Creating Tactile Maps for the Blind using a GIS

Jerry Clark
Cartographic Applications Group
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Deanna Durr Clark
Orientation & Mobility Specialist
Lincoln School
Los Angeles County Office of Education
600 East Grand Avenue
San Gabriel, CA 91776

Abstract

Tactile maps are sometimes used to help orient blind students to school and college campuses. Often the maps are hand-made with poster board cut-outs, representing buildings or obstacles, pasted on cardboard and annotated with braille. Sometimes the maps are derived from photocopies of site maps and are tactilely-enhanced using micro-encapsulated paper and a Stereocopier machine that "puffs up" the darkened lines and symbols. An alternative approach described in this paper is to use a GIS (geographic information system) and coordinate digitizer. Relevant spatial information is organized into layers that can be selected and combined according to need, then printed on micro-encapsulated paper to provide students with a series of customized maps.

Problem

Introducing, or orienting, a blind student to a school or college campus is a common task for the student's Orientation and Mobility (O & M) Instructor. The orientation is intended to allow the student to effectively and safely navigate the campus from point of entry to the classroom, as well as between classrooms and other points on campus. The usual approach to the orientation process is for the student and the instructor to walk every route and go to every destination, with the instructor describing landmarks, obstacles, turning points, distances, and other details of accessing buildings and classrooms. To augment this initial orientation, the instructor may construct a tactile map using stylized cardboard cut-outs of buildings and other features pasted on poster board and annotated with cut-out braille labels.

The problem with making tactile maps from poster board or other material is that it takes considerable effort to construct them. Besides the time involved, the resulting map is large, unwieldy, and comparatively crude. So with the intent of simplifying the construction process, speeding it up, and making the resulting product more manageable and adaptable to other students this study was begun. A secondary intent was to show that computer and document technology could be applied to a specialized educational setting. Specifically, the intent was to use a desktop computer-based GIS and coordinate digitizer to create paper maps that can be converted via a specialized form of photocopying to make maps of raised shapes, lines, symbols, and braille annotations. These tactile maps become reference maps for the blind student, In addition, the instructor would benefit by being able to sequence the instruction in such a way as to add detail with subsequent maps.

Approach

The approach to creating the tactile maps was straight-forward, given availability of necessary equipment. The various steps included acquiring a paper map of the campus; digitizing the map for buildings, routes, and landmarks important to blind students, and organizing the information on layers of the GIS, as well as annotating features with a braille font; printing a paper map after selecting the GIS map layers that were relevant to the student; making the tactile map using specialized photocopying equipment; and then letting the student use the map on campus to evaluate its usability.

A site map of the Pasadena (California) City College campus was provided by the coordinator of the disabled student services office. It was a generalized map of the campus that included buildings, sidewalks, parking lots, streets, and driveways, as well as annotations such as building names and other features on campus. The blue line map was larger than the active area of the coordinate digitizer surface so the map was photo-reduced on a standard photocopy machine,

The map was selectively digitized according to categories of information on the map, such as buildings, parking, athletic fields, and locations of entrances, bus stops, and obstructions. Some locations and information that was useful for blind students was not on the site map but was added to the GIS database based on the personal experience of the O & M Instructor with the campus. During digitizing, each category was allocated to a separate layer of the GIS. Intervening layers had annotations printed out in a braille font, such as building names, or had symbols, such as those indicating whether the entrance was at the same grade as the walkway or was associated with a stairway (see Figure 1). By using the braille font, each letter of the alphabet typed on the keyboard was represented by a braille character, in "Grade 1" braille, with a letter-for-letter transcription without the space-saving contractions a braille transcriber would use. The reason for creating numerous layers was to allow custom tactile maps to be made for the individual needs of students. The GIS database contained more detailed information than could effective y displayed at one time (see Figure 2). Layers were allocated as needed, and others were not allocated. Maps that were printed out only included information from the choosen layers (see Figure 3).

The actual tactile map results from a special three-dimensional photocopy process that includes printing the map on specially-coated paper that is considerably thicker (0.2 millimeters) than bond paper and is available in A4 and B4 formats (285 by 210 millimeters, and 364 by 257 millimeters, respectively). The paper, encoated with microcapsules of light- and heat-sensitive foam, was fed one sheet at a time into a standard photocopy machine. The light-sensitive portion of the coated paper produced results similar to regular photocopies in that black lines, shapes, and symbols were faithfully duplicated, The paper was then run through a special "stereo copy developing" machine that heats up the microcapsule paper causing the paper to puff up wherever black was copied. The result was a tactile map with raised linear surfaces, symbols, and braille dots,

The following is an equipment list for equipment and computer software used in this study (Note: this list does not indicate endorsement, but does indicate equipment that was available to the authors): Macintosh computer and Apple Laserwriter printer (Apple Computers, Inc., Cupertino, CA); CalComp Drawing Board II coordinate digitizer (CalComp Digitizer Products Division, Anaheim, CA); MapGrafix GIS (ComGrafix, Inc., Clearwater, FL); Braille font (Raised Dot Computing, Madison, WI); Matsumoto Stereo Copy Developing System, and microcapsule paper (J. P. Trading Inc., Brisbane, CA).

The evaluation of the tactile map on campus is covered' in the next section.

Evaluation

The blind student who evaluated the tactile maps created during this study was a recent graduate of high school who was beginning classwork at Pasadena City College, He is a bright student who is accomplished at white cane travel but is accompanied by a guide dog when he travels to school and attends classes. His O & M Instructor, during orientation activities on campus, worked with him to evaluate the effectiveness of the shapes, lines, symbols, braille, and organization used in the tactile map. Effectiveness of the various elements in the map was defined as being tactilely discernible. In other words, a line or symbol would be considered effective and useful to the student if it was easily discernible by touch and if it provided useful information without being confusing. An evaluation of shapes, lines, symbols, braille, and organization follows:

Shapes: In general, a tactile map faithfully representing all buildings or spaces was too complex, especially when the scale was too small. As a remedy, smaller, remote, or unimportant buildings and spaces could be ignored during digitizing, thus not represented in the GIS database. Shapes with interior patterns were confusing (even though a sighted-person might find patterning to be useful for differentiating spaces.

Lines: Effective lines were single or double solid lines, and single, dashed lines. Ineffective lines were dotted lines, or single lines with cross-hatching or patterning;

additional textures beyond the linear aspect of the line were ineffective at conveying information. Lines define the shape of features, but were especially important in delineating pathways to the entrances of destinations.

Symbols: Effective symbols were simple shapes, like circles, triangles, squares, however, differences between open versus filled-in shapes could not be detected. Ineffective symbols were complex shapes or patterns that would be visually-discernible but not tactilely.

Braille: An effective braille font had a size similar to standard braille produced by braille machines. It was important, to facilitate use by the student, to maintain the size of braille at a constant scale, regardless of changes in scale to the map between overall view and detailed views.

Organization of map: Building shapes should be simplified to emphasize spatial relationships between buildings. Routes and specific classroom destinations should be emphasized. As general orientation to the map, streets should be labelled, cardinal orientation noted, a key or legend provided, bus stops indicated when they are the beginning points of routes, and the map should be squared off.

Perhaps the most important point from a GIS perspective was to organize and label layers carefully while digitizing and editing so that appropriate features and annotation could be selected easily and quickly to customize the student's tactile maps without undue rework. The point of using the digitizer-GIS-Stereocopier approach is to make map creation and customization easier and quicker, while providing the student with a complete and effective map or series of maps of high quality.

Conclusions

This study is a work-in-progress, but numerous conclusions have resulted to date, such as: Simple representation of features is vital, so faithful digitization of each nook and cranny is not necessary; the simple form and relatively accurate placement of buildings and other spaces provide the sense of scale and placement so the map can be an effective source of distances and locations for the student. In certain situations, it can be very important to digitize walkways with exact details, especially when the paths to destinations are confusing and disorienting and could result in an issue of safety. An overall, large-scale, site map is useful for initial orientation to the campus, while a series of small-scale maps will provide the details of specific areas and routes.

The ability to customize tactile maps of a campus to the individual needs of a new student is facilitated by this digitizer-GIS-Stereocopier approach to making the maps. Tactile maps are useful for the student whose learning style is spatially-oriented, however, for blind students who are used to learning by movement through a new environment with their instructor, they may not benefit completely from tactile maps without previous experience with spatially-oriented material. Other uses for technique that would benefit blind students: tactual graphics for scientific and mathematical drawings, for instance, sequential series of drawings that amplify the detail of a complex process, like cell growth, in order to build on the detail of the previous drawing.

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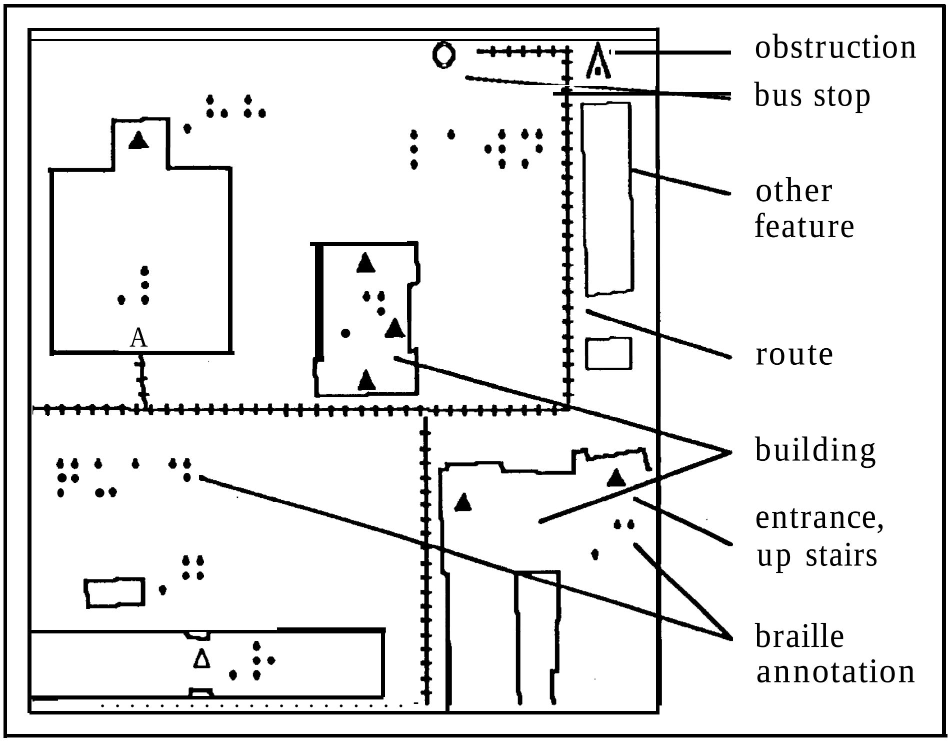

Figure 1. Portion of tactile map, with types of features noted.

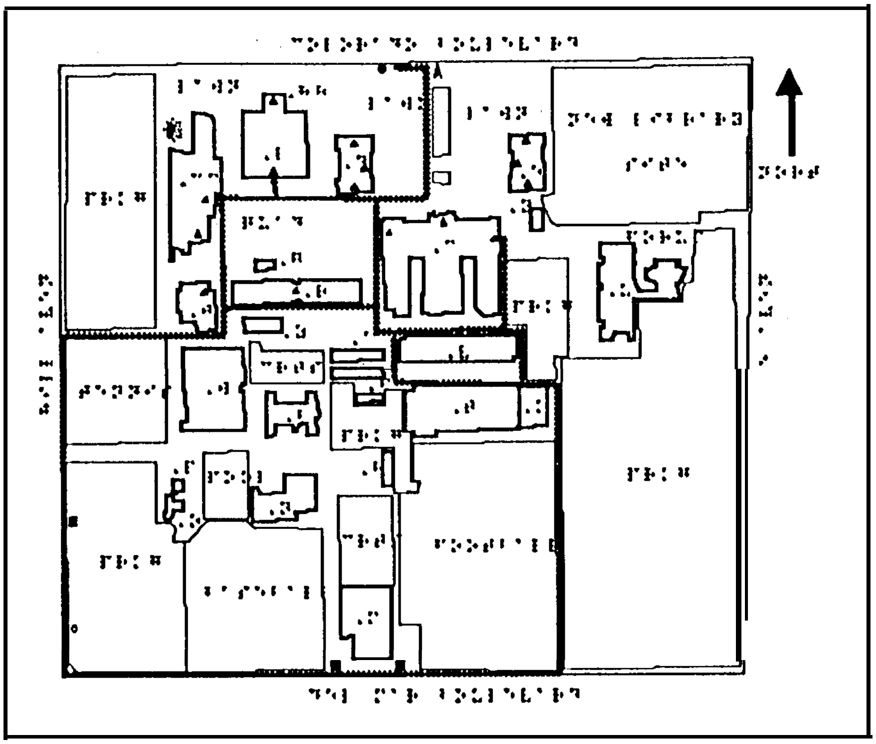

Figure 2. Tactile map of campus, showing complexity of features and annotation.

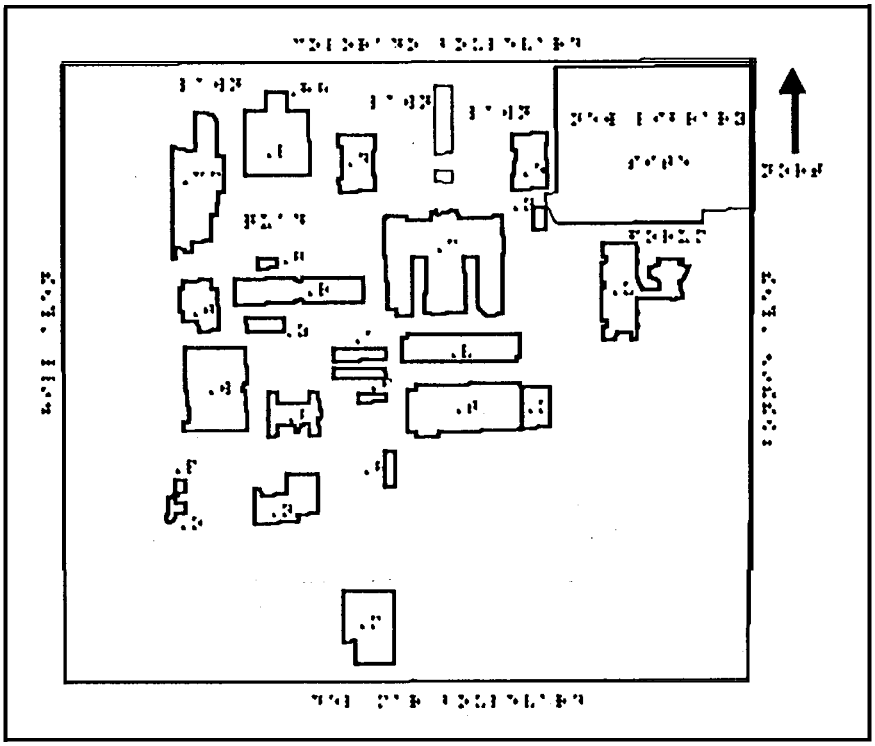

Figure 3. Selected features and annotation, customized to match needs of student.