TRIANGLE: A Practical Application of Non-SpeechAudio for Imparting Information

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In this presentation, we will give a status report on our use of non-speech audio in the TRIANGLE computer program recently released by the Oregon State University Science Access Project. We will specifically focus on the ability of the TRIANGLE program to produce stereo data sonification from standard PC computer data as an alternative to traditional graphing methods.

TRIANGLE is a DOS workspace program intended for severely print-impaired students and professionals in math, science, and engineering. TRIANGLE includes a math and science word processor, a graphing calculator, a viewer for y vs. x plots, a table viewer, and the Touch-and-Tell Program for audio or for braille-assistive reading of tactile figures on an external digitizing pad.

The keyboard or any keyboard emulating device may be used for input and control of the program's functions. TRIANGLE's output may be viewed visually (on the DOS text screen), audibly (using a screen-reading program and external voice synthesizer for text and the PC speaker or an SB16-compatible sound output for other audio), or tactually (using a braille screen access program and external refreshable braille display). Any combination of the above output methods can be used simultaneously.

The x-y plot viewer, the table viewer, and the Touch-and-Tell Figure viewer all use non-speech audio. Users can hear curves of y vs. x by a tone plot in either viewer. The view is either obtained manually, by sweeping x either a point at a time, or automatically at approximately 100 points per second. The plot is normalized so the lowest, highest frequency (smallest, largest y) is well within the range of most human hearing. The viewer includes a locator for maxima, minima, and zeros.

To produce the sonification of mathematical equations, the function, constants, and evaluation parameters are first entered. The range and the number of data points are specified through a command for the minimum value to be evaluated, the maximum value to be evaluated, and the overall number of evaluation points. Constant valued expressions are evaluated, and the function is then evaluated for all points, which are then plotted on the screen. Graph sonification is immediately available for either listening to single data points or for listening to the entire plot. The graph is also represented by stereo location with the reference of the left channel to the left side (minimum evaluated value) and that of the right channel to the right side (maximum evaluated value) of the plotted points. The magnitude of the evaluated points is represented by pitch.

Sonification of tabulated data is also available. Once a data set is entered or imported into TRIANGLE's table viewer, a plot of a given column's data can be graphed and listened to in the same plot viewer used by the graphing calculator. Another option for sonification of data points is the audio "bar-graph" reader that is also included in the table viewer. A column of numerical data can be displayed by short sounds that use rising pitch to reflect the magnitude of individual data elements. The increase in length and pitch is both proportional to the displayed number, and these sound graphs give the user a quick, semi-quantitative overview of a series of numerical data points. Individual data points are displayed and can also be read using a screen reader or braille display.

A previously produced data set can be incorporated into the Touch-and-Tell Figure viewer. When a figure created for use in the TRIANGLE program is printed on a graphical braille printer, that picture can be placed onto a digitizing pad, and objects on the figure can play the sonification of the data sets represented by the graph. Thus, a user will not only feel the data set, but he or she can also hear it in order to gain a better

understanding of that data set's meaning. The table viewer and the tone graphs of the graphing calculator both provide the only presently-feasible methods for people with very poor vision or very serious visual processing disabilities to "view" plots quickly and without an external braille printer. TRIANGLE and a small laptop computer provide the severely print-impaired person with the sighted person's equivalent of a backpack full of books and notes, a pencil and pad of writing paper, and a graphing calculator.

The tone graph display of the graphing calculator and the audio bar-graph reader in the table viewer will be demonstrated. Research plans to use additional non-speech audio to enhance tone graph information will be discussed. These research plans include the use of various short sounds to indicate zero crossings or inflection points, sound qualities that convey information about curvature, and possibilities for indicating discrete data points, error bars, etc. along with smooth-fitting curves for such physical data. A beta version of TRIANGLE is available for download by ftp[1] or from our world webwebsite[2].

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Acknowledgments

References

[1] FTP download is available at dots.physics.orst.edu. The TRIANGLE program is located in the pub/triangle/ subdirectory and is called triangle.zip. Log in with 'anonymous' for the user.

[2] TRIANGLE and other projects of the Science Access Project are described on the World Wide Web at http://dots.physics.orst.edu.