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GENERIC MIDI DEVICES AS NEW INPUT FOR SPECIALIZED SOFTWARE

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ABSTRACT
There are plenty of sublime devices, including input devices, for all kinds of specialists working with computers available on the market. Furthermore, the more specific solutions are needed, the more expensive and complicated they are. At the time when many people prefer to try as many things as possible before selecting the specific learning paths, both high price and high entry threshold, can appear as blockers.
In the paper, there are selected some hardware and software solutions for facilitating the work of the professionals , who expect more analog-like interfaces and more natural ways to control computers presented. Additionally, the authors describe original software and hardware solution that allows the use of wide range MIDI devices as custom input devices. The concept of the software made is being presented, as well as some results of initial interaction of different kind of professionals and the proposed solution software and hardware.
KEYWORDS: MIDI, DjToKey, specialized input devices, personalized input devices, keyboard and mouse mapping, human-computer interaction

URZĄDZENIA MIDI JAKO NOWY SPOSÓB INTERAKCJI Z OPROGRAMOWANIEM SPECJALISTYCZNYM

STRESZCZENIE
Dostępne jest na rynku wiele urządzeń, w tym urządzeń wejściowych, dla różnych kategorii wymagających użytkowników komputerów. Dodatkowo, im bardziej skomplikowane rozwiązania są potrzebne, tym bardziej są one skomplikowane i kosztowne. Wysoka cena i wysoki próg wejścia utrudnia możliwość znalezienia urządzenia dostosowanego do konkretnych, specyficznych potrzeb użytkownika.
W artykule zaprezentowano szereg wybranych rozwiązań sprzętowych i programowych pozwalających na wypełnienie luki w urządzeniach wejścia dla specjalistów oczekujących interfejsów w stylu analogowym oraz bardziej naturalnych sposób na interakcję z oprogramowaniem. Autorzy demonstrują także budowane własne oprogramowanie pozwalające na wykorzystanie szeroko dostępnych urządzeń MIDI jako urządzeń wejścia. Ogólna koncepcja proponowanego oprogramowania jest zaprezentowana, jak również wstępne rezultaty badań odczucia użytkowników korzystających z proponowanego rozwiązania.
SŁOWA KLUCZOWE: MIDI, DjToKey, specjalizowane urządzenia wejściowe, spersonalizowane urządzenia wejściowe, mapowanie klawiatury i myszy, interakcja człowiek-komputer

1. Introduction

It is known that professionals, such as racing drivers, jet pilots, or heavy machinery operators, use very specialized input devices with features like force feedback or various ways for personalization. Until recently, these interfaces had been becoming more digital related, with growing number of sensors and buttons. Presently, all gained experience from all tested interfaces adjustment methods, and come to many other areas, such as computer graphic.

The specialized software, used by different group of professionals – every of different kinds – graphic designers, photographers, software developers etc., is requiring a different kind of input, allowing people to improve their workflow, and for faster and simpler manipulation of digital objects. It applies not only to design and production aspect, but also to product life cycle stages [1]. Specialized input devices are as old as home computing itself – to mention only gamepads and joysticks available for early home computers allowing players to play different roles.

However, there is no huge innovation in the scope of different means of human-computer interaction being broadly adopted – the users are still using their keyboards and mice, and while touch-based and gesture-based devices being available, especially professionals are not using customized devices. Besides, nowadays everyone can not only buy decent input devices, but also build it by themselves and create interfaces that fully meet the needs to increase productivity of very specific target group (e.g. controlling electrical drives with MIDI-based controller [2]), or just either for pure science or fun. A good example of such solutions are glove based controllers [3], that can be used to create and modulate music [4] [5], as well as robots remote control devices and other robots-related teleoperation and remote manipulation interfaces [6].

Despite the fact that this solution gives the most freedom to adjust control, it also requires a knowledge of electronics, which may prove to be an obstacle for some amateurs. In this paper, authors are willing to introduce a concept of using a generally available devices, especially MIDI (Musical Instrument Digital Interface) devices usually targeted for DJs and composers with a customized software, allowing usage of such devices in totally different scenarios.

While there are already available customized devices from different manufacturers, for different workflows, the authors decided to use a generally available and inexpensive class of devices and provide a middleware for usage of them in additional scenarios. The goal of the research is to find out, if the custom input devices is going to improve productivity of the professional user over the classic keyboard and mouse combo. The concepts proposed in this paper have already been developed into a stage of a publicly available software [7], after a state of proof-of-concept prototyping, and will be base of a user experience testing in the coming months.

2. Existing commercial devices

Currently, there are a lot of systems, devices and software on the market that can be used to control certain functions, or mapping the keyboard and mouse. Each stands out with (1) the level of hardware complexity (inputs number and variety), (2) level of freedom of the user's personalization of available devices or software elements (3), and price. In this chapter, the authors present a few examples of such devices and systems.

Probably, the most complex solution is Pusher Labs, built with hardware MIDI console and PFIxer software, that can be use as enrichment Adobe Lightroom program environment [8]. Pusher Labs company offers huge variety of devices for each level of specialization. Next one is Palette Gear – the modular system for building a personalized controller for graphic editors [9]. The system provides compatibility with most of commonly used professional 2D editors that is fully modular with up to 32 pieces. Pallete Gear may be also used for keyboard mapping, MIDI device or game controller. While the Pallete Gear allows ease of adding peripheral devices, the Nob Control offers small device Nob with

one knob and two levers. Similarly to Pallete Gear, the result of crowdfunding campaign the goal was to provide additional interfaces for interaction in graphic design software, with removal of number of additional devices on the user's desk [10]. Furthermore, the newly introduced Microsoft's Surface Surface Dial, which is a rotating knob demonstrated for adjusting colors pallete during drawing or similar activities, may be used with any compatible Windows 10-based device, but touch digitizer reports the onscreen location through a capacitive pattern on Surface Studio devices [11]. This controller will be available shortly and is already compatible with a set of both graphic design and commonly-used office software.

ShuttleXpress, a device which major parts are jumping and smooth dial [12]. ShuttleXpress can be used to work with many graphic and video editing programs and other software. A similar approach with similar characteristics is minimalist PowerMate, which mainly consists of programmable knobs [13].

G13 advanced gameboard from Logitech is directed mainly to the players [14]. The device resembles a traditional mouse, enriched with 25 programmable buttons, joystick and screen displays. Similar periphery has been introduced by Razor – Tartarus Chroma Keypad has 15 programmable, illuminated buttons and a joystick [15]. Its appearance resembles a mouse Razer Tartarus profiled for the left hand –- manufacturer does not provide a version for the right hand. Both G13 advanced gameboard and Razer Tartarus Chroma Keypad had been primarily designed for gamers. These devices are a left-handed periphery, for users who typically use a small amount of buttons on the keyboard, but almost always use a mouse. Moreover, the range of buttons functions assigned to the keys can be fully defined by the user through the software provided by the manufacturers.

All described devices are useful for very specific scenarios, but the main downside is the cost of the device (e.g. the most complex device configurations of Pallete Gear costs over $1560) and their lack of versatility – every device was made with a specific software suite, with potential for great personalization but with lack of hardware modularity or inputs number and variety, which can be seen in the Table 1., below.

Table 1. Comparison of selected available commercial solutions

Device name	**Pusher Labs system**	**Palette Gear**	**Nob**	**Shuttle Xpress**	**PowerMate**	**G13 advanced gameboard**	**Razer Tartarus Chroma Keypad**	**Microsoft Surface Dial**
hardware modularity level	Low (the variety of available devices)	High (up to 32 moduls with any arrangement)	None	None	None	None	None (lights color only)	None
Hardware inputs variety	Medium (buttons, sliders and dials)	Medium (buttons, sliders and dials)	Low	Low (buttons and nob)	None (nob only)	Low (buttons and joystick)	Low (buttons and joystick)	None (nob only)
Level of software personalization	Medium (Adobe Lightroom oriented design)	High (big catalog of presets and great ability for customization)	Medium (through producer software)	Medium (through producer software)	Medium (through producer software)	Medium (through producer software)	Medium (through producer software)	Medium (through producer software)
Retail price	$179	from $29 single piece to $499 (a set of recommended amounts of components for professionals)	$130	~$59	45$	$100	$60	$100

Furthermore, there are some software solutions, like MIDI2LR [16], Paddy for Lightroom [17], Knobroom [18], which can be useful while changing any MIDI controller into device for professionals,

but is limited to only one kind of software. In addition, there are some programs (Midi Touch [19], LRPAD [20]) that allow achieving similar effect by making tablets and phones act like virtual MIDI.

Still, most of these solutions work as plug-in for specific program (e.g. Adobe Lightroom), and do not allow more customizations. Therefore, this is where the authors believe the innovation should be made – and to cope with that, the custom middleware for generic MIDI devices were proposed and developed. On the other hands, existence of the custom device group, even when not backed with their popularity, indicated there is an interest in this topic. Different, "esoteric", forms of input are also discussed by various researchers [21] [22], so authors of this paper are sure that not only touch, pen gestures or voice are the possible future of human-computer interaction.

3. Selected devices and custom software design

MIDI devices were chosen (for the purpose of this paper it was the DJ console) as the examples of inexpensive (less than $95) and versatile devices, with multiple knobs, buttons and levers already available. The missing point was to design a kind of middleware to translate movements of physical controls into actions performed in the software. The controller used in the research is DjControl MP3 LE from Hercules, available only on second-hand and depicted in the Figure 1. The device is equipped with 8 different knobs, two deck controls, three sliders and a series of different buttons.

The second device, the proposed middleware was made to work with, is a MPK mini musical keyboard from Akai, allowing for input multiple keys, but also equipped with 8 knobs, presented in the Figure 2.

Fig. 1. Hercules DJControl MP3 LE (source: [23])

Fig. 2. Akai MPK Mini (source: [24])

The middleware, dubbed "DjToKey", is a software suite designed for a simple mapping of MIDI messages from the input devices into scripts performed in the operation system [7].

The proposed software works in the background and receives MIDI messages and recognizes from which input device (multiple devices are supported, but only one can be active at the current time) and input control the message came. Then it runs the script bound with the specific control – the basic schema for the workflow of the application itself is presented in the Fig. 3.

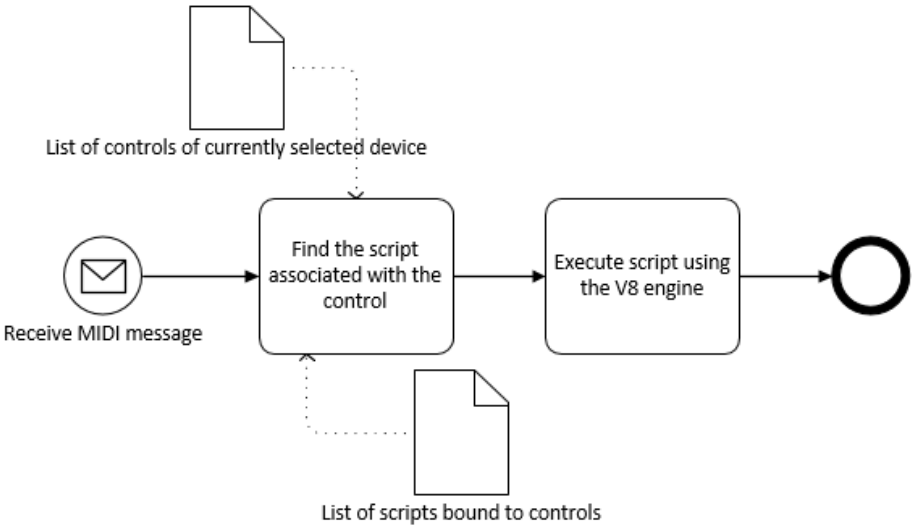

Fig. 3. Workflow of the DjToKey software

Provided script language is the regular ECMAScript run using embedded V8 engine, with a set of additional objects available for the user allowing for interoperation with operating system and its applications, e.g.:

- simulation of mouse movements and mouse buttons down and up events,
- simulation of keypresses, key down and up events,
- text input,
- listing of windows and processes,
- global dictionary object for data storage.

For the each of controls available for the device, user may prepare his or hers own schema of commonly performed actions and these macros may be played when the corresponding MIDI message is received. The software allows for customization of controls in the form of graphical user interface showing input devices and its available controls.

In the Fig. 4. the screen of DjToKey application with connected DJControl MP3 LE controller is shown, while in the Fig. 5. – the screen of the raster software editing platform with a set of controls, which may be manipulated using provided physical controls, instead of only virtual ones.

Fig. 4. DjToKey application interface

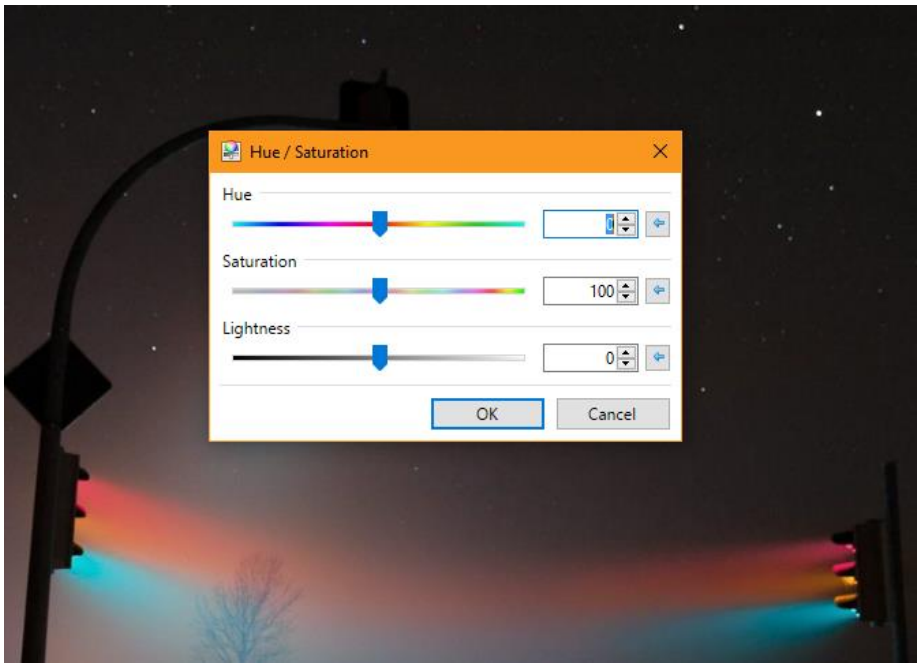

Fig. 5. Virtual sliders being manipulated by physical controls by the presented software

The software was built in modularity in mind – adding profiles for new MIDI input devices, as well as whole new classes of devices (not limited to MIDI devices) may be performed with addition of package files, not requiring applications recompilation. DjToKey is also published as a free software for the Windows platform, available on GitHub, under the MIT license.

4. Early study on user experience

For the early study, if the concept was successful, the experts using graphical design software were asked to evaluate the device without a software. They were asked to describe what actions every control would perform in his software of choice. Some of actions users were interested in were:

- Horizontal and vertical screen scrolling,
- Scrolling through properties sliders,
- Zooming in and out with a defined step or smoothly,
- Color balance, brightness and contrast change,
- Loading files and moving between files,
- Running specific software macros and action sequences.

After evaluation, a series of scripts was prepared, allowing such actions as a macros for the software defined, and the expert was asked again to perform actions using the provided hardware and software.

After prototype testing, all the experts found the system worked correct and confirmed its usefulness. At the same time they offered to participate in developing the system, seeing it as an opportunity to improve their jobs and facilitate everyday activities related to editing files. Every expert made a list of suggested improvements for DjToKey software, which have been or will be implemented over coming months.

During the experiments, the experts found, however, that simple emulation of keyboard presses or mouse movements may result in improper behavior of the application when the controlled software is not in a known state. This is not the case with some of the specialized controlled the authors

discussed earlier, where the custom hardware was designed with the software in mind, instead of trying the universal approach the authors propose in this paper.

To cope with that, the modularity of the software is to be used again – at the moment, there is a possibility for adding new functions available to the scripts via the plug-in mechanism. The authors will try to provide the plug-in directly communicating with the controllable software, instead of mouse/keyboard emulation, allowing “best of both worlds” approach.

5. Conclusion and future works

The existence of commercial custom input controllers proves there is a need for such equipment for professionals. Yet, the device availability is still very limited, and there is no universal solution for different software platforms. The research of the user experience when using specialized input device is also lacking, which brings new research possibilities.

The authors have prepared fully working prototype, which allows mapping of keyboard presses and mouse movements (inter alia) using the inexpensive MIDI device, to allow professionals for easier and more intuitive cooperation with the software. After developing the prototype system and the interviews of potential representatives of the target group, the authors were able to determine whether there was a demand for this type of hardware solution.

The authors are willing to continue cooperation with experts, working on fully functional program that will be understandable and accessible for every enthusiast of graphics editing or similar activities at every level of experience. The next research goal is to determine, if the user experience and effectiveness is possible to rise with new kind of input devices.

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