TIM (Tactile Interactive Multimedia):
Development and adaptation of computer games
for young blind children

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Abstract. The Tim Project concerns the development of computer games for young blind children using a tactile equipment connected to the computer. A scripting language (the TIM language) was designed to write scripts allowing to drive a tactile equipment and to display audio resources. The TIM language covers a large variety of software : from specific software intended especially for blind children to adaptation of existing CD-ROMs for blind children. Two examples of realisations will be presented, corresponding to these two categories. These software games (the TIM games) allow blind children to use a computer in early youth, like sighted children. The software give to the computer a double role: ludic and educational. For some children, having additional disabilities, like cognitive troubles, it can have a third role: a therapeutic tool.

1.   INTRODUCTION

The purpose of the project TIM (Tactile Interactive Multimedia) is to conceive computer games intended for the young blind children. These games are planned to be used by the children in an autonomous way, without assistance of a sighted person, as it is the case of hundreds of titles usable by the sighted children.

The principle is to adapt existing toys or software, for example CD-ROM games. This way has several advantages. First we can reuse very rich audio resources, corresponding to hours of recorded messages, music and various sound effects, with coherent educational and ludic contents. All the work of creation of contents is not to make, and it is only necessary to adapt the interface. One example, based upon educational CD-ROM will be presented. Applications derived from games using audio tapes can also be built, like the sound matching game which will be described in this paper.

TIM computer games can be used by children of various levels of psychomotor development who cannot use the keyboard (young children or children with multiple disabilities). The TIM software makes it possible to build various kinds of games:
▪ Discovery games intended for youngest (from 3 years old and possibly younger, or for blind children with an additional disability),

- Games based upon sound and tactile recognition, for children who cannot read,
- Games in which child navigates and listens to various sound environments, stories, explanations, intended for children who cannot read or children who learn reading,
- Games intended for children who learn Braille.

This list is not closed. These are only ideas of games already achieved or under development.

First, the TIM software will be described, and then the TIM games. We will conclude by discussing the didactic interest of the games.

2.   THE TIM SOFTWARE

2.1.   Which specific hardware?

To use classical educational software with blind children, a sighted person (often an adult) is necessary. Even if keyboard shortcuts exist or if some software can be accessed using standard access software (like JAWS or DraculaWin), these can only be used by older children, able to use a computer in an autonomous way. The main purpose of TIM is to allow a completely autonomous use of the games by the younger ones. The adult has to start the computer and to launch the game. Then the child can figure out and play alone.

For that we use a specific hardware : a touch device called *"Concept Keyboard"* (manufactured by The Concept Keyboard Company™). It is a tactile board which can be connected to the computer on a serial port. Paper sheets can be inserted in, on which objects are embossed and words are written in Braille. The child controls the game by pressing on these sheets (on embossed pictures or Braille words). The board is parcelled into 128 or 256 cells (this can be adjusted), and it sends the number of the pressed cell to the serial port of the computer.

We already used this equipment in an education multimedia application dedicated to blind children called *"Tactison"* [Burger 94, Burger 96]. Tactison already allows to create educational exercises. Virtual objects with audio properties are created and they can move on the tactile sheet.

The sheets can be handmade (in an artisanal way) by sticking pieces of baize, lather, various material and textures (fur, feathers, leather, wood…), or Braille labels. They also can be drawn, manually or using a drawing software, and then reproduced using embossing photocopy process (Zy-Tech™).

This hardware is relatively cheap (approximately 260 Euro) compared to the cost of specific hardware. Outside of this "Concept Keyboard", a multimedia computer with low configuration (Pentium or K6, with 32 MB), running under Windows (starting from Windows 95), equipped with a sound card, loudspeakers and a CD-ROM drive is enough to use the TIM games.

Other applications are being considered using interactive Braille displays and speech synthesis.

2.2. The TIM language

A simple language (the "TIM language") was designed to describe the script of the games. The TIM language is an interpreted pseudo-object oriented language.

A TIM program is composed by **objects**, **actions** and an **initial map of objects**.

Objects have a number, a name and 2 methods, corresponding to the 2 events currently supported by cells : click and double-click. Each method is formalised by the call of an "action". The objects can be associated to cells. The **initial map of objects** describes the state of the Concept Keyboard when the game starts, that is the initial associations between cells and objects.

Each **action** has a number and is composed of a sequence of instructions. These instructions allow to perform different tasks:
- play a sound from a "wav" audio file,
- associate an object to a cell or to a set of cells,
- create an integer variable,
- set an integer variable with a given value or with a random value,
- add a value to an integer variable,
- execute another instruction,
- execute another instruction, selected from an if-then-else structure,
- execute another instruction, selected from a switch structure,
- select an object according to an integer variable,
- load another TIM program from a file,
- return to the preceding TIM program (and reload it from its file)
- …

When the game starts, objects and actions are created, the initial map is set and the initial action is performed, then TIM waits for events on the keyboard.

2.3. The TIM software

The TIM software includes several software components [Archambault 99]. One drives the Concept Keyboard, another allows to display the audio resources, and the main component is a simple interpreter. When an action is performed on a cell of the Concept Keyboard, a message is sent to the object associated with this cell by the Concept Keyboard component. The corresponding action is then launched by the interpreter. By default, no other action will be accepted until this action is over (including the sounds).

Scripts written in TIM language can be very easily generated. Currently we use essentially perl scripts to generate TIM programs. A TIM authoring software is planned. It will be able to generate TIM programs with a friendly interface, allowing to create objects and actions, and to associate objects with cells.

3. THE TIM GAMES

3.1. The Universe of « Pomme d'Api »

First concrete realisation of the TIM project was an adaptation of 3 French CD-ROM's from the series *"The Universe of « Pomme d'Api »"* (Bayard-Presse/Ubi-Soft) entitled :

- *« Ça se transforme »* (*"That changes"*)
- *« Il y a quelque chose dedans »* (*"There is something inside"*)
- *« Ça fait peur »* (*"It is frightening"*)

In each one of these 3 games, intended for the 3-6 years, 14 words are illustrated by a film, with a vocal comment and musical accompaniment, and one or two short sound sequences. Their translation in English, in Spanish and in German can be accessed. The child can also play to the "Quizz", random questions (from about 40) are asked, that can be responded by yes or no, and after 5 correct answers, a song is played. Additionally the CD-ROM includes 14 computer games.

For the adaptation of this CD-ROM, we could reuse all the resources from the illustrations of the 14 words, including the comments of films which stay consistent without the image; the translations; the whole quizz (also in 4 languages). But the 14 additional games were exclusively based upon vision and had to be cancelled (in another adaptation of CD-ROM currently in development, based upon an "interactive story", 5 from 20 additional games can be adapted, because they are based upon questions, classification, or audio recognition).

Two tactile sheets, on which embossed buttons corresponding to the several commands available on the CD-ROM were carried out. These commands are "read the current word", "play the associated comment", "play only the musical accompaniment", "play the associated audio illustration", "go to previous word", "go to next word", "change language", "enter the Quizz", "get a question", "answer yes to the question", "answer no to the question".

The first sheet reproduces the screen of the original CD-ROM's interface and allows all the commands. The second gives access only to the main contents (without the foreign languages and the Quizz) and can be used by the youngest and also by children with additional disability.

With the resources of the 3 CD-ROM, 1 adapted CD-ROM was built, allowing to access to the 3 contents.

3.2.   The animals matching game

In another realisation, the animals matching game, the resources are the cries of animals and counting rhymes and songs, get from various CD and audio tapes. The principle is to recognise an animal thanks to its cry. With each correct answer, the computer plays a short counting rhyme or some words of a song, corresponding to the recognised animal. After a certain number of correct answers the computer will play a whole song about animals (from a set of 5).

On the same resources, several tactile sheets were created, corresponding to sets of 4, 8, 12 or 30 different animals. The simplest are intended for youngest, they are made of embossed pictures, and different textures stuck (fur, feathers,...) on the board. The child has to recognise the sound he heard, and then to press the correct texture. In the other ones, more complete (12 and 30 animals), the boards simply contain Braille labels with the name of the animal. The child has to read each label to find out the sought animal.

3.3. Adaptable games

New games are currently in development. In particular a game of the type of "ordiABC" from Nathan™ or the games of VTech™. That game uses additionally a speech synthesis. Buttons with Braille letters are drawn on the embossed sheet, in the order of the keyboard of a computer. It allows a large variety of exercises like "What is the first letter of a word?", "Spell a word",…

Several discovery games and matching games can also be cited, about music (instruments, notes) and environment (conveyance, home).

The kind of CD-ROM material that can be used is every CD-ROM on which a large amount of audio content can be understood independently. For example interactive books are good examples: a virtual book is presented page by page. Each page is read and have an audio illustration; some words of the page are explained or illustrated. In these CD-ROMs additional games can often be also adapted.

4. EVALUATION AND TEACHING ASPECTS

4.1. Evaluation of "The Universe of « Pomme d'Api »"

The CD-ROM "The Universe of « Pomme d'Api »" was evaluated by 4 blind children in their families, and in 2 special schools for blind children. The conclusions were very promising. Here are extracts from reports of parents of the children who evaluated the CD-ROM.

> *"the experience was positive and should deserve to be continued through the adaptation or the creation of new games. The Concept Keyboard happens to be of particularly well adapted use for children who have not learned to use a keyboard yet."*

> *"the Concept Keyboard has a big advantage : it allows an entirely independent use of the software, and learning it is quite easy even for children who cannot read […]. The equipment is very interesting and can bring much to the learning for the young blind child."*

> *"[…] his tool seems to me to be usable for the children integration."*

One of the children was particularly happy to use the computer alone because his sighted brother just 1 year older already could do it while he had to be assisted by his parents.

The comments of the parents and teachers give ideas of improvements of the games and ideas for new games.

4.2. Teaching aspects

The use of the computer has some consequential advantages. The main thing of these advantages is perhaps the early use of the computer in itself. Indeed this tool is to be increasingly useful in every domain for handicapped children (teaching, everyday life…). The contact with a computer in the early youth allows to make this tool commonplace, to remove to him this aura of "magic" which makes more complex its use by the first

generations which dealt with it. For children who can use a computer in early youth, it becomes an everyday tool, as well as a television or any domestic machine.

More and more used at school, as an educational tool, the fact of using it to play is significant too. The computer is not only a school object, solely used for work, but it is also a plaything (end even work with it can become ludic). Thus work at school with the computer, will be facilitated.

Finally these games can be a great tool for children with additional disability, including cognitive troubles [Algranti-Fildier 98, Virole]. The computer allows to avoid the direct relationship which is often implicated in cognitive troubles, because it does not have personality. Then child does not develop emotional tie or affective relationship with it. The software is very attractive: it stimulates responses, cognitive work from the child. Then it can allow him to react, to interact freely. The child does not press the sheet because he fears punishments, or to please someone. He will be able to regain trust in his capacity to learn, to think.

In the same time, the educator can place himself as an observer, and he can objectify his statements. The cognitive difficulties are projected on a constraint space: the software space. The observation may help him to understand where are these difficulties, and then to work on these difficulties with the child.

These arguments are not specific to visually impaired children, and sighted children can find these advantage in using computers early. But these facts are perhaps more important in the case of handicapped children. The TIM program allows the software designed for sighted children to be adapted to blind children. It allows computers to be ludic as well as educational tool and therapeutic tool.

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