LMNKui: Overlaying computer controls on a piano keyboard

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ABSTRACT
We introduce the *Look Ma No Keyboard user interface*, an ergonomic and intuitive method for controlling a music sequencing software from the piano controller by adding a momentary foot switch. After describing the current practices and the design of our system, we discuss the results of our early user testing, comparing the current input device with ours.

Keywords
Musical Instrument Digital Interface (MIDI), sequencing, synthesizer, octaves, foot switch, controller, composer.

INTRODUCTION
Existing user interfaces for sequencing electronic music are cumbersome, as they require the use of three input devices; a piano controller, a computer keyboard and a mouse. Synthesizer software such as CSOUND, features the ability to map a limited number of MIDI events to keys on the piano controller. Standard electronic piano controllers have additional sliders, knobs and dials that can be programmed to trigger MIDI events. One disadvantage of these conventional methods is the excessive space they occupy. More importantly, the musician's workflow is negatively impacted by the time spent switching between multiple input devices. *LMNKui* has a mapping of these control functions in an octave structure with a key based segmentation. This mapping provides the musician with a familiar configuration of space and sound, allowing him to focus on the creative aspects of music composition.

LMNKui SYSTEM
LMNKui eliminates the need of the computer keyboard and mouse for many computer composition functions by relocating the keyboard and mouse functions to the piano controller. An example of a macro that can be relocated to the controller is the copy function, or [Control]-[C], to copy a highlighted sequence to the clipboard. To distinguish between keystrokes that represent a note and a macro, a momentary foot switch is used as a mode switch, thereby reducing mode errors. [1] Though a secondary body channel like the foot has a lower information processing bandwidth, it sets the framework, and the reference for the primary body channel and the task in this system as shown in Figure 1.

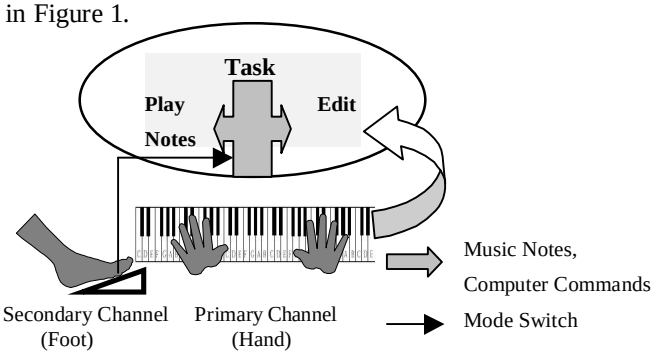

Figure 1: LMNKui System setup

Additionally, the system state is reinforced by the foot proprioceptive feedback and the relocation of the functions to a single input device minimizes the device acquisition time. [2]

DESIGN
We chose the Cubase sequencing program by Steinberg on Microsoft Windows, which is a popular setup among composers. Macros from the different Cubase windows were mapped to specific octaves on the controller keyboard for separation.

Keyboard Layout Design
The design of the layout incorporates four windows most commonly used by the composer. The functions associated with a window map to a specific octave on the synthesizer.

The synthesizer keyboard has been laid out as follows:

- The octaves used are the central ones found on every standard music keyboard and the layout is shown in Table 1.

WINDOW	OCTAVE USED
Transport bar	C3 to B3
Arrange Window	C4 to B4
Key Edit Window	C5 to B5
File Handling	C6 to B6

Table 1: Window-Octave Layout

- The first note, which is the 'C' of the different octaves or the different windows, is designed to 'open' or 'create' something new, as shown in Figure 2.
- The middle fours keys (E, F, F# and G) are used for either going up or going down the tracks or parts, or punching in or out as shown in Figure 2. They correspond to the computer commands ←, ↓, ↑, →.
- The remaining mappings take into consideration the timbre associated with the notes.
- The highest note (C7) is used as an 'Enter' key for all confirmation functions. We anticipate that musicians can quickly hit this key as it is at the extreme end and hence don't need to look for it.

For example, the transport octave is used to play, stop, record, mute and solo a sequence or a specific MIDI channel.

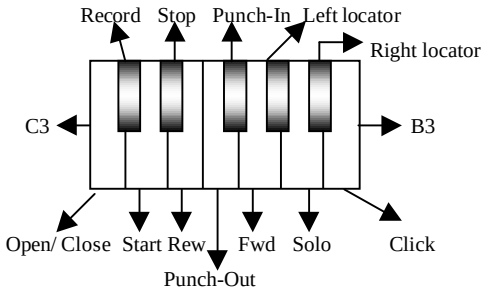

Figure 2: Transport Octave

EXPERIMENT DESIGN

Two interaction methods were tested in the experiment: Computer keyboard and Piano controller. A total of 6 subjects with sequencing experience performed the tests with the two methods in a pre-assigned order. Subjects were given a practice run to explore different modes and strategies. Two tasks involving repetitive sequencing and editing were performed twice, to test for the mean completion time, thereby requiring the subjects to switch back and forth between the modes on their own. We chose to turn the sound on, while the piano controller was in the control mode to see the effectiveness of the associated earcons. After the tests, the subjects were asked to rate the input devices on a 0 (terrible) to 6 (great) scale based on their experience. During the testing, we explicitly checked for any mode errors while using the piano controller.

EVALUATION

With an average learning time of about 5 minutes, subjects performed both the tasks significantly better with the piano controller in Test1 ($p<0.05$, t-Test) and Test2 ($p<0.06$, t-Test), and Test2 was done faster than Test1 as shown in Figure 3.

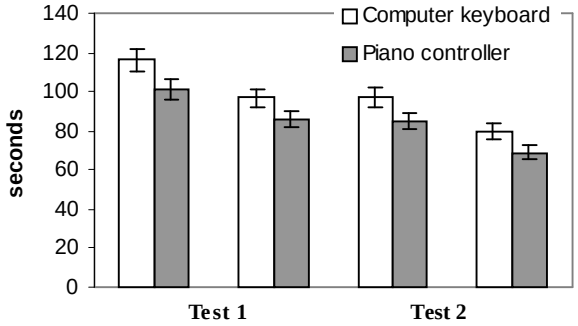

Figure 3: Mean Time with 95% Confidence Error Bars

Subjects gave the computer keyboard a significantly lower rating than the piano controller ($p<0.021$, t-Test). They found the piano interaction intuitive and an effective link between playing and editing. Though the no-sound condition was not tested in our study, from the questionnaires, we learnt that the earcons were effective in doing the tasks due to subjects' already acquired auditory memory of the piano. Interestingly, no mode errors were detected during the testing using the piano controller. We suspect that this is due to the subjects' familiarity with damper and sustain pedals, which are momentary pedals as well, and are commonly used in their industry.

FUTURE DIRECTIONS

Our future research will be in the following directions:

- Applying the principles to other music instruments
- Leveraging principles of musical structure
- Investigating different key boundaries

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