
   3.3 CPU ....................................................................................................... 4
   3.4 Disk Space ............................................................................................. 4

4.0 Software ...................................................................................................... 5
   4.1 Limitations .............................................................................................. 5
   4.2 Applications ............................................................................................ 5
      4.2.1 ArcView ......................................................................................... 5
      4.2.2 Flash ............................................................................................. 6
4.2.3 Ordix Mpack 2000 ........................................ 7
4.2.4 Real Player ........................................... 7
4.2.5 Quick Time ........................................... 7
4.2.6 Windows media player ................................. 7

5.0 Presentation options ..................................... 8

6.0 Conclusion ............................................... 11

Bibliography .................................................. 11

Appendix A: How to create a 3 dimensional image ....................... 12
Appendix B: How to convert a 3 dimensional Image into a 3 dimensional animation ........................................... 15
Appendix C: Thanks ............................................ 20
Appendix D: Sample 2 Dimensional images ................................. 21
Appendix E: Sample 3 Dimensional images ................................ 28
Appendix F: Attached CD contents .................................. attached

1. AAA.MPG
2. BBB2.MPG
3. CCC2.MPG
4. ffgsIsouth.mpg
5. north1000.mpg
6. northhalf.mpg
7. southhalf.mpg
8. RealCombined.mpg (only plays correctly with Real Player)
9. world.swf
10. animation extension
11. full text of paper

List of Figures

Figure 5.1 Mountain shaded with un-shaded valley
Figure 5.2 Neither mountains or valley shaded
Figure 5.3 Image with Mountain not shaded, but valley shaded
Figure 5.4 close-up of shaded valley image
Figure A.1 Arcview 3D scene viewer
Figure A.2 Steps to create an Arcview 3D scene
Figure A.3 Flight path trajectory and camera angle
Figure B.1 Animation Properties window
Figure D.1 2D image showing all coverages used in animation
Figure D.2 Lakes, Rivers, and WWTPs
Figure D.3 2 D image of the animation valley boundaries
Figure D.4 Close-up 2 D of Jordan River inlet to Great Salt Lake
Figure D.5 Close-up of Jordan River inlet to Great Salt Lake over topographic map image
Figure D.6 Close-up of mid valley 2 D image
Figure D.7 Close-up of mid valley with freeways
Figure E.1 View looking up canyons to the East (North valley)
Figure E.2 North edge of image, Jordan River inlet to Great Salt Lake
Figure E.3  View looking East of mid valley

Figure E.5  View south from Great Salt Lake (start of animation)

Figure E.5  Full world image at start of zoom

Figure E.6  Final zoomed image of Utah (approx.)
1.0 Overview

1.1 Background

This project was requested by Dr. Brett Borup as an introduction to a Jordan River water quality presentation he would be doing in Paris. This animation would give the international attendees unfamiliar with the area a perspective on the conditions. This animation allows the attendees to see the position of the river in the valley as well as where the populated and industrial areas are relative to the river and the water treatment plants.

1.2 Scope

With the use of several applications I successfully created 9 15-45 second animations in mpeg format. These segments included different flight paths, directions, altitudes, and regions of the valley. I then combined 5 of the segments into a single mpeg with a run time of 1 minute and 18 seconds that showed the entire course of the Jordan River flying both South and North. I also created a short Flash animation that zooms in from a global perspective to the scale of the state of Utah to further orient the international conference attendees to the area discussed. Land uses, river locations, highway locations, and the location of the 4 water treatment plants in the Salt Lake valley were all included in the animations, in addition to the relative elevations shown in 3 dimensions.

1.3 Process Outline

The overall process to create the animation consisted of 5 steps. First the data is gathered, and then a 2 dimensional image is created. The 2 dimensional image is then converted
into a 3 dimensional image and then animated. Finally, the shorter mpegs are combined into a single longer mpeg.

2.0 Data

2.1 Formats and sources

The data required for this project include elevation, land use, river locations, lake locations, and location of the 4 water treatment plants. Freeways were also included in the animation for reference and perspective. The data came from various sources and therefore scale, and coordinate systems had to be compared and adjusted.

The land use and elevation data came from the USGS website, www.epa.gov/ostwater/BASINS/gisdata.html. This data was at a 1:250,000 scale and data had to be merged from several files. The files came in "core" format that had to be unzipped. The rivers, lakes, water treatment plants, and freeway locations all came from an ESRI produced GIS CD of data. This data was all in Arcview shape file format, mostly in lat/lon coordinate system.

2.2 Data volume

There was a great deal of all the desired data with one exception. Originally, we had wanted to include all inflows into the Jordan River including treatment plants, rivers, and storm inflows. There were inadequate data available to show the storm water inflows, but it worked out that most if not all of those inflows would not have been visible at the scale of the animation anyway. The elevation data as well as the position data of the rivers, land uses, water treatment plants were adequate for the scale of the animation. The accuracy of the animation increases
with the amount of data, but so does the processing time. The processing time resulting from too much data became the limiting factor much more than the lack of data.

2.3 Manipulation

Most of the data gathered were in the Latitude Longitude coordinate system in meters. It was therefore logical to select that as the coordinate system and unit for the final presentation. The elevation and land use data were available in meters, but it had to be converted from UTM NAD 27 to Latitude Longitude. The image TIF was also in the Latitude Longitude coordinate system. The river and highway coverages covered several states so they had to be clipped to include only the desired area. The elevation data came in several smaller sections that had to be combined into one coverage for the animation. The rivers, roads, and land use coverages had to be clipped to the extents of the valley so they weren’t seen up the mountainside where they in reality can’t be seen.

3.0 hardware

3.1 General

As with any computer project this project was limited by the hardware the software was running on. All 3 major hardware constraints came into play at various points throughout the project. First a short history of the hardware resources available for this project. I started by using a relatively older computer with minimal access to memory, CPU, and disk resources that I needed to run the software in a manner that would meet the end of July deadline. I was later given access to a workstation that had quadruple the memory, almost double the CPU power and 130 times the hard disk space. On average the first workstation took two and a half minutes to
networked and physical media files on the hard drive where they could be accessed much more quickly.

4.0 Software

4.1 Limitations

Arcview had very few limitations to what I wanted to do. There were some features that would have been nice, but everything I needed done could be done through the proper sequence of steps. The 3-D animation extension in general worked exactly as advertised, with one undocumented exception that greatly impacted the final resulting animations. The animation extension basically displays the 3D image as rendered by Arcview's 3D analyst and then saves the image. The image is then rotated as described in the "flight path" of the animation and another image is saved. This process is repeated until the entire "flight path" has been traversed and the images have all been saved. At this point the animation extension then runs a batch job on the workstation to convert the string of jpeg files into an mpeg animation. The greatest limitation to this process was a 1000 image limit to the number of images that can be combined into an mpeg. The extension will allow you to make more than 1000 images, but it won't create the mpeg at the end of the processing like it does if there are fewer than 1000 images.

4.2 Applications

a. Arcview
   i. version
   ii. extensions used
      1. 3D analyst
2. Flyby Animation builder
3. Geoprocessing
4. Dialog Designer
5. Projector!
6. JPEG (JFIF) Image Support
7. Projection Utility Wizard
8. Spatial Analyst

Arcview version 3.1 was the primary application used. This application was used to compile all the data, convert the data to common units, clip it to the region of interest, manipulate the data to include the area of interest, and then display the data in 2 dimensions. Then with the addition of the 3D analyst extension of Arcview convert the 2 dimensional image to 3 dimensions. Finally, with the addition of the animation extension define a flight path and camera angles over the 3D image for the animation to be created. This application was very powerful as well as versatile.

b. Flash

Flash 4 is an application that allows you to place a sequence of images in a series and then plays them back quickly in flash format. Because of the 1000 image limit on the animation extension I was hoping that this application could play the images back with more than 1000 images. Flash did have that functionality, but because of the large size of the images it couldn’t play the images back fast enough to have a smooth animation. This application was used to create the zoom animation from the full world image down to the state of Utah image. Flash obviously played the zoom in flash, but would only show the first 30 seconds of the combined mpegs making it no better than just playing them all individually.
c. Ordix Mpack 2000

Ordix Mpack 2000 was just the application I needed to combine the several mpegs of less than 1000 images (approx. 30 seconds) into a single mpeg of longer duration. The application made it so that the mpegs did not have to be played in sequence, but all at once.

d. Real Player

Real Player was the only application I found that would play the combined mpegs. While it was very nice to have the mpegs combined into a single animation there was one limitation to be overcome. Not all media players had the functionality necessary to show the combined mpegs. Real Player was found to play the combined animation. It was great to find an application that would combine the mpegs, but without an application to play the resulting animation would make it useless.

e. Quicktime

Quicktime was the most disappointing of all the applications I tried since it wouldn’t play any of the animations at all.

f. Windows media player

The Windows media player worked very well for the mpegs created by the Arcview animation extension, but would not play the zoom in flash, or the combined mpegs.
5.0 Presentation options

Figure 5.1 Mountain shaded with un-shaded valley
Figure 5.2 Neither mountains or valley shaded
Figure 5.3 Image with Mountain not shaded, but valley shaded
Figure 5.4 close-up of shaded valley image

6.0 Conclusion

This is a powerful tool for any application that has 3 Dimensional relationships, and in particular helping less technical people visualize these relationships easier.

Bibliography

1. Melanie Burgoyne’s project at http://class.et.byu.edu/ce514/Projects99/msb.html

Appendix A.2.a through A.2.f. Including figure A.2

2. Appendix B is almost entirely excerpted from the Animation Extension help file with some specific changes to be more directly applicable to this project.
Appendix A: How to create a 3 dimensional image animation using Arcview GIS 3.2

Instructions assume knowledge of Arcview and the use of extensions, views and themes

A.1 create a 2D image
Create a 2 dimensional view using any Arcview method or extension desired.

A.2 create a 3D image
a. Make sure the 3D Analyst extension is selected
b. Converting to Grid, if necessary
   i. The DEM's that I used did not need any conversion since they were already in shape file format.
   ii. I clipped the grid to the area of interest.
c. Converting to TIN
   The grids could now be opened into ArcView and converted to TINs. The grid theme must be the active theme in order to use the Convert Grid to TIN option under the Theme menu. ArcView prompts for the output theme name, and the z-tolerance value. The z tolerance value determines the accuracy of the TIN as well as the time required to complete the conversion. The smaller z-tolerance the more accurate the image, however, the more accurate tins take considerably longer to convert.

d. Creating a 3D Scene
   A 3D scene can be created by clicking New on the 3D Scene icon in the Project Manager. The TIN Theme can be added by clicking the Add Theme button. The view can then be rotated by clicking on the sailboat button and dragging the sailboat on the scene.
e. Adding features to a 3D Scene
   The coverages can be added into ArcView and converted into 3D shapefiles. The heights of objects must be added into the attribute table. After adding the themes to the 3D scene, the base heights must be specified so that the features will be placed at ground level. This is done by going into the 3D Properties dialog box in the Theme menu and assigning the base heights as the TIN surface. The buildings were extruded in the 3D scene to give them a third dimension by assigning the extrusion height in the 3D Properties as an expression and letting that expression equal the values of the height field in the attribute table.
f. Draping an Image Over a TIN surface
   To drape an image over the surface, it must be added as a theme (image data source) to the 3D scene and made the active theme. Under the 3D Properties option in the Theme menu, the base height is assigned by the TIN surface. (Burgoyne, 99)
g. When using multiple themes in a 3D image special care must be taken to set the elevation offset of the theme so it will appear correctly in the image. In other words if all the themes are set at the same elevation (usually the elevation of the TIN) then all the images would be using the same pixel on the screen and the computer can not
know which theme to display on top. Depending on the scale of the scene simply making each theme 1-2 ft apart from each other solves the problem. Line and point themes are the main source of this problem, and setting the thickness to be greater helps them to be displayed correctly.

Figure A.1 Arcview 3D scene viewer
Using Arcview 3D Analyst

by: Melanie Burgoyne

The objective of this project was to explore the capabilities of the ArcView 3D Analyst Extension. Using a USGS Digital Elevation Model and Digital Raster Graphic of the Mesquite, Nevada 7.5° Quadrangle, the steps shown were followed to produce a 3D scene. 3D scenes can make any project concerned with elevation data be more easily viewed and understood by clients.

ArcView 3D SCENES

Figure A.2 Steps to create an Arcview 3D scene
Appendix B: How to convert a 3 dimensional Image into a 3 dimensional animation (excerpted from Animation extension ReadMe)

B.1 Install animation extension

Currently, this sample extension only works for 3D Analyst on Windows NT. It is mainly used to create Mpeg animations, but it can also be used to make other kind of animations such as animated GIFs that can be used directly on a web page or MS Word document. The following content focuses on the creation of an Mpeg movie.

The following files need to be copied into specified Locations before you can use the extension:

$AVHOME/bin32/: djpeg.exe, mpeg_encode-nt.exe, ppm.par
$AVHOME/ext32/: movie.avx
$AVHOME/help/: movie.htm

B.2 Use Animation extension to create an animation

1. open an ArcView 3D Analyst project and load Flyby Animation Builder extension (this extension depends on 3D Analyst extension, which, if not already loaded, would be loaded automatically when loading this extension);
2. make a view document active and under Animations menu, select Associate View with Scene submenu (assuming there's a 3D Scene document existed in the project);  
3. after the view is associated with a scene, under the same menu, select Animation Properties submenu; and  
4. set and adjust the parameters in the Flyby Animation Builder dialog to create an Mpeg movie or make preparations for other animations.

![Figure B.1 Animation Properties window](image)

There is no warrantee written or implied on the contents of this sample. Users should be aware of this and use these samples at their own risk.

### B.3 Explanation of Figure B.1

This extension is mainly used to create Mpeg animations, but it can also be used to make animated GIFs that can be used directly on a web page or MS Word document. The following content focuses on the creation of an Mpeg movie.

What's involved? Major Procedures to Create an Mpeg Movie:

1. to make a series of Jpeg image files (*.jpg) with 3D Analyst using snapshot request on a 3D scene viewer;  
2. to decompose Jpeg image files into portable pixmap files (*.ppm) using a djpeg program; and  
3. to compile the serial portable pixmap files into a Mpeg movie file using a Mpeg encoder program, mpeg_encode-nt.exe, which is a freeware developed by Berkeley.

Currently, this sample extension only works for 3D Analyst on Windows NT.
About the Flyby Animation Builder Dialog:

There are three blocks in the dialog, Flight Path Properties, Observer Properties, and Flyby Animations, and some controls in each block. Flight Path Properties define the flight path itself. Observer Properties decide the subject viewpoint properties. Flyby Animations finalize the creation of an Mpeg movie or prepare for a GIF animation. Generally, each block (with its associated controls) should be checked in this order.

Flight Path Properties:

Densify Step Distance decides how dense the flight path line will be after smoothing, which also decides the number of frames created for making an Mpeg movie or GIF animation.
Major Densification Factor deals with the major step distance (a segment) to densify the path line; the larger the factor, the flatter the path line curve.
Minor Densification Factor is similar to the last one except it only deals with a segment of the path line. Its impact on the curvature of the whole path line is much less.
Draw Flight Path in View. If you want to draw a flight path yourself in the View, you need to check this radio button. Clicking the tool button that follows draws the flight path line in the View document. Double click to finish the line drawing in the View. The line drawn is densified and smoothed with the parameters set in the Flight Path Properties block of the dialog.
Select Path Theme from View. If you want to use a line shape as your flight path, you need to check this radio button.
Shape Offset sets an offset off the original line shape. So if the flight path shape theme were a profile line lying on the surface, you’d be able to fly above the surface at this specified offset value off the original line shape. (The easiest way to make the flight path line shape theme that the offset is based on is through using the profile tool offered by the 3D Analyst built-in GUI.)
Select selects a shape theme from the view document. It only takes a line/polyline shape or its subclass shapes (excluding polygon class). For line shape theme with multiple line features, if there’s a selection, then the last selected line is used as the flight path; if there’s no selection in, the first record is used.
Densify Flight Path densifies the specified line shape theme, which is the default. If the input line shape has already been done so you may want to check it off.

The smoothing algorithm, referred to as Besier algorithm, is used by default when you draw a flight path in the View document or smooth the specified line shape.

Observer Properties:

Flight Height sets the flight height above a surface. The surface used is assumed to be the first surface theme in the View. The default flight height value is set to equal the maximum Z value of the underlying surface or 100 when no surface is found. The flight height value is taken when you draw a flight path in the View document (a 2D line) or when you specify a 2D-line shape theme from the View. It is disabled when you specify a 3D-line shape theme as the flight path in the View.
Camera Roll Factor, defaults to 1.0, determines the extent of side rolls as the flyer turns. The
smaller the factor, the less roll it takes.

View Range Step is defaulted to 1, and you may want to change it to another value. When it’s set to 1, it means along the flight path line of view points, as can be shown in the 3D viewer after you click Draw Path button, an observer is only aiming or looking at the immediate next point as a target. When you set it to N, it'll aim or look at the Nth point as a target from the observer. This way you can control your view range (i.e. across how many points) by setting the appropriate step value, hence the name.

Declination sets the pitch of the observer between 0 and 90 degrees inclusive. The angle means the degree between a horizontal line and your down tilting view line. You can either set it using the text line input or drag the vertical scroll bar.

Left/Right controls the observer view orientation. When it’s 0, the view points directly to the front (to the next target point). When it’s between –90 and 0, the view points to somewhere of the observer’s left side. When it’s between 0 and 90, the view points to somewhere of the observer’s right side.

View Camera Info draws camera information (observation point in green, target point blue, view line in green and view angle in magenta) graphics at 10 equally divided points along the flight path in the View window. It reflects the changes in View Range Step and Left/Right view angle when it’s been redrawn.

After a flight path is drawn in the view document or a specified flight path line shape theme is selected, its properties are set. If you want to change the flight path properties, you’ll have to do either one of them again in the Flight Path Properties block. However, you can modify the observer properties in the Observer Properties block using the defined flight path to have different effect in your flyby animation.

Flyby Animations:

Two Major Radio Buttons:

Flyby Preview lets you see a flyby within the 3D Analyst using a 3D-scene viewer. It acts as a test fly before you make the real movie.

Make Movies Once you are satisfied with the flyby, you can switch to this choice to create the final Mpeg movie or make ready for a GIF animation.

The first two buttons deal with flight path graphics in scene viewer.

Draw Path  Flight path is always drawn in View document by default. If you want to see the flight path in 3D Scene Viewer, click this button to draw the graphics in the viewer. The flight path shown in the Viewer, different from that in View, only draws the serial densified and smoothed observer 3D points, not continuous path line.

Clear Path clears any graphics in the 3D Scene Viewer.

The next two checks controls flight orientations and directions.

Fly in Opposite Direction, defaults off; let you fly in opposite direction along the defined flight path.
Backward Movement. defaults off, let you fly backward along the flight path.

Estimated # of Frames gives you an estimated number of frames to be created in the movie construction.
Width reflects and sets the width of the Viewer OpenGL window.
Height reflects and sets the height of the Viewer OpenGL window.
Image Width (pixels) defaulted to 300 screen pixels, decides the final Mpeg movie size. If you set a different width of the exported images, the width and height ratio will keep the same.
Exported Image Format lets you choose among JPEG and BMP (bitmap images). To create an Mpeg movie using this extension, you need to check JPEG on. If you want to make a GIF animation, export JPEG images and use a 3rd party image convertor to convert the images to GIF. You'll also need a GIF animator (can be downloaded from the web) to complete the GIF animation and the process could be very easy.

Delete Exported Files, when checked on, deletes the exported JPEG or BMP image files. If you want to make GIF or other kind of animations, you'll need these exported image files and should leave it unchecked (which is the default setting when you check GIF or BMP radio button). If you only want to create an Mpeg movie, then you don't need them and should check it on, as is the default setting. (One occasion you may want it unchecked is that you want to create a GIF animation using exported JPEG images that have been used for an Mpeg movie construction.)
Delete Secondary Files, decides whether to delete converted (from *.jpg) portable pixmap files (*.ppm). If you don't want to manipulate them for recreation of another Mpeg movie, check them on, as is the default setting. This option is disabled when you select exported image format as GIF or BMP.
Current Frame shows the current frame number as the flyby animation goes. Compare this number with the Estimated # of Frames and you'll know how far your animation is at.
Create Mpeg Movie starts the Mpeg movie construction process. The image format has to be set to JPEG before this feature is enabled. You need to specify a subdirectory where the serial image files and the final Mpeg movie file are to be stored. This data directory had better be the one solely used for the creation of this movie, because there'll be a lot of intermediate files to be created during the process and you don't want to mess them up with other files. You'll need to wait for a few seconds, depending on how many frames are to be created, before the Mpeg movie file is completed. There'll be a message box showing that the Mpeg movie is done after the second process log windows disappear.

Movie Playback is shared with 3D-scene viewer flyby preview. When you select the Flyby Preview radio button in this block, this button displays as Scene Preview. When you are in the movie creation mode (Make Movies... checked) this button displays as Movie Playback. It uses Microsoft Windows Media Player to play the Mpeg Movie or any other accepted animation file loaded. If the extension cannot find the player, it'll send out a message telling you to find your own Mpeg player. The Microsoft Windows Media Player can be downloaded from http://www.microsoft.com/windows/mediaplayer/default.asp.

Load lets you load another Mpeg Movie file or any other MS Media Player accepted animation file.
Delete lets you delete the current Mpeg Movie file or other animation file permanently. Help pops up this help contents (or hit F1 when the Flyby Animation Builder dialog is active). Cancel dismisses the Flyby Animation Builder dialog.

Legal Stuff

There is no warrantee written or implied on the contents of this sample. Users should be aware of this and use these samples at their own risk.

Appendix C: Thanks

Thanks to Stephanee Smith and Nathan Haws for access to their projects and some of their Arcview files of the Jordan River region. Their projects were used for general familiarity with the area and verification of treatment plant locations.
Appendix D: Sample 2 Dimensional images

Figure D.1 2D image showing all coverages used in animation
Figure D.2 Lakes, Rivers, and WWTPs
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