

Riverside.2003: Multi-Media Exploration of a Tree-Growth Database

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Abstract

This paper describes the design of Riverside.2003 – an application for visually exploring a multi-media collection of ecosystem data. Riverside.2003 allows one or more users to examine the growth patterns of a collection of trees planted as part of an experiment in ecosystem restoration. Graphic symbols are used to portray information about the trees. Riverside.2003 monitors the choices users are making about what aspects of the data to look at, analyzes these choices, and displays relevant photos drawn from the project’s digital photo archive. Riverside.2003 runs on the PercepTable, and is designed to be useful to the researchers involved in the restoration project, as well as the general public.

1 Introduction

This paper describes the design of Riverside.2003 – a prototype application for exploring a multi-media collection of data gathered as part of an ongoing research project in ecosystem restoration. The Riverside.2003 application is intended to be useful to the researchers conducting the restoration experiment, giving them a way to detect overall patterns in the data quickly. It is also designed to be usable by children and adults among the general public, especially those who might frequent museums or science centers. We anticipate that this population will find the application interesting, usable, and engaging.

Riverside.2003 is designed for use on the PercepTable [1], a display configuration designed in the VIS Lab [2]. The PercepTable integrates both a vertical display and a horizontal display surface, providing a significant amount of “screen” real estate that can be used for information display.

1.1 ARBOR Ecosystem Restoration Project

The ARBOR project (Answers for Restoring the Bank Of the River) is a continuing research study in strategies for ecosystem restoration in a riparian setting [3]. The study defines 8 different plots, each about an acre in size. A total of 1300 trees were planted in the plots, using different planting methods. Two plots were planted in straight rows, two were planted using a diagonal pattern, two were planted using random locations for the trees, and two were left as control plots. The 1300 trees that were planted are of 12 different species. The sapling stock was of two types: containerized and bare-root. Under conditions of the study, container-grown trees

were planted in the straight-row plots and bare-root trees were put into the random-location plots and the diagonal row plots.

The research team has surveyed the trees twice a year. During a survey, each tree is located and measurements are taken of its height, width at the ground, and width at about chest height. Notes are made about the general condition of the tree: is it living, dead, healthy, diseased, broken over, missing completely, munched by predators (beavers and deer, e.g.), etc.

Currently, the tree survey data collection process is done by hand. Survey team personnel take the measurements in the field and record the numbers on pre-printed paper survey forms. Back in the office, the numbers are transferred to spreadsheet templates. The spreadsheets are converted to “comma-separated values” files, which are then parsed by custom data translators that add the data entries into an SQL database.

In addition to the trees that were planted by the restoration project, another 8000 trees (“natural recruits”) have sprouted and grown on the site. The species and location of each of these trees has been noted. Additionally, surveys of birds, butterflies, and dragonflies have been conducted on the site, as a measure of the progress of habitat establishment.

The restoration site also includes 16 wells of varying depths. Each well is instrumented with hardware to measure the height of the water and the water pressure. Data is stored locally at the instrument until it is collected by the research team.

Finally, the restoration project is well documented in terms of digital photographs, with over 6000 pictures taken so far. The photos provide a good visual record of the project – there are pictures of the planting process, pictures of every species of tree, pictures of the tree survey process, and pictures of flora and fauna observed on the site.

The RIVER project includes among its goals the ability to visualize, synthesize, and analyze the full complement of data gathered during the riverbank restoration project. The Riverside.2003 application prototype, in its early form reported here, is primarily concerned with the tree survey data, showing tree growth of the planted trees. The data from the natural recruits, from the wells, and from the flora and fauna surveys will be included in subsequent versions.

2 PercepTable

The PercepTable is a top-down display device, in which a projector throws an image to a horizontal surface positioned 30” up from the floor (see Figure 1). A plasma panel, mounted vertically at the upper edge of the table, provides a second display surface. Users interact with the PercepTable by manipulating small tools that lie on the table surface. The tools are pieces of lightweight wood decorated with reflective tape. A video camera captures the tabletop scene, including the tools and the tape-shape symbols on the tools. Computer vision algorithms process the video image and detect the presence of a previously trained symbol, its location on the table, and its orientation. The display application communicates with the optical tracking application to get this information, do the translation to an application-specific user action, and adjust the display accordingly.

The PercepTable is a particularly good environment for the Riverside.2003 application. The horizontal surface is an obvious place to display geospatial information, much as we would spread a map out on a table. Further, supporting user interaction through optically-tracked tools means that users can interact with the system in a natural and intuitive way. Multiple users can



Figure 1. The PercepTable includes both horizontal and vertical display surfaces.

be involved simultaneously, and no one need ever touch, or contend over, the keyboard or a mouse. Finally, the plasma panel provides a second surface for display, giving us a place to put more information drawn from the project database. In the version of Riverside.2003 reported here, we use the plasma panel to display photos drawn from the project's extensive archive of digital pictures.

3 Riverside.2003 Display and User Interface

The Riverside.2003 data display and user interface allows one or more users to examine the growth patterns of the trees that were planted as part of the ecosystem restoration study. The tree growth data base includes, for each tree, its species, the planting location, the height and width measurements taken at 6 survey dates, and notes about the condition of the tree. In addition, geographic information describing the layout of the site is available, including the coordinates outlining each plot and aerial photos showing the river, the site, and the adjacent landscape.

3.1 Design Goals

In designing the data display and user interface to Riverside.2003, our goals were to provide easy and effective ways to interact with the tree growth data such that users could:

- Understand the overall layout of the site.
- See the spatial distribution and planting patterns of the trees within the various plots, and see the per-species distribution of the trees throughout the plots.
- View the variation in tree size across species and plot at planting time.
- See the survival rates and the growth patterns of the trees over time.
- Compare the tree survival rate or growth pattern of a particular species against the overall population. Compare the tree survival rate or growth pattern of the trees in each plot against the others.

- Detect relationships between tree species, planting method, and survival rates or growth patterns.

Note that the goals for this version of Riverside.2003 do not include the ability to convey quantitative information. Rather, our goals are to allow users to discover an overall sense of what is happening with the trees at the site. This is consistent with our goals of making this application enjoyable and interesting for the general public. This approach is also useful for the researcher team, in that it can point out possible relationships that might warrant a more analytical investigation.

The Riverside.2003 data display user interface can also be seen as a graphical means to specify queries against the ARBOR tree growth data base. Using the table-top tools provided by the PercepTable, users select by time, space and planting method (i.e., plot location), or species characteristic.

3.2 Data Display

The data display and user interface aspects of Riverside.2003 use the horizontal surface of the PercepTable and the PercepTable user interaction tools. Computer-generated graphics are projected to the table.

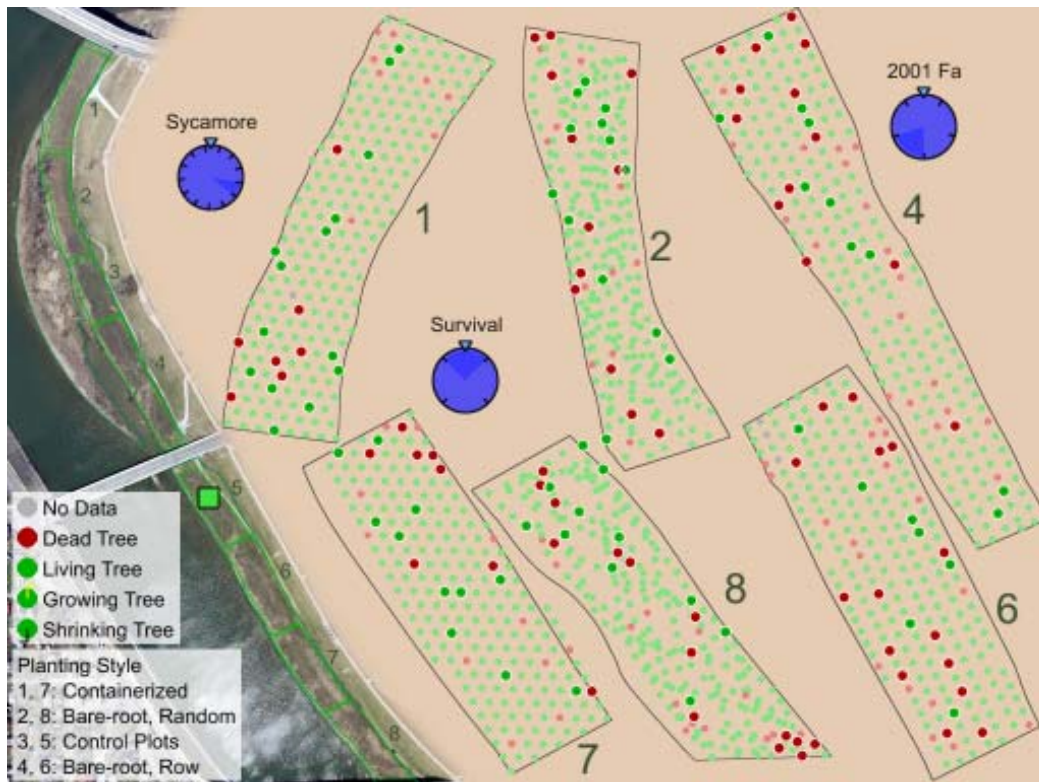


Figure 2. The overall data display.

The left side of the display is used to provide an overall spatial context and legend information. As shown in Figure 2, an aerial photo is rendered as a backdrop and shows the river and the study

area. The outlines for the 8 ARBOR plots are drawn as an overlay, and each plot's study number appears as a text label just to the right of the plot.

As shown in the legend, the study plots were planted in pairs: plots 1 and 7 were planted with container-grown trees, plots 2 and 8 were planted with bare-root trees in random locations, plots 4 and 6 were planted with bare-root trees in rows, and 3 and 5 are control plots where no trees were planted.

The rest of the table surface is used to show the tree growth data. There are currently 2 modes to this display: a *single-plot mode* for looking at just one plot, and a *multi-plot mode* for looking at all 6 plots that have been planted with trees. In either mode, the plots are drawn using the shape and orientation that exists in true geophysical space. The plot number appears close to each plot to identify the plot and to associate it with its location in the overview panel on the left.

In the multi-plot mode, the plots are arranged in 2 rows of 3 columns each. Each column contains the 2 plots planted with the same planting style. The top row shows the plots from the northern half of the study, and the bottom row shows the plots from the downstream half of the ARBOR area.

Each tree is rendered as a glyph at its planting location within the plot. A variety of glyphs are used to portray the data related to each tree. The simplest glyph is a circle drawn at the appropriate location. The color of the circle is used to differentiate between living and dead trees. As shown in Figure 3(a), trees that have survived are shown in green, and trees that have died are shown in red. Color is also used to indicate that no data exists for a tree for a particular survey period – these trees are drawn in gray.

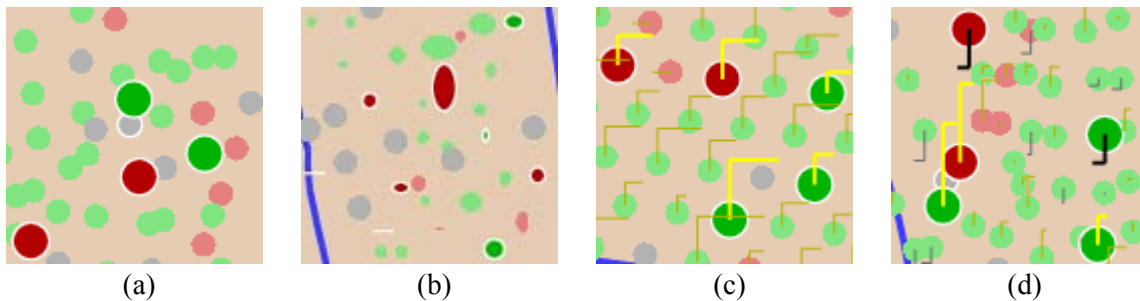


Figure 3. A variety of glyph styles are used to represent the trees.

The circle glyph is also used to select out a particular species of tree. This lets the viewer spot (e.g.) relationships between tree species and survival. To highlight a particular species, the circle glyph is drawn with a slightly larger disc, the color of the disc is intensified, and a white outline is added to the shape. Additionally, glyphs of the selected species are drawn on top of any others that lie in the same space. Perceptually, these changes cause the selected trees to appear to come to the foreground, making them easily distinguishable from the rest, yet still allowing for comparison with other species by keeping the same basic attributes of shape and hue.

Riverside.2003 uses a couple of different ways to show the size of the trees. The simplest method is to stretch the “circle” glyph along the major and minor axes, to show the height and width of the trees at a particular time, as shown in Figure 3(b). Alternatively, a *size vane* can be added to the circle glyph. The size vane uses a vertical segment to show relative height of a tree and a horizontal segment to show relative width. For trees of the selected species (if any), the vane segments are drawn in a bright yellow, while a dull color is used for the rest of the vanes.

Growth (change in height and width) is shown using a *growth vane* glyph. A vertical bar shows a change in height. Since a tree could be eaten by browsing deer or broken over by debris during a flood, a decrease in height is possible and would be shown by a segment extending downward. A horizontal bar shows a change in the diameter of a tree. Again, this change can be in either the positive or negative direction. Positive changes are drawn in yellow, negative changes are drawn in black. This glyph is used in two modes. In the *overall growth* mode, the glyph represents the change in height and width since planting time. The *recent growth* mode shows the amount of change as measured from the previous survey period.

3.3 User Interaction

Riverside.2003 users manipulate the Perceptable table-top tools to drive the application. Four different tools are used. The *plot selection* tool is used to request that a particular plot be magnified and displayed by itself in the data display area. The physical tool that the user manipulates is shaped like a fir tree and the graphical symbol that is projected to the table is a small green square. A user selects a particular plot for detailed viewing by putting the square inside the boundary outline of the plot in the site view area of the display, as shown in Figure 4(a). When an individual plot is selected, the graphics for that plot smoothly move from the site view to the center stage of the table.

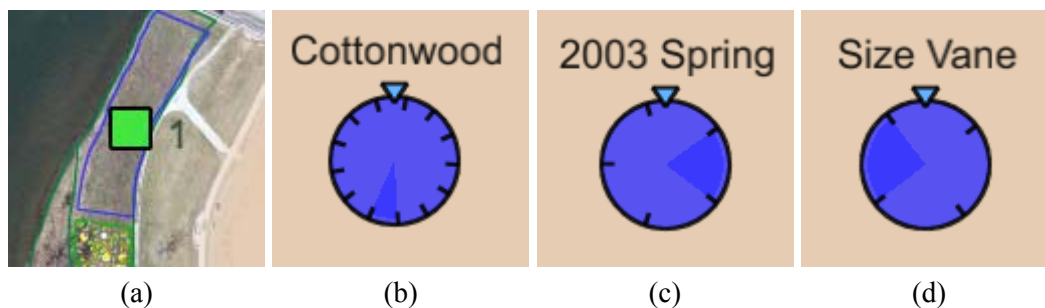


Figure 4. The plot selection tool and the 3 dial tools.

The other three tools used in Riverside.2003 are dials, allowing the user to select one item from among a set of choices. In each case, the dial is divided into multiple wedges. Turning the Perceptable's physical tool rotates the wedges. The wedge that rotates into the 12 o'clock position, pointed at by the bright blue triangle, is reported as the current selection. A text label is projected at the top of the tool, identifying the selected position.

The dial tools are used to select:

1. Species. There are 13 divisions to the dial, labeled with the 12 species names or the setting "All". The *All* setting is drawn in a slightly darker blue, and is used to show all the trees in the same way.
2. Tree survey date. This dial has 5 choices. The first survey date, conducted at the time of tree planting, is the 'start' position and is shown in the darker blue.
3. Representation. This dial has choices for each of the glyph choices used to represent the trees.

4 PicStream

Computer-generated visualizations of real-world physical spaces raise interesting questions about the level of fidelity that is appropriate. In some situations, a highly realistic, true-to-life environment is the best choice. In other situations, more abstract or even cartoon-like drawings are appropriate to the task or to the type of user experience the program author wants to create.

In Riverside.2003, we experiment with combining the abstract visualizations (the data displays) with true-to-life visuals, using photos from the project's digital image archive. The Photos are displayed by PicStream – a simple animation application, written in Macromedia Flash. PicStream reads XML messages from a socket connection. Given a URL and some indication of “importance”, PicStream fetches a photo and displays it on the screen.

PicStream includes a number of pre-defined motion paths. Each path is appropriate for showing images of a particular weight. For example, the path of greatest importance scales a photo to a larger size, moves it quickly to the center of the screen, and holds it there for several seconds before finally floating the picture to the top of the display and out of view. By contrast, the path of least importance uses a small-scale version of a photo and just fades it into view and then out. The picture is on the screen for just a few seconds and there is no movement of the picture across the screen.

4.1 User Activity Analysis

In the current version of Riverside.2003, the data display and the photo display are only loosely combined – they are entirely separate applications, they use different display surfaces, and they never co-mingle in space: the data display appears on the PercepTable's table-top surface, while the photos are always shown on the vertical plasma panel.

However, the PicStream photo display is tied to and reflects the interactive data exploration. User interaction with the PercepTable's tools drives the selection of pictures for PicStream to show. For example, user selection of a particular species triggers the display of trees of that species. Selection of a particular plot shows trees planted in that plot, using the appropriate planting method. And selection of a particular survey date triggers display of photos taken at about the same time.

A user-event analysis module is responsible for examining user activity and choosing which photos to display. Riverside.2003's data display and user interaction program captures user activity – each turn of a dial tool or movement of the Plot Selection tool is relayed to the analysis module. This module operates on the most recent user requests, examining events as they are received and determining when changes stabilize. The module generates queries to retrieve information about relevant photos from the picture archive. The results of these queries are saved and updated as new events are received. The module sends picture information to PicStream on a regular interval, which can be adjusted so that more or fewer pictures are displayed. Communication with PicStream is structured in an XML message. The message includes the URL of the picture, and a weight. The weight is a measure of relevance of the picture to the user's current activity.

5 Discussion

Riverside.2003 demonstrates the combined use of multiple media types, presented through a novel display platform with innovative user interaction strategies, to provide an interactive experience for exploring the growth patterns of trees planted as part of an ecosystem restoration study. Design goals for the Riverside prototype are to build the hardware environment and software application such that users can easily develop an overall understanding of the progress towards establishment of the stand of trees, and an intuition about possible patterns of correlation between tree species, planting methods, and tree growth and survival. Aerial photography, computer-generated glyphs, and photos drawn from the project's digital image archive are used. User interactions are supported that allow participants to highlight various species, plots, and survey dates and to view the trees by size or growth.

The VIS Lab PercepTable is a useful environment for this prototype since it provides ample screen space to display the overall site, individual plots with glyphs for each and every tree, as well as reasonably sized photographs showing specifics of individual trees or other flora from the site.

Future work for the project includes more experimentation with the symbols used to communicate the tree data. We will also look at ways to show habitat evolution, perhaps combining the tree data with the observations from the birds, butterflies, and dragonfly surveys.

6 References

- [1] See <http://vis.iu.edu/Projects/PercepTable.html>
- [2] The VIS Lab is at <http://vis.iu.edu>
- [3] See www.cees.iupui.edu