Merging Tactile Sensory Input and Audio Data by Means of The Talking Tactile Tablet

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Abstract. Given that the use of a tactile diagram or map usually facilitates and enhances the learning process for a blind or visually impaired user, the question we would like to address is, "Is the use of one sensory input sufficient in itself, or should other senses also be involved, and if so, how can we best make use of developing technology to assist in this multi-sensory learning process?" We believe that the development of the Talking Tactile Tablet[1] (TTT) which combines tactile input with relevant and immediate audio data, not only improves the speed and ease with which the visually impaired user can learn, but reinforces learning through dual modality. In the context of neuroscience a great deal of evidence has been presented regarding the significance of cross-modal exchange between different sensing systems by researchers such as Le Doux, Hubel, Cynader and Frost. In the education context the effectiveness of multimodal interfaces and multi-sensory learning have been promoted from Montessori, and Dewey through to more recent protagonists in the field such as Aldrich, and Ungar. Our aim is to build on this body of knowledge whilst developing this new use for technology.

1 A History of Tactiles in Education

The use of tactiles has a surprisingly long history, with tactile embossed books being produced as far back as the 1860s. With few exceptions, a tactile diagram needs some kind of explanation before the user can make sense of it. So, in a sense, tactiles have always needed associated audio data, usually in the form of another human. Even when a tactile diagram has Braille legends, or symbols, some cursory introduction is usually required. Where the user is not a Braille reader, the dependence on another person can be greater, and correspondingly their loss of autonomy. In the usual classroom context, dependence on input from a teacher is nothing out of the ordinary, since even sighted students often need further information on photos and graphics from an initiated source, but outside of the classroom the parallel stops. When the sighted student takes a text book containing relevant diagrams home, he or she can continue to study independently, but for the blind or VI student this is far more difficult. Accompanying information in the form of Braille books or audio tapes have

[1] US patent application serial number 60/323,416 by Touch Graphics and CUNY

been used to remedy this but can seems rather labour intensive from the learner's point of view.

2 The Technology of the Talking Tactile Tablet

The TTT is an aluminium and acrylic tray with a hinged frame (fig 1); the user opens the frame and mounts one of a collection of tactile sheets, then closes the frame to hold the sheet motionless against a touch-sensitive surface. The TTT is connected to a host computer by a single USB cable. Users interact with the computer by pressing on the tactile drawing; the computer registers the position of each pick in the context of a program created with Macromedia *Director*, and then returns an appropriate audio response. The design of sheets produced for the TTT is based on a simple Tactile Graphic User Interface (fig. 2) that sets out standards for the position and appearance of a variety of controls and tools. A user quickly becomes familiar with this layout, and can, as in Windows computing, expect to have some instant intuitive familiarity with a new application based on previous experience. Touch Graphics has created a library of titles for the TTT that include sophisticated curricula, reference materials and games. Additionally, through the use of the TTT *Authoring Tool*, elaborate interactive programming can be created by teachers and other non-programmers for the TTT. Using this system, the potential for producing rich, multi-media computer applications that can be competently run by blind and visually impaired users appears to be limitless. Because the *Authoring System* works by giving audio instructions to the user and by accepting their input of areas for audio tagging on a tactile image working interactively through the TTT, a blind or visually impaired teacher can produces talking tactile programs for his or her students.

Fig. 1. The tacile talking tablet

Perhaps the most fundamental concept demonstrated in the TTT is that the computer can assign changing values to place-holding tactile shapes. In other words, even though the tactile display is static, and cannot offer moving pictures in the way

that video does, a single tactile diagram can actually be used to depict a great deal of information. In a simple case like the *Match Game* (a version of *Pelmanism*) each time a new game is begun, the identities of the hidden animal sounds are reshuffled by the computer. In a more complex case, a single tactile drawing of the human anatomy may have many levels of information that can be isolated for study, much like a book may use a series of transparencies to accomplish the same ends. In the tactile case, for example, when the digestive system is being studied, all information about the skeleton is shut off. This allows the student to focus on only those structures germane to the current discussion, without losing a sense of the adjacencies and relationships of the different biological systems depicted.

3 The Development of the TTT in a Pedagogical Context

With the development of the Talking Tactile Tablet we see the convergence of the well established tactile map or diagram with current developments in the production of digital audio files and pointing devices. Any tactile information can now be fully enhanced by the association of applicable audio data. For example, if the user is searching the TTT World Atlas, they could select *index* from the menu options which would offer them a list of countries they could locate; having selected the country (or city, or river, or sea etc) they are instructed to press anywhere on the map and audio directions are then given in terms of 'go north', 'go west' and so forth, until the required place is located. Other menu options include, distance between two given points, 'facts' which might include demographical, geographical and topographical information and language samples, or a 'history timeline'. This latter option allows the user to select a period in history and move around the globe gathering historic information relevant to that time. Alternatively, the user can bypass the menu system and simply move around the map or diagram hearing items named as they touch, and spelled out if they keep pressing. Staying with the World Atlas example, if the student requires more specific information on one country, they will be instructed to insert the relevant map, this process of 'zooming in' can be repeated until a particular town is located. Clearly this system can be applied to most areas of study where information is required at both macro and micro levels and all stages in between; the study of human anatomy and physiology being an obvious example, where the student might move from the outline of the body and the major organs, to a diagram of the eye, and onto the cellular structure of the aqueous humour.

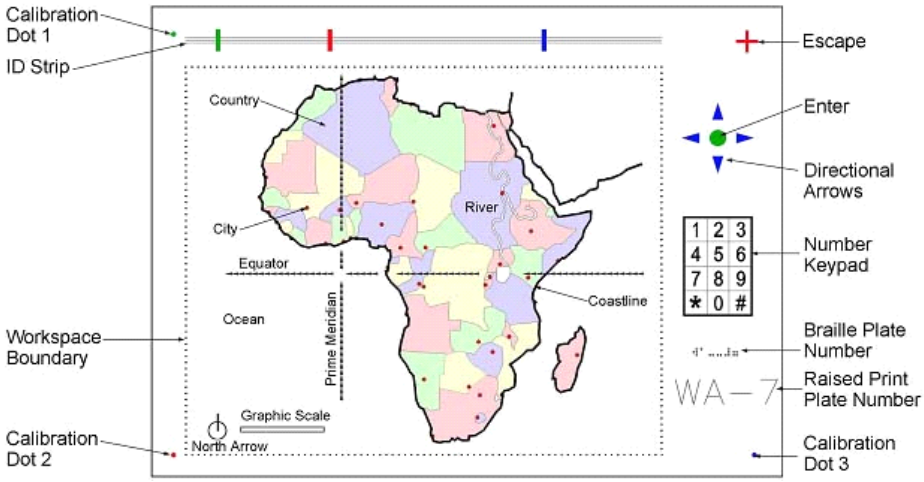

Fig. 2. Close-up of the tactile talking tablet

3.1 Current Research Projects

The Talking Tactile Tablet has been tested on both a numbers of students and teachers at the Royal National College for the Blind (UK) and members of the visually impaired community in America, it is very clear from the responses made that it is a device that people find enjoyable and easy to use, and one that enhances the learning experience. Despite the Talking Tactile Tablet being relatively inexpensive in terms of the actual device and the tactile sheets required, such empirical evidence will probably not be sufficient to encourage those who purchase tactile technology (as opposed to actually use it) in schools, colleges and public libraries, to buy the machine and support its development for the UK education curriculum. It is more likely that they will need hard evidence that audio data associated with tactile input does indeed enhance and facilitate the learning experience to a far greater degree than merely using tactile diagrams on their own. To this end, and number of research projects are now underway in the UK, with Touch Graphics, RNCB and groups from Anglia Polytechnic University working in collaboration to test the TTT in a variety of contexts. The latest project is to prepare TTT overlays that would offer both VI and sighted children the opportunity to use tactiles to reinforce learning in mainstream education.

The department of Education is intending to use the TTT to re-establish the importance of multimodal learning in primary education. Multi-sensory learning was first promoted in educational settings by Maria Montessori, and has often been described as a more “natural” way of learning. In the 1930's Orton and Gillingham devised a system of teaching structured, systematic, rule-based phonics using multi-sensory reinforcement to cement new learning into long-term memory, and more recently we have Fernauld's concepts of multi-sensory learning.

Most of this theory, however, has come out of the observation of children in the general classroom context, and even where those with special needs have been the focus, adult learning rarely features. That the average adult needs to reinforce the evidence of their eyes by haptic evidence is well understood, at least on a personal and empirical level. Most people are convinced that snakes are slimy creatures until they first handled one, here is clear case of the evidence of our eyes not matching our haptic experience. The case for using the TTT as a teaching aid in Adult Education is now be explored by the department of Higher Education at Anglia. This research will focus on developing relevant tactile plates for visually impaired students in higher education, and will incorporate findings from other research groups as to what constitutes a 'good' tactile map or diagram, but it will also consider how the TTT might be used to assist adults with learning difficulties such as dyslexia. There is an obvious correlation here with the research into 'dual-modality' use of tactiles in mainstream primary education mentioned above.

A research project is currently in progress at the Royal National College to prove the "added value" of instant audio feedback from a pedagogical point of view. In the first round of tests one group of learners is given just a tactile map and minimum information on it's content and format by means of a Braille legend, a second group have as much (or little) audio input as they required through the means of the Talking Tactile Tablet. After the test the students are asked to give an assessment on the ease of learning, and are quizzed on what they have remembered. After the first round of tests results suggest that students rate the 'enjoyment' and 'ease of use' factors as 73% higher when using the TTT. The results of what they have remembered suggest a retention rate that is 33% when the TTT is used compared to just a tactile map and accompanying Braille information. These test have to be refined and repeated before we publish the results.

If the outcome of these tests suggests that the tactile learning experience is indeed enhanced by the association of immediate audio feedback offered through a hierarchical menu structure, then the next stage in our research programme will be to find the best process of producing Tackling Tactile Tablet programs that will support and augment the learning process for students working through the British national curriculum. Bespoke maps of towns and transports systems would be included as well as diagrams and maps to support adult learners in vocational and higher education. If the marriage of tactile with audio data means offering an extra dimension to learning, then the original question must be expanded to ask, 'should not this method of learning also be available to both children and adults and both sighted and unsighted learners?