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Learning Environment for Touch Access to Digital Interfaces.

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Abstract. Through screen-reader and Braille display, trained blind persons can nowadays manage to access to a lot of activities using computers. However, graphical interfaces and content where the spatial dimension is key for understanding, like charts, pictures or the majority of videogames, are remaining hardly accessible. The Tactos and Intertact technologies are aimed to overcome these limits by providing an efficient sensory supplementation technology enabling blind users to access the spatial dimension of content through touch. Adoption is key when it comes to develop technologies and we report here on the research we conduct for enabling an independent learning of our system by blind persons. From our perspective, this possibility is a cornerstone for the development of an active users' community.

Keywords. tactile interfaces, perceptual supplementation, technology learning, visual impairment and blindness.

Introduction.

Screen reader technologies and electronic Braille cells are now providing access to many digital activities and information sources for the blind and visually impaired persons. However, these solutions have the drawback of hardly conveying spatial information like data charts and tables, drawings, graphical interfaces and web pages layouts. As more and more digital world software applications are now enabling to work and play through the Internet, for instance productivity and office software on the cloud, or multiplayer games, the accessibility of these rich applications also requests for interface technologies enabling to build a shared interactive space for all users.

For this purpose we have developed the "Tactos" and the "Intertact" system, which allows the exploration of the computer screen and interaction through the Internet (Lenay et al., 2003). Tactos is a compound of a touch interaction module and the associated driver software. Intertact is a web server that distributes interactive and multiuser applications through the Internet to Tactos users.

This paper presents the principles of the aforementioned systems which enable the user to perceive digital content through touch. We then present the challenges associated with the learning of our system and the work we are currently conducting to enable an independent teaching of Tactos inside a blind and visually impaired persons' local association (APICADEV). We conclude by discussing the implication for building an active Tactos users' community, which appear to us as a condition for the development of relevant and useful application to support blind persons in their daily life.

The Tactos and Intertact Systems.

The user's finger movements on a touchscreen are controlling the position of a receptor field in the digital environment. When the receptor field crosses the colored pixels of a shape on the screen, a tactile stimulation is triggered. This stimulation is produced by the activation of a pair of electronic Braille cells consisting of a matrix of 16 pins (two piezoelectric cells of 8 pins) that the user touch with the index finger of her/his free hand (Ziat et al., 2007).

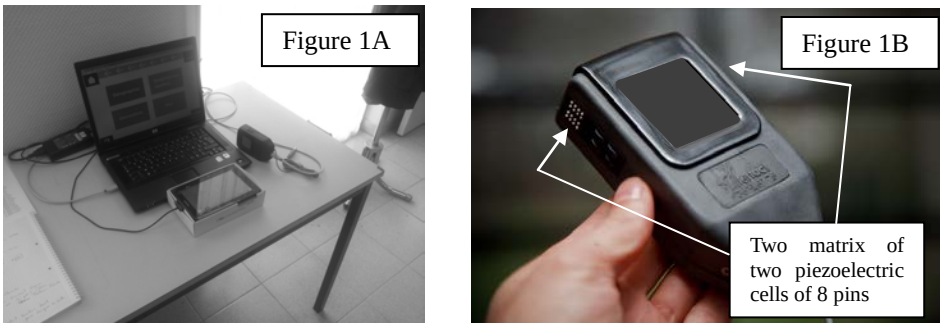

Figure 1A: The Tactos system installed at the APICADEV office.
Here, for a left-handed person, the tactile interaction module is to the right of the touch pad.
Figure 1B: The Tactile Interaction Module
The matrix of two Braille cells is on the left on the side of the device. Another two matrix Braille cells is disposed on the opposite side (not visible in the picture). We no longer use the touchpad that was present on the face of the device.

Thus the users can perceive the shapes and the layout of objects on the screen through the attention they pay to the tactile stimulation and the movements of their fingers on the screen as well. The mastery of this device requires a systematic learning that we have already presented (Stewart & Gapenne, 2004). Straight lines and basic geometrical shapes, like squares or triangles, are recognizable in few hours of training. With the user engagement in learning, more complex content like maps or webpages layout become meaningful.

The evaluation of these devices was conducted jointly by experimental studies on pattern recognition (Hanneton et al., 1999), interpersonal interactions (Deschamps et al., 2012; Lenay & Stewart, 2012) and the longitudinal tracking of several young users (Rovira & Gapenne, 2009). The interest of the Tactos system as a support for teaching geometry to young blind students from a special education school has also been demonstrated (Sribunruangrit et al., 2004). One of the key features provided by Tactos lie in the ability for students to check the results of the spatial operations they perform (ie. tracing a circle tangent) without the assistance of a sighted person.

As we mentioned earlier, the current widespread of Information and Communication Technologies (ICT) lead us to consider the use and relevance of Tactos in broader application fields in order to support blind persons in their daily life. We have especially identified the access to information (layout of objects and windows on the desk, discovery the organization of a web page, direct access to input fields),

wayfinding and social interaction as areas of special concern (Tixier et al., 2013). Adoption is key when it comes to develop technologies and we describe the research we conduct for enabling an independent learning of our technologies by blind persons.

Enabling an Independent Learning Situation.

In order to enable a blind person to teach the use of "Tactos" and "Intertact" to another blind person we achieved a specific device that we present in this section.

The teacher supports the learner in his exploration of the screen while receiving the same tactile signals. Indeed, the touch interaction module used includes two tactile arrays, one for the learner and the other for the teacher in the current situation.

The teacher places his hand underneath the module on the first tactile array and the learner places his hand on top of the module on the second tactile array. The two tactile arrays distribute exactly the same signals. The learner explores the image on the screen while listening to the advice of the teacher who receives exactly the same tactile information than him. This way they feel they "touch" the same thing at the same time. A situation which overcomes physical constraints since two persons can never touch simultaneously the same point.

Figure 2: Learning session
While a blind learner (pink sweater) explores virtual forms, she can be guided by her blind teacher (white sweater) that shares the same tactile signals

The first uses of this device are particularly encouraging. Two students have so far followed a series of more than 4 sessions. Their already enthusiastic feedback and their requests for improvements help us to develop our devices, to define useful content on the "Intertact" server and to design new applications. For instance, we have developed games like the "Memory" or the "Sudoku" that allow the users to work orientation and spatial memory. We have also developed an application for reading maps (Tixier, Lenay, Gapenne, & Aubert, 2013).

Discussion and Future Work.

Many support systems turn out to be invalidating if they increase the awareness of disability by making the user dependent on learning from a non-disabled person. The situation of an independent learning of our tools in the community of blind people seems to us crucial.

On one hand, it signifies the maturity of an aid project that does not have the former drawbacks. On the other hand, we are confident that this learning process will allow the development of users' communities that can then autonomously improve the system and supply the content that it makes accessible.

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