A Demonstration of Molder: An Accessible Design Tool for Tactile Maps

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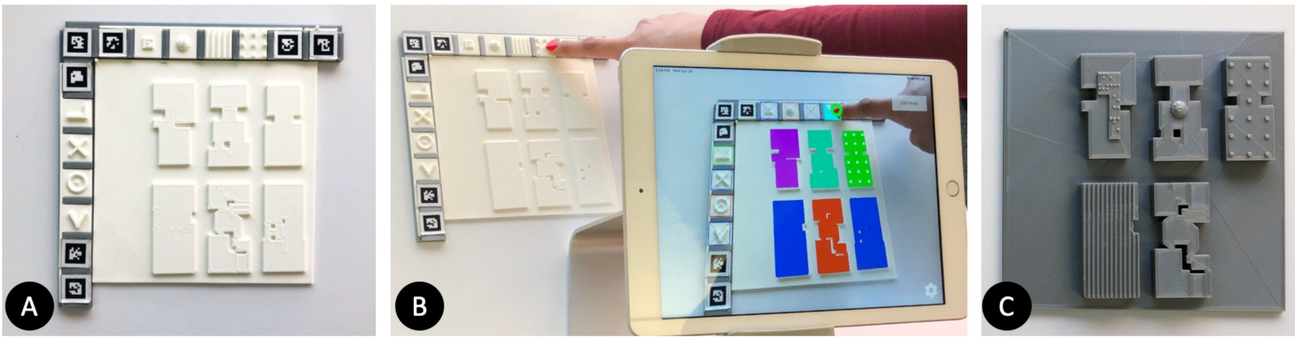

Figure 1. A designer uses Molder to modify a map model. (A) She prints a draft map model and places it in the Physical Ruler. (B) Then, she uses her finger to select buildings on the printed model and choose desired functions. (C) When she finishes, she prints out the final model, where the buildings are taller with different tactile patterns.

ABSTRACT

Tactile maps are important tools for people with visual impairments (VIs). Teachers and orientation and mobility (O&M) specialists often design tactile maps to help their VI students and clients learn about geographic areas. To design these maps, a designer must use modeling software applications, which require professional training and rely on visual feedback. However, most teachers and O&M specialists do not have professional modeling skills, and many have visual impairments. The complexity and inaccessibility of current modeling tools thus become major barriers for TVIs and O&M specialists when designing tactile maps. We present Molder, an accessible design tool for tactile maps. A designer creates a draft map model using Molder and prints the model. Then, she uses Molder to modify the draft model by directly interacting with it. Molder provides auditory feedback and high-contrast visuals to assist the designer in the design process.

Author Keywords

Visual impairments; tactile maps; design tool

ACM Classification Keywords

• **Human-centered computing~Accessibility technologies.**

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INTRODUCTION

Tactile maps, raised-line representations of spaces, are used extensively to enable people with VIs to navigate the physical environment independently. For example, a teacher of the visually impaired (TVI) or O&M specialist may create a tactile map of a university campus to help a student better navigate to different locations on the campus [9,13].

With recent advances in 3D printing, professionals with VIs have begun 3D printing tactile maps to support accessibility tasks [7]. The 3D designs of tactile maps can be shared and reused by different professionals. 3D printed maps are more robust than the ones made by hands and can potentially provide more detailed and accurate tactile features.

However, most TVIs and O&M specialists are not trained as professional designers, and the design process of printed tactile maps is cumbersome for non-expert designers. To design or customize a printable map model, designers need to use modeling software applications (e.g., Rhino [14]). Most modeling applications use graphical user interfaces (GUIs), which are not accessible for the TVIs and O&M specialists with visual impairments. In addition, these applications are not specialized for map design and often require complex operations to perform a single task.

We present Molder, an accessible map design tool that enables non-expert model designers, especially designers with VIs, to easily create tactile maps. Molder supports key modeling functions such as adding braille labels, tactile patterns, and audio labels. All these features can make tactile maps more accessible and easier to understand for people with VIs [1,3–6,8,10–12,16,17]. In this demonstration, we present the design and implementation of Molder.

MOLDER WORKFLOW

A designer starts the design process by generating a draft model using Molder. The designer generates a draft model by entering coordinates in an accessible website. Then, the designer prints out the draft model, and places it in rulers tagged with fiducial markers, which helps Molder locate the model, as shown in Figure 1A. Instead of performing functions on a 2D GUI on a computer screen, the designer uses her finger to select buildings from the printed model and choose desired functions by touching the corresponding printed tangible buttons (Figure 1B). Molder senses the designer's gestures and processes the model data. The final model (Figure 1C) can have a variety of tactile patterns and a different size based on the users' modifications. Molder provides high-contrast visual and auditory feedback for each performed operation, which allows designers with different vision abilities to edit the models. Once the designer finishes her edits, she can print the new model for her students. Molder has an interaction mode that allows students to explore the model with its tactile features and audio labels.

THE DESIGN AND IMPLEMENTATION OF MOLDER

Molder integrates functions that help a designer create a draft map model, edit the draft model using common modeling activities, and add audio labels. These tasks are implemented as eight functions: (1) creating a draft model, (2) adding braille labels, (3) adding tactile patterns (e.g., the raised line pattern and dot pattern in Figure 1C), and (4) adding audio labels. In addition, Molder also supports (5) building deletion, (6) model scaling, (7) undo function, and (8) interacting with audio labels. To make these functions accessible and easy to use, we designed and implemented two software components and four types of tangible objects.

Software Components

Molder has two software components: the Molder App and the Molder Server. The Molder App senses user input and renders output, while the Molder Server processes the model data according to the sensed user input.

The Molder App is an iOS application that uses computer vision to locate the position of the tangible objects and tracks finger gestures. It also renders feedback to a model designer. In addition, end users (e.g., students with VIs) can use this application in interaction mode to retrieve the audio labels on models. The algorithms and implementation of the application are similar to those in Talkit++ [15].

The Molder Server processes the model data. It is implemented as an add-on in Blender [2], a modeling software that includes basic modeling functions (e.g., Transformation, Boolean Modifiers). Blender provides a Python API to its built-in functions, which allows us to edit 3D models using Python scripts.

Tangible Objects

Molder has four types of tangible objects to make the modeling experience accessible. These include a printed draft model, the Physical Ruler, the Tangible Widgets, and the Indicator. Figure 2 and 3 show these tangible objects.

Molder automatically generates a draft model using the geographic information entered by a designer. Then, the designer prints out the draft model using a 3D printer and places the printed model to the Physical Ruler.

The Physical Ruler is made of two orthogonal rulers. There are three markers on the Physical Ruler to help the Molder App locate the position of model. There are twelve empty slots on the Physical Ruler for the tangible widgets to be placed.

We designed two Tangible Widgets: the Tactile Widget and the Function Widget. Both consist of tactile representations of different functions. The Tactile Widget has four functions related to tactile features: Braille, Dot, Line, and Icon. Function Widget has four other functions: Label, Delete, Scale, and Undo. Each Tangible Widget has two markers on its two sides, which enable the Molder App to locate their positions.

The Indicator is used in the Scale function; it is a rectangle that has trackable markers.

FUTURE WORK

In the future, we will work with target users (e.g., TVIs, O&M specialists, students with VIs) to evaluate and iterate on the design of Molder. In addition, we will explore how to use the tangible interaction paradigms to design other types of 3D models (e.g., a globe model).

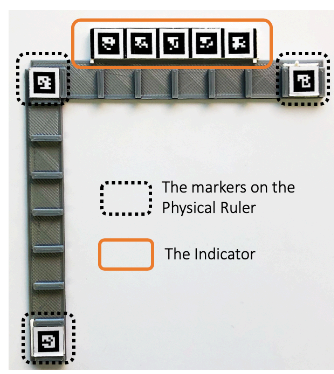

Figure 2. The Physical Ruler and the Indicator.

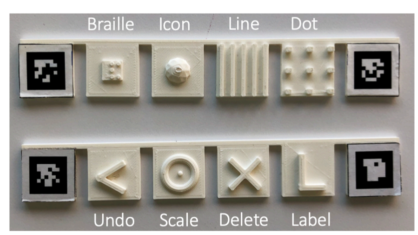

Figure 3. The Tactile Widget and the Function Widget. The Tactile Widget has four functions: Braille, Icon, Line, and Dot. The Function Widget consists of four functions: Undo, Scale, Delete, and Label.

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