Empowering spatial thinking of students with visual impairment

O2.1/A1.2 Training and Support Material (b. Augmented Reality Toolkit)

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Executive Summary

This document describes the system developed by INRIA in the context of VISTE. The Augmented Reality Toolkit has undergone several adjustments and improvements throughout the project's life-cycle in an attempt to make it as stable as possible for schools to use them in the classroom. The final version of it is presented herein; it is the one used in Implementation and Validation Activities (Phase B). Scenarios implemented with the system are presented in O2.1/A1.2 Training and Support Material (c. Implemented Scenarios).

1.VISTE – Augmented Reality Toolkit

1.1. Function

The system augments existing tactile O&M tools such as raised-line maps and magnet boards, by adding audio feedback about map elements. It also adds visual feedback in the form of projection for the benefit of low vision users and sighted users, for instance teachers and families. Three modes have been implemented for the prototype: Exploration Mode, Quiz Mode and Creation Mode.

Exploration mode provides audio caption about the element touched by the finger. In exploration mode, our prototype enables visually impaired students to explore existing maps by combining raised-line maps with audio output and projection (see Figure 1). With the toolkit, any maps can be tactile. For Orientation & Mobility, the users explore the tactile map with both hands as they are accustomed to. Complementary visual information is projected on the raised-line map, for the benefit of low vision students. Students can obtain an audio description by simply pointing to a tactile element with one finger. Beside Orientation & Mobility, it can be applied to any tactile media: the description of the exploration mode can describe elements of a tactile image for instance a piece of art.

Figure 1: Exploration Mode: a raised-line map is augmented with projection and audio feedback

Quiz mode asks a question to the user, and the user can answer by touching correct part of the map. Used in Orientation & Mobility, the quiz mode of our prototype enables visually impaired users to construct maps or itineraries them-selves by combining magnet boards with audio output and projection. O&M instructors developed a step-by-step learning scenario, and our augmented reality prototype follows this scenario to provide instructions to the students. Starting from elements placed by the teacher, the system prompts the student to place a point of interest or a road on the map in relation to these starting elements. The student then places elements on the map: magnets with foam paper for POIs, and Wikki Stix for road elements. For POIs, the user may verify whether an element is placed correctly using the same interaction as in exploration mode that is by pointing to an element and pressing a key to hear an audio description. If the element is not in the right place according to the scenario, then the system provides corrective directions (left/right/top/down). For line elements, the "verification" was more challenging to design, and to our knowledge no prior study has investigated this. We designed an interaction technique, in which the student points of the start position of the line with one finger. He or she then follows the line by sliding the finger along the WikkiStix. As long as the line is correctly placed, a beep sound is played. When the finger touches a portion of the line which is incorrectly placed, the system verbally provides directions to help the student correct his construction (as for POIs).We designed this interaction technique, as it allows users to identify which parts of the line are correctly placed and to modify only the incorrect parts. Beside Orientation & Mobility, it can be used for any tactile media. For a botanical atlas, the system can ask about “Where is the leave?” (as POIs) and “Follow the central rib of the leave from the branch to the extremity” (for the line elements).

Figure 2: Construction Mode: augmenting a magnet board with projection and audio feedback. Wikki Stix a used to represent line elements, and magnets with foam paper to represent points of interest

Creation mode enables teachers to create interactive content for exploration mode and creation mode. The user selects the type of content (shape or line) to create. He/She can draw with the finger directly the interactive content on the tactile graphics. A microphone enables to register a description, i.e. an audio caption for exploration mode, and a question, i.e. the instruction of the quiz mode.

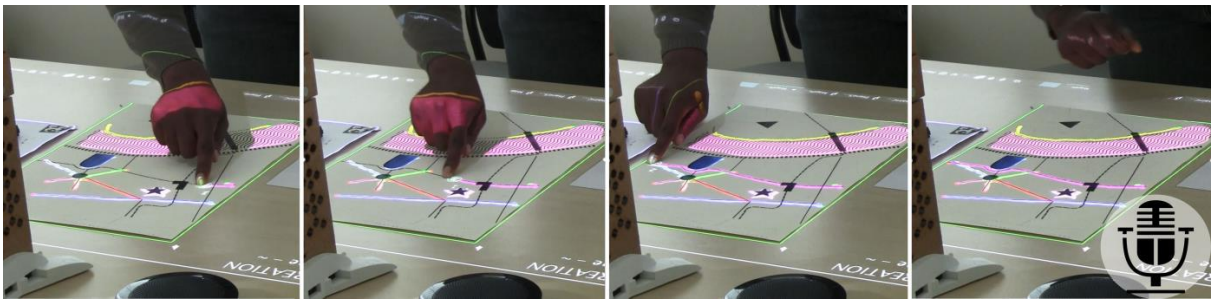

Figure3: Creation Mode: A teacher draws interactive zones directly on a tactile map with his finger and records the associated audio-feedback using a microphone. Touching the same zone later will later launch the recorded audio-feedback.

1.2. Implementation

The augmented reality toolkit is based on an existing spatial augmented reality framework (PapARt), previously developed by the partner team at INRIA Bordeaux and commercialized by the company RealityTech[1].

[1] http://rea.lity.tech/

Two hardware versions exist of the prototype, shown in Figure 4a and b.

The first one is equipped with an ASUS B1MR short throw 720p projector, a Kinect camera for Xbox 360, and a Playstation Eye camera. The computer is an Intel NUC with a core i5 and 8Gb of RAM.

The second version uses an ASUS P3B short throw 720p projector, and an Orbec ASTRA camera (combining depth and color camera), as well as a custom-built computer with an Intel core i3CPU and 8Gb of RAM. The second version is easier to transport, as it was more light weight than the first one and it could be disassembled into several pieces.

A microphone is added to register description and question of the Exploration and Quiz modes.

Figure 4a and b:Two versions of the PapARt hardware: 1 - left, 2 – right