Integrating Audio and User-Controlled Text to Query Digital Databases and to Present Geographic Names on Digital Maps and Images

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Background

A human's need for an appreciation of the spatial arrangement of the physical objects in the environment and their relationships to one another is fundamental for our understanding of and navigation through life. Digital maps and digital images have the potential to provide graphic representations of the surface of the Earth showing geographic objects such as rivers, roads, houses, etc. exactly like previously available hard-copy printed maps. With electronic technology, digital graphic representation of the surface of the Earth is becoming easier and less expensive, and this promotes the use of this technology by more and more individuals. Everyone can be a cartographer.

As electronic technology permits us to develop new and more precise sensors that use smaller portions of a larger range of the electromagnetic spectrum, we are collecting images of the Earth surface at a rate never before attained. Unfortunately, this increase in the image collection rate exceeds the rate of the use of these images. The current number of trained users cannot possibly use all of the currently collected remotely sensed data, and perhaps the capability of the current data collection rate exceeds human capabilities to utilize the data. There are many reasons for this. First, the use of digital maps and images of the Earth's surface is complex. The skilled user needs to have a more extensive background in geo-sciences than that of the unskilled map individual. The skilled user needs to know about coordinate systems, datums, map projections, coordinate transformations, scale, etc. Secondly, the skilled user needs to be familiar with the nature of the data. Are the data in raster or vector format? If vector, are the data in DLG, Arcview, Microstation, or another format? If the data are raster images, are the data from Landsat, SPOT, Ikonos, IRS, etc? Is the format of the files TIFF, JPG, GIF, etc? Third, the skilled user needs to be familiar with the area in which he/she is interested. What are the major landmarks? How do these landmarks look from above? etc.

Yet, with all of these demands, more unskilled users, in terms of total absolute numbers, than skilled users, are taking advantage of the technology to create their own spatial views of the earth. Therefore easy to use, theoretically transparent, methods to enable the unskilled user to view digital spatial and image data are necessary. In the long run, skilled cartographers will have to program many of their skills into machines that will (1) automatically receive the vast arrays of remotely sensed data, (2) provide numerous layers of capabilities that match the individual user's skill level, and (3) make the entire system run quickly and smoothly giving the appearance of simplicity. These facts underlie the work reported here. We want to add to the simple and quick routines that are needed to aid the least skilled users, access to and use of the increasingly large volume of available digital spatial data. In fact cartographers must create an entirely new level of automatic processing which will be used between data collection and end user use.

Problem addressed

One convenient and easy entry point for a majority of unskilled users to access geographic data of interest is through the use of geographic place names. A second convenience would be to enable the user to point at an area, feature, or landmark shown on a screen and to have the geographic name of that entity appear as text on the screen or to hear the name spoken by the computer. A third capability would be to allow the name to follow the image or map as the user zooms in or out on the display screen. These capabilities are needed at all skill levels, but this paper primarily addresses these capabilities at the most unskilled level of use and will concentrate on the use of audio to create machine spoken place names.

Currently a major limitation on the use of digital geographic data, even for geo-scientists, is the inability to interact with digital spatial data by using known geographic names. When the only product was a printed map, geographic names were an integral part of the map. Maps had titles, most often with place names as part of the title. Names were an indivisible layer from the printed map. Electronic technology has separated the name layer from the other layers and thereby makes possible the introduction of the presentation of names by the use of a separate media, sound, in addition to the ability to intermittently display names on the screen.

Geographic names are fundamental in the recognition and location of specific areas and features of interest on digital maps and images. They are a link between our accumulated personal knowledge and perceptions of our local environments and their representation on digital maps and images. It is not difficult to realize that identification and location of specific areas of interest on digital maps and images would be much easier if these maps and images (or portions of them) could be accessed interactively by geographic name. Accessing by name is common in the use of hard-copy maps, for instance “highway map of Ohio,” or the “Franklin County map”.

Fortunately, there is no lack of geographic names in digital format. In the United States the USGS, in cooperation with the U.S. Board of Geographic Names, developed the Geographic Names Information System (GNIS). The GNIS is currently composed of three databases:

1. National Geographic Names Database (NGNDB). The NGNDB contains names and locations of geographic features primarily taken from the 1:24,000-scale topographic maps.
2. Topographic Map Names Database (TMNDB). The TMNDB is an inventory of all 57,000+ USGS topographic maps and includes the latitude and longitude of each quadrangle sheet.
3. Reference Database (RDB). The RDB contains information about sources used in compiling the NGNDB.

The NGNDB is the largest of the three databases. It contains about two million geocoded names of physical and cultural geographic features in the United States.

Also, the National Imagery and Mapping Agency (NIMA) has its GEOnet Names Server (GNS) a database of foreign geographic feature names containing over 3.5 million items.
The U.S. Bureau of the Census issues the Census Tract Street Index that lists the names of streets in each census tract within the United States. All of these are freely available to be used by individuals creating maps.

The ultimate goal of this research is to integrate files of geographic names, such as those mentioned above, with digital vector and raster spatial data in such a way that a user could (1) access any region on the earth by geographic name, or (2) query a screen image of raster and/or vector data for the geographic name of a feature.

Related Work

To date most attention has been placed on the problem of geographic names placement on computerized maps. The goals of this previous research have been to program electronic equipment to automatically place names on a computer generated map that results in a quality of placement equivalent to that achieved previously on printed maps or manually on computer generated maps. In other words the research supporting these capabilities still considers the name layer as an integral part of the map, not as an independent separate layer. Much research has been conducted in the area of geographic name placement on maps (Ahn and Freeman, 1983, Freeman and Ahn, 1984, Doerschler and Freeman, 1989, Ebinger and Goulette, 1989, Johnson and Basoglu, 1989, Jones and Cook, 1989). Perhaps, the best automated solution to this particular problem to date is the one developed by Freeman and associates resulting in the commercial product Label-EZ™. But, Label-EZ™ is a scale-dependent product. What that means is that in order to place geographic names for the same area at two different scales (as when one zooms in or out on a map area), it is necessary to run the names placement program for each point the zoom stops to successfully achieve valid results.

Previous works on displaying maps on computer screens are also found in McGranaghan (1995), and Mersey (1995). The goal of McGranaghan's research was the presentation of choropleth maps on liquid crystal displays (LCDs). This work deals with the display of graphic symbols but not text. Mersey's work focuses on the design of symbols but does not deal with text either. In fact, the process of displaying geographic names on maps and images shown on computer screens is very different from the process of placing and printing geographic names on paper maps. First the visualization media are very different (computer screen in one case; hard-copy material in the other). Second, the nature of the process of displaying geographic names is different (instantaneous or just for a particular time interval for computer screens; permanent for hard-copy material). Third, the process is not dependent on the graphic scale (map scale) for computer screens but the process is constrained by graphic scale for printed maps.

Because of these differences, it is obvious that the process of displaying geographic names on computer screens requires a fresh look, availing itself of the capabilities of the electronic equipment. For this research we considered placing text on a screen, zooming in, and zooming out as the three primary functions that unskilled users would find most valuable when using digital spatial area about the earth.

Research Goals

Overall our research goals are simple:

1) Provide the capability for unskilled users to incorporate geographic names on digital maps and images by the
    (a) Use of audio to relate the names of geographic features to the user.
    (b) Use of text characters displayed under user-command.
2) Provide the capability for users to access a digital spatial data and image database by geographic name.
3) Design a "proof-of-concept" system with these capabilities.

In order to maintain simplicity, we felt it necessary to try to minimize the size of useable files, and the number of options initially available. We have therefore limited our experimentation to type sizes between 8 and 14-point. We have only considered placement of text horizontal to the screen (map) border. We have elected to keep only the digital name files and to transform a name file to a wave file (audio) each time it is requested rather than storing both the name and its corresponding wave file.

Conceptual Plan

As stated in http://www.nyu.edu/atg/library/papers/internet.audio/SoundInInterface.html "A number of studies have shown how audio contributes to the human-computer interaction process to provide a richer, more robust environment than with mere graphic feedback. Auditory feedback can present further information when the bandwidth of graphic information has been exhausted, as is often the case with the present emphasis on graphic presentation. By expanding conventional interfaces in an additional dimension, sounds make tasks easier and more productive. Other studies have even shown certain types of information to be represented better by sound than through graphics or text. Additionally, audio feedback may complement graphics and text to create valuable redundancy, reinforcing or reconfirming a concept in the user's mind."

Figure 1 illustrates our initial display of the system. The user has the choice of audio or text. When the user clicks on the button "Audio On," the audio option is activated. After the audio option is on, the user is able to listen to the name of any geographic feature by placing the mouse (and clicking) on the feature.

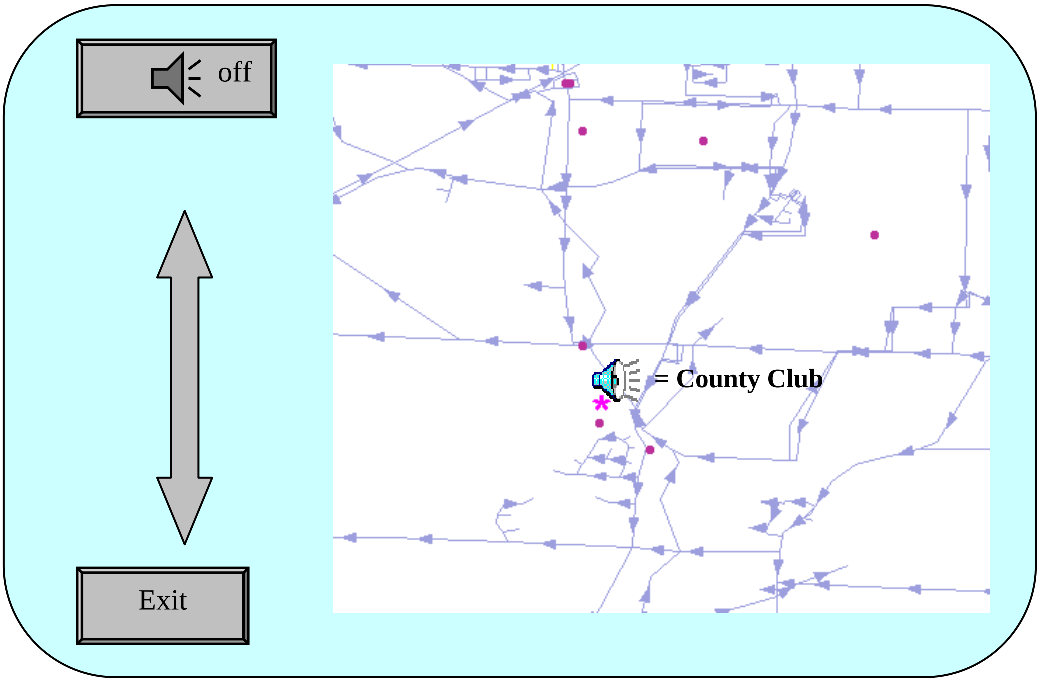


Figure 1. Initial Display

Figure 2 shows a conceptualization of the use of the audio option. The icon above the image indicates the audio is activated. When the user places the cursor (and clicks on) the geographic feature "North High St.," he/she will hear the words "North High Street". The user can adjust the audio volume by sliding the volume control up or down, and can disable the audio option at any time by clicking on the button "Audio off." After that a display similar to Figure 1 will reappear.

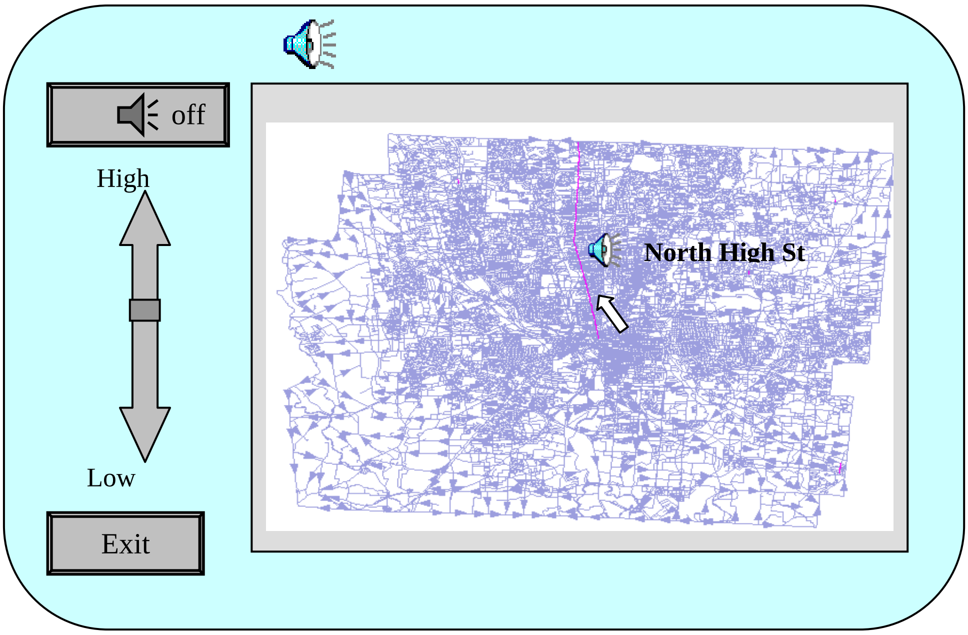


Figure 2. Sound Option "On"

Use of Text Character Displayed under User-Command

In many situations a user of digital maps and images may want to display geographic names as text on the computer screen. This will be accomplished by selecting the "Text On" option.

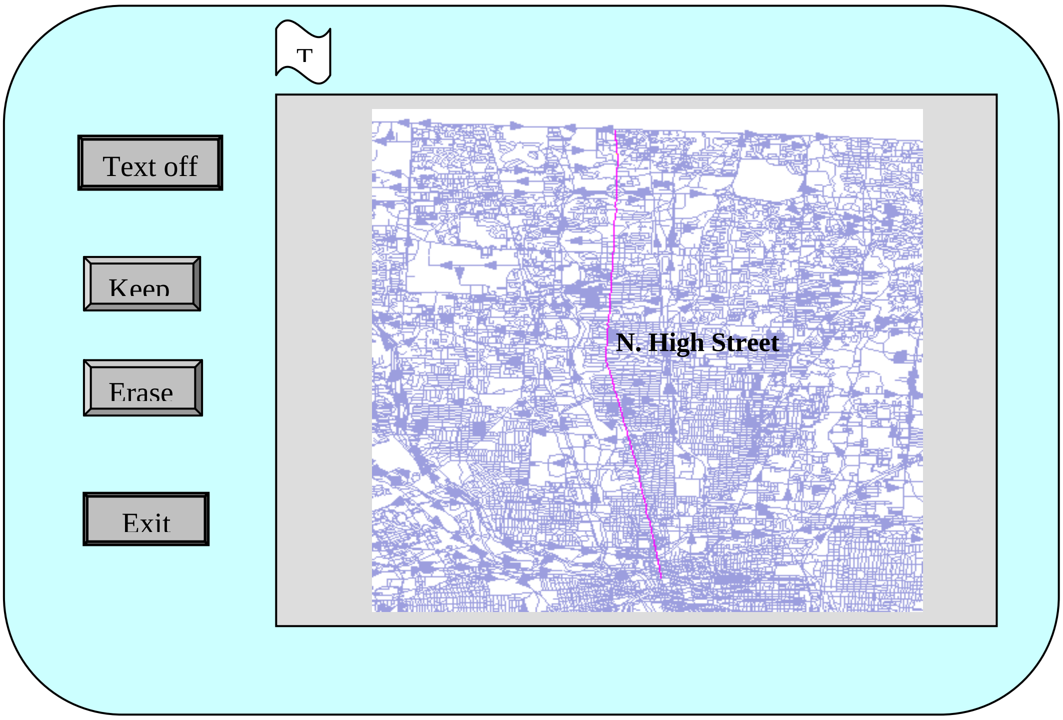
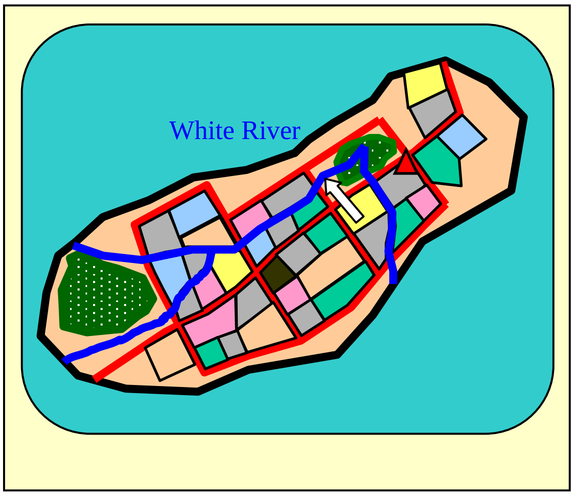


Figure 3. Text Option "On"

Figure 3 illustrates the use of the text option. The icon above the image indicates that text is activated. When the user places (and clicks) the mouse on the geographic feature "North High Street" he/she will see the text “N. High Street” displayed on the screen. By default, the system will delete any previous name once a new geographic name is selected. The user can override the default by pressing the "Keep" button or he/she can remove any geographic name at any time by selecting the "Erase" button and then clicking on the geographic name.

In the context of this research, the placement of geographic names on digital maps and images as described above is different from the placement of geographic names on hard-copy maps. What is the scope of the area surrounding a feature that will result in the name of that feature if the user chooses to point and click on it? This scope of area is similar to what we need to enable the user to query a database by geographic name. Research into this problem is part of a companion OhioView research proposal.

With regard to name placement, there are several unique problems to be considered. For example, location of geographic names may vary between two consecutive displays due to the panning or/and zooming of the area of interest. Figure 4 illustrates this. To enable the user to keep names from one display to the next and to incorporate zooming, we present the idea of "sliding" geographic names for linear and area features. "Sliding" names are those names that move with the feature (see Figure 4). The basic idea is that once a name is selected to be displayed, the name will stay with the corresponding feature, moving automatically along with it until the user decides to turn it off. In Figure 4 the user elects to display the name of a river (White River), then the user zooms in on the river and the name automatically adjusts itself and it is displayed. When the user pans the image, the name follows the display of the river.



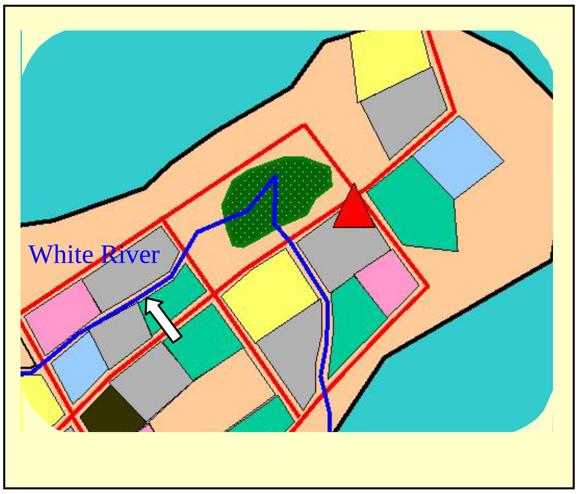
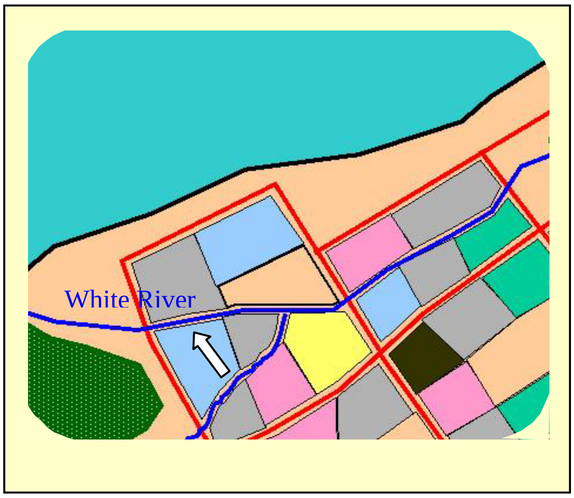


Figure 4. "Sliding" Text



Geographic names on a graphic screen can be removed or re-located by the user, thereby seemingly making the initial placement less critical.

Outcome

The major outcomes of this project are:

1) A conceptual framework to incorporate audio and user-controlled text on digital maps and images.
2) A more complete understanding of problems, advantages, and disadvantages of the use of audio to present geographic names in maps and images.
3) A more complete understanding of problems, advantages, and disadvantages for the use of user-controlled text to present geographic names in digital maps and images.
4) A "proof-of-concept" system demonstrating the use of audio and user-controlled text with digital maps and images.

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