

Self-Identifying Tactile Overlays

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ABSTRACT

Tactile overlays for touch-screen devices are an opportunity to display content for users with visual impairments. However, when users switch tactile overlays, the displayed content on the touch-screen devices still correspond to the previous overlay. Currently, users have to change the displayed content on the touch screen devices manually which hinders a fluid user interaction. In this paper, we introduce self-identifying overlays – an automated method for touch-screen devices to identify tactile overlays placed on the screen and to adapt the displayed content based on the applied tactile overlay. We report on a pilot study with two participants with visual impairments to evaluate this approach with a functional content exploration application based on an adapted textbook.

Author Keywords

Visual impairments; Tactile overlays; Self-identification

INTRODUCTION AND BACKGROUND

Static tactile overlays on touch screens have been used to display interactive maps, diagrams and other kinds of pictorial and spatially distributed elements [1, 2, 3, 6, 9]. Furthermore, accessibility of touch-screen based interfaces for visually impaired users increased by deploying tactile overlays [4, 8]. However, one limitation of the current static overlays to display graphical contents is that each overlay represents only a single view. Thus, for interaction with an application that supports multiple views, multiple overlays are required, and the displayed content on the touch-screen devices has to be changed manually (e.g., in the case of educational material such as world atlas with multiple maps or textbooks in pdf-format).

In this paper, we investigate self-identifying tactile overlays that can request the running application on the touch-screen device to automatically change the displayed content based on the applied tactile overlay. Self-identifying overlays support visually impaired users to interact with different interfaces and enable access to dynamic contents. For our prototype, we used

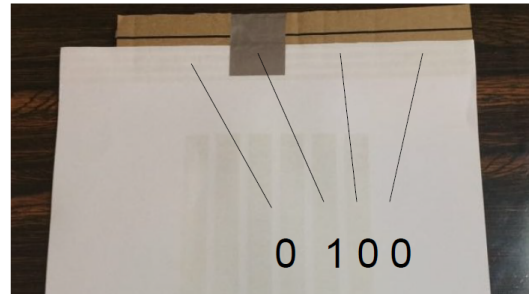


Figure 1. Coding scheme of a with 4-bit binary code of tactile overlay readable by the touch screen. Every conductive tape represents 1 bit.

tactile overlays made out of engraved paper and an 11.6" tablet. We developed an application that displays an adapted a school textbook and produced a set of tactile overlays to display the book's content and structure. We evaluated our approach in a pilot study with 2 participants with visual impairments.

SELF-IDENTIFYING TACTILE OVERLAYS

Our work is inspired by the approach of using coding schemes for the automatic identification of 3D-printed objects based on touch inputs by Götzelmann et al. [5]. For our application, we used coding schemes to develop self-identifying paper-based tactile overlays. We applied conductive aluminum adhesive tape on our paper-based tactile overlays to generate 4-bit binary codes. Every bit of a binary code is coded on the top of a tactile overlay as a possible touch point (cf. Figure 1). A positive touch point (i.e., with applied conductive tape) represents 1, and no touch point represents 0. Each supported tactile overlay has its own binary code that gets identified by the application on the touch device once the corresponding touch positions are matched.

Conductive tactile overlays

Tactile overlays [9] were made of 150g paper sheets with a size of DIN A4. The coding patterns are added on both sides of the tactile overlay to ensure to have a touch surface on both sides, i.e., front and back. In the front, we applied one touch bar which the user has to touch for the activation of the self-identification of the tactile overlay. On the back of the sheet, the tape was divided into multiple parts, in order to simulate multiple touch points and to represent the binary codes. The touch surfaces of the front and back sides of a tactile overlay are connected with wrapped the conductive aluminum tape on the upper edge of the paper sheet. Thus, the users had to touch the coding bar in the front of the tactile overlay to trigger the

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ASSETS '18 October 22–24, 2018, Galway, Ireland

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ACM ISBN 978-1-4503-5650-3/18/10.

DOI: <https://doi.org/10.1145/3234695.3241021>

identification of the overlay. To support the longevity of the self-identifying tactile overlays and to prevent folds on the touch points (i.e., resulting in misinterpreted coding patterns), we added a strip of cardboard between the sheet and the tape.

Application

The software to recognize coding patterns of the tactile overlays was developed using Windows Presentation Foundation (WPF) in C#. The program is deployed on a windows tablet in the full-screen mode. All supported views are stored in a WPF Tabcontrol.

The upper part of the tablet screen is used to recognize coding patterns adhered to the tactile overlays (i.e., first 80 pixels at the top of the touch-screen). This part was then separated into four parts to represent a 4-bit binary code. For the start of the binary code recognition, all bits of the binary code are set to 0 initially. When a user applies the overlay to the touch-screen and activates the self-identification of the tactile overlay by pressing the top surface area, the application will switch for all touched parts the corresponding bits to 1. After the application detected a code, the application adapts the view by opening the tab in the foreground that corresponds to the recognized binary code. Furthermore, the application stores the last detected code and resets the binary code recognition. When the application detects a code, the application will refresh the view only if the currently detected code differs from the previous detected code. Thus, we avoid that the interface refreshes the view when a user touches the coding pattern on the tactile overlay accidentally during the exploration of the displayed content.

PILOT STUDY

We conducted a pilot study to investigate the usability of self-identifying tactile overlays for content exploration.

Apparatus

For our application, we adapted six pages from a high school geography textbook using the process of Avila Sota et al. [9]. We reproduced the pages layouts as tactile overlays but used different tactile patterns for different layout elements (i.e., paragraphs blocks, tables, picture frames and their captions, highlighted text, and section titles). Every element is embodied by a button control which triggers a pre-recorded speech feedback. For every tactile overlay, we added a unique coding pattern as well as a braille tag to display a page number.

Participants & Procedure

We recruited two participants with visual impairments (1 male, 23 and 27 years). All participants were totally blind (one from early adolescence, one from late childhood) and college students and experienced with the use of touch-screen devices.

Once the participants were familiarized with the content exploration application, they explored the layout and content of the textbook for 10 minutes using the tactile overlays. For this, they took the numbered page they wanted to study out of a folder and placed it on the tablet. Subsequently, they were given a number of tasks typical for teacher-student interactions, such as to go to a section with exercises or look for paragraphs with definitions and highlighted terms. Afterwards, we interviewed the participants about their experience.



Figure 2. A user with visual impairment handling the self-identified tactile sheets application with a capacitive touch screen device.

Results

Participants were able to locate all the requested elements in the content exploration application. Also, they had a positive attitude towards self-identifying tactile overlays. Both participants were enthusiastic about the opportunity to interact with physical elements integrated into the application's interface. Participants mentioned that the numbered braille tags were useful for arranging the overlays and that this generated an experience like turning pages in an old school book. However, participants were concerned about how to place and hold the overlay on the tablet. We observed that placing and holding the overlay was a prominent source of delay; in several occasions, the participants had to place the overlay a second time or readjust the overlay in its clip.

Furthermore, participants suggested implementing self-identifying overlays for more content types such as maps, powerpoint presentations, and tables. Finally, they mentioned the potential to develop sets of interactive tactile overlays also for educational and game applications.

CONCLUSION

In this work, we presented paper-based self-identifying tactile overlays to represent different content types of an application. While tactile overlays for touch-screen devices have been explored in prior work [1, 2, 3, 6, 9], our main contribution is the self-identification to change the displayed content based on the applied overlay automatically. We conducted a pilot study using a functional prototype using an adapted textbook. We obtained positive feedback from our participants. In the future, we want to continue our work with the following steps: (1) Conduct a more extensive usability evaluation to further improve our approach. (2) Implement self-identifying tactile overlays for more content types such as presentation slides or diagram types. (3) Explore the possibility of applying our coding patterns on other tactile overlays approaches [1, 7, 8].

ACKNOWLEDGMENTS

This work was supported by the European Research Council, under grant number 683008 (Amplify).

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