COMB – A Modular Low-Resolution Display to Support Electronic Musical Pre-Education

Beat Rossmy, Alexander Wiethoff
Media Informatics Lab, LMU Munich
Munich, Germany
beat.rossmy@ifi.lmu.de, alexander.wiethoff@ifi.lmu.de

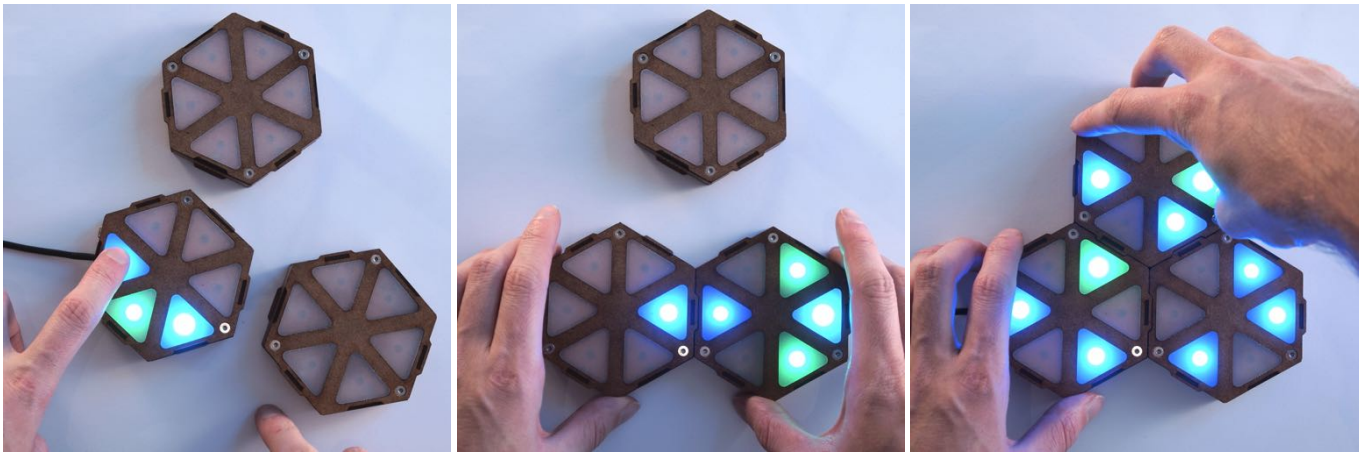

Figure 1. Modular displays can form meaningful shapes, which are related to different available functionalities. By restructuring the user can constantly switch those functionalities, like switching tabs in his browser.

ABSTRACT

Displays are ubiquitous in our everyday lives. Since most smart phones or tablets try to avoid control elements, touch screens are primarily the only remaining component of interaction. Beyond the restriction of input methods, static screens define the frame for our applications. Designers and developers, as well as users have to align with standard manufactured screen sizes and resolutions. Modular displays are able to overcome this restriction. Their arrangement can be adapted to fit momentary needs, but an even greater potential lies in their capability to create meaningful objects. Derived from toddlers constructive play with blocks, we introduce COMB. Our prototype demo includes an interaction concept centered around the idea of modular low-resolution displays representing accessible functionality by their arrangement and provide educational benefits for children.

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INTRODUCTION

Low-resolution displays, incorporating MIDI controllers, are widespread interfaces, used in music performance and production [1, 7]. Such interfaces offer directly accessible information, displayed as single pixels. Those pixels represent for example note values, control data or act as high level representations of audio or MIDI information. In this context the resolution and arrangement of the display can have a direct influence on musical parameters such as loop-length or time accuracy. Typical interfaces are optimized for common time schemes like four quarters or derived meters. Customizable interfaces, however, allow the musician to adjust these properties to their musical needs. In commercial product development the modularity is used to enable customization [5]. Users can combine modules of different functionalities to construct interfaces fitting their ergonomic needs and artistic requirements. However, this approach does not consider the foreknowledge derived from constructive play [4], where form is not primarily used to accommodate ergonomic needs but meaning. In the academic research domain of Organic User

Interface Design (OUI) shape and form are considered as the representation of functionality [8]. At the same time the structure of the interface enables changes of functionality through the manipulation of its appearance performed by the user. The user interface "Ninja track" by Katsumoto et al. [2], can be structural adapted to serve different purposes, however, its limitations and constraints are interconnected to the mechanical structure. A more progressive vision of an OUI concept including freely transformable digital clay has been described by Reed [6]. However, prototyping or developing such interfaces from scratch bears several technical challenges at the moment. As the missing link between today's interfaces and tomorrow's mobile tech infrastructure, constructive/form-centered interfaces could be inspired by the concepts described by OUI design. Hence, we consider it worthwhile investigating this domain further. A fairly new research field incorporating such ideas is Swarm User Interfaces (SUI) including independent robotic elements [3] as they enable the display of information as well as the user manipulating information. In this vein, the concept of our experience prototype COMB focuses on the meaning of shape and form, to communicate functionality to the user (see Figure 1). As an additional advantage, the separation of input methods emphasizes the meaning of certain interactions. In screen based systems, touch is the only remaining input method, so changing or handling applications is hardly distinguishable.

COMB – DESCRIPTION AND TECHNICAL DETAILS

COMB assigns the main tasks, of switching musical applications and controlling those to different input methods. The restructuring process of the interface changes the availability of functionality, whereas touch based interaction allows editing of parameters. Our prototype consists of three hexagonal modules, each divided into six backlit silicone pads. Via USB the interface acts as a class compliant MIDI controller and common Digital Audio Workstations (DAW) can be used as a sound source. Each module contains a microcontroller (Teensy LC: ARM Cortex-M0+ 48 MHz), which enables their intercommunication through magnetic pogo-pin connectors placed on each side. Via these connectors power (+5V, 500mA) is distributed between the connected modules and communication (I^2C) as well as neighbor-detection via Pulse-Width Modulation (PWM) is enabled. Based on the implemented neighbor-detection, the modules can recognize their current arrangement and adapt the displayed information accordingly. One advantage of this solution is that no external equipment such as cameras or trackers is necessary to recognize the interface shape and thus, its current functionality. In this configuration, form is seen as the relative arrangement of modules, hence, no absolute positioning or rotation is taken into account to define shapes. The current prototype of COMB provides access to three layers of drum sequences. Each layer is represented via one of three symbolic shapes: (a) dot, (b) line and (c) triangle. The corresponding instruments are, in the above mentioned order: kick-drum, percussions and hi-hats. Rhythmic patterns can be created by touching the backlit silicone-pads. The silicone-pads represent different steps of the sequences, following established paradigms of widespread step-sequencers.

DEMONSTRATION SETUP

Our COMB experience prototype will be displayed on a small stand measuring 40cm x 40cm x 120cm, so users can access the interface from three sides simultaneously. During explorations, users are able to listen to their creations via speakers, which also enable bystanders to follow the performances. Basic instructions on how to operate our prototype are presented on a poster showing the symbolic meaning of shapes and related instruments. Initial preliminary evaluations at the ARS Electronica 2017 have shown the positive potential of the concept and sparked discussions about the interface and new ideas for further developments. A presentation at PerDis '18 will generate insights on how HCI professionals perceive the concept and generate further learning from different user groups which in turn will accelerate the further development. Doing so we hope to support children in the near future learning about electronic music and music theory supported through our research and by introducing novel tangible musical interfaces, as the one presented in this paper.

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