PanMan – a modular tangible controller for sound spatialization

Krzysztof Cybulski
Feliks Nowowiejski Academy of Music in Bydgoszcz

Szczepan Buśko
Feliks Nowowiejski Academy of Music in Bydgoszcz

Zachariasz Zalewski
Feliks Nowowiejski Academy of Music in Bydgoszcz

ABSTRACT

PanMan is a performance-oriented modular midi controller, conceived as a tangible interface for panning multiple sound sources in multichannel audio systems. It consists of four independent control units and a docking base - the modular design allows each of the units to be either physically attached to the base (in which case it might be used as a single controller by a single user) or connected to it via extension cords, allowing up to four users to participate in an interactive sound installation experience or a collaborative performance setting.

The physical controls on a single module consist of a joystick/trackball hybrid – a dome-shaped control device designed to be operated with a single finger – and a thumbwheel for additional parameter control, positioned at the edge of the module, allowing for one-handed operation of three parameters. The design facilitates operation by both right- and left-handed users, also allowing a single user to operate two or more controllers simultaneously, controlling a number of parameters at once.

Author Keywords

tangible, spatial, controller, interaction

1. INTRODUCTION

Figure 1. The PanMan

Initial motivation behind this research was a realization that, when using multichannel systems for live electronic music performance, performers usually rely on the FOH engineer, granting them full authority over sound placement in the multichannel system. Even though for most performers this might not be an issue, some might prefer to take control of spatial signal placement themselves. Hence, the purpose of PanMan was to provide performers with the ability to position four different signals in real time in a performative manner. Our main goal was to create a solution in a form of a physical, tangible controller, which would also enable multiple users, which eventually evolved into a concept of modular controller that could also be used outside of the initially conceived usage scenario.

Existing spatial controllers generally tend to be screen- or touchscreen-based, which may not be ideal for a live performance, where musicians tend to rely on tactile cues, especially so when a couple of sound sources are to be controlled independently. As observed by Magnusson et al, "(a)fter decades of digital systems, people are increasingly wanting to explore sound and complexity in tactile form" [1]. There is, however, a number of spatial controllers which offer physical interaction. For instance, notable examples from the NIME community include The Sound Flinger [2], in which the movement of the sound source in a 4-channel space can be controlled with four motorized faders, providing haptic feedback. A different approach was utilized in the SoundMorpheus [3] which uses myoelectric sensors for sensing the position and movement of the performer's hands in space. This controller, however, does not provide any haptic feedback to the performer.

On the other hand, the commercially available joystick controllers are rather scarce in number [4], and the existing devices – especially in multi-joystick configuration - tend to be on the expensive side [5][6]. One way of overcoming these shortcomings could be repurposing the multi-trackball controllers used for color-correction [7] or utilizing a couple of existing joystick components (usually also quite expensive) and fitting them into a common housing. Nevertheless, we have decided to repurpose our earlier prototype of a simple dome-shaped joystick and, as a result, we've came up with a new design based on standard potentiometers, which could be easily assembled from simple, 3d-printed elements. As 3d printers are becoming widely available, such design offers an inexpensive, alternative solution.

With regard to the aforementioned controllers, the distinctive aspect of the PanMan is the design and physical properties of the dome-shaped joystick itself, which is more convenient to operate than a regular joystick with an actual stick. The concept of a modular midi controller is also not new, as a number of such devices already exist (at least in a prototype form)[8][9]. In the case of the PanMan, however, the main motivation for the modular design was to allow for each of the modules to be physically detached from the docking base in order to create alternative joystick arrangements for a single user, or to facilitate a cooperative musical activity.

2. PROJECT DESCRIPTION

Apart from the initial motivations, the PanMan was also a testbed for two design ideas – first one is a novel joystick, which is dome-shaped, rather than having a typical "stick" form. We perceive this design to be less confining to a given handling scenario – a standard joystick has to be held between fingers, so

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a whole hand has to be dedicated to its operation. With our dome-shaped design, the joystick can be operated more in a trackball fashion – a single finger is enough to control its position, hence the thumb is free to operate an additional control (the thumbwheel), or a single hand can be used to control more joysticks at once.

The joystick consists of three 3d-printed elements, held together by two potentiometers and a single M3 bolt with a nut. We made the 3d-files open-source – it can be printed and assembled for use in many other possible ways (i.e. as a pitchbend/modulation controller). The 3d files can be downloaded from:
https://github.com/HybridInstrumentsLab/PanMan

Figure 2. 3D model and an actual view of the dome-shaped joystick component

Second design idea is the modularity of the PanMan – each joystick has a separate housing, attached to the base with two ¼'' jack TRS plugs, which also transmit the signals from the potentiometers and switch to a Teensy 3.2 microcontroller, housed in the base.

Figure 3. The joystick module

Such arrangement allows each of the joysticks to be either attached to the base, or operated remotely by connecting it with two 3-wire jack extension cords. This way it can be used by a couple of performers or form the basis of an interactive sound installation, or provide an alternative control arrangement for a single performer/operator. The modular nature of the PanMan means that a different set of control modules can be created in the future, as long as they follow the basic dimensions and plug spacings of the original joystick housings.

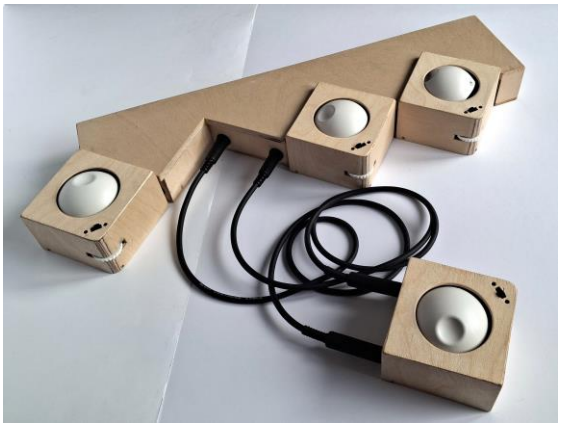

Figure 4. PanMan with one of its modules attached via extension cords

The docking base serves as a housing for a protoboard, distributing signals from the jack sockets to a Teensy 3.2 microcontroller. Teensy 3.2 was chosen as it offers a sufficient number of analog inputs (12 of total 21 are used for the PanMan) and a readily available "Serial + MIDI" mode, which facilitates fast prototyping of DIY midi controllers.

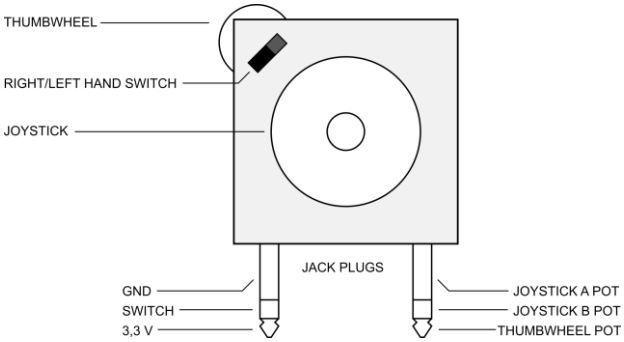

Figure 5. Schematic of the joystick module

As we wanted the PanMan to be accessible to both right- and left-handed users, each module has an additional slider switch which changes the joystick axes and the polarity of the thumbwheel. The switches are connected to digital inputs of the Teensy microcontroller and the axis/polarity swap is executed on the software level.

3. RESULTS

As the PanMan prototype was completed very recently, it has only been tested in a "laboratory" setting – after ensuring the correct technical operation, we have conducted basic functionality tests of sound-panning four monophonic sound sources across a 4-channel speaker system, using a simple Pure Data patch, and the controller worked as expected. We have also patched a simple 4-voice synthesizer and mapped the vertical joystick axis to the oscillator pitch (quantized to the steps of a dorian scale), horizontal axis to stereo pan, and the thumbwheel to the filter cutoff. This patch has been used for the video documentation presenting the basic functionality of the PanMan – as the video (and most readers' sound systems) only has two channels, 4-channes sound would be difficult to translate properly. The video presentation of the PanMan can be seen at https://krzysztofcybulski.com/panman.php

4. FUTURE WORK

The PanMan has yet to be tested in a real-life performance scenario for which it has been conceived. We are also hoping to organize user trials to achieve feedback regarding the ergonomics of the dome-shaped controller from musicians and non-musicians alike, and to test its usability as an installation/cooperative performance control device. The feedback could also be used for refining the joystick operation, and – possibly – as a starting point for different types of new control module designs.

As the project develops, additional resources would be added to the dedicated Github repository.

5. ETHICAL STANDARDS

This research didn't involve any human or animal participants.

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