A Low Cost Computing Interface to Speed Up Braille Music Notation

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Abstract *– Braille music notation is used by visually impaired musicians to engrave music. As normally performed, this is a difficult and time consuming task. This paper presents a study, a work in progress, on the design of a simple and affordable hardware interface that turns the process of braille music notation in computers easier and faster. Braille uses the same set of 6 dots to make all representations of letters, numbers, symbols and music notation according a context. The hardware presented here has two handles with 3 pushbuttons, each one related to one braille dot. An Arduino board reads the state of these 6 pushbuttons, translate them into a bitmask and send it to a computer. At the computer side there is a driver to make it possible to convert pushbuttons actions into image and sound.*

1. Introduction

Music notation using computers is both a necessity and a problem for the visually impaired or low vision musicians. Benefits conveyed by this method of music notation are many, such as "corrections without blot, printing with high quality and speed, instant separation of parts in a grand staff, transposition, replication and distribution, automatic digitalization without the use of a scanner, sound generation, etc." [Penteado and Fornari], but the drawback is that mainstream softwares for music notation make extensive use of GUI (Graphical User Interface) which depends on the computer mouse. It is self-evident that visually impaired (blind) people can't operate a mouse in a graphic-oriented system. This is the case of proprietary softwares, such as: Sibelius (http://www.sibelius.com), Finale (http://www.finalemusic.com/), Encore (http://www.passportmusic.com/), as well as free softwares, such as: Musescore (https://musescore.org/), Rosegarden (http://www.rosegardenmusic.com/), Tux Guitar (www.tuxguitar.com.ar), among others.

Blind musicians may use auditory information to replace the visual one, and it is exactly what a class of softwares called "screen readers" does. Screen readers convert text on the screen to audio (language spoken by a voice synthesizer), but it is impossible to convert images into audio, thus they can't help with graphical interfaces. The most famous screen readers softwares are the proprietary one JAWS (http://www.freedomscientific.com/) and the open source NVDA (http://www.nvaccess.org/), both run only in Windows Operating System. For Linux, there is ORCA (https://wiki.gnome.org/Projects/Orca).

Another way to replace visual information is through the use of tactile computer interfaces, and for this, there is a class of devices called “braille displays” that can convert text displayed on the screen into braille, by an array of braille cells, each one formed by a combination of six dots (sometimes 8 dots) that can toggle in low or high relief to provide a tactile surface for finger reading. However this solution, like screen readers, is also inefficient to display images from a graphical software, and this interface is very expensive, ranging from US$3,500 to US$15,000 according to American Foundation for the Blind (http://www.afb.org).

It's remarkable that, in spite of the problems above mentioned, there is yet another issue regarding the way of inputting musical data in a computer. Music is notated mainly using symbols and drawings and the principal device to input data in a computer is the keyboard, which was developed for inputting text and only text, not graphics, images or drawings.

An alternative to overcome these problems is to modify the traditional music notation paradigm and, rather than representing music with drawings, use text to do this task. There is a growing community of developers related to free software that are investing a great amount of effort in this concept of using plain text for music notation, being Lilypond (http://www.lilypond.org/) one of the major projects. Lilypond uses a syntax similar to Latex (http://www.latex-project.org/) but to represent music.

This paper shows a research on the use of a new interface to make it easier to input braille music notation into a computer. This interface was created by the main author of this work and it is applied here to write music as text by a visually impaired person in a faster and easier way, when compared to traditional music notation softwares that are controlled through the mouse and the keyboard.

This is a work in progress, a prototype subject to further developments and implementations that are discussed in this theoretical paper.

2. The interface: Braille handles

This experience used two handles made of PVC pipes (40mm in diameter and 120mm in length) with three pushbuttons in each one.

Pushbuttons were connected independently to a breadboard using network 4-pair wires, each one with one terminal grounded and another connected through a 10k pull-up resistor to +5v and also directly to a digital input of an Arduino board, using then six digital inputs.No extra electronic components where used, only 6 groups of pushbuttons with the same schematic showed in the figure (Fig. 2), schematics for the Arduino board can be found in the link https://goo.gl/2X0FD8.

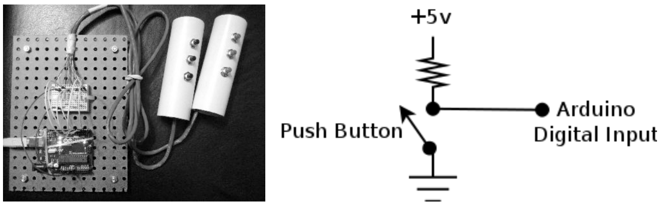

Fig. 2. The “Braille handle” device and pushbutton connection.

Arduino detects the pushbuttons states and convert them in to a 6 bits number, in fact a so called “bitmask” where each bit represent the state of a certain pushbutton; this number ranges from 0 up to 63 and is sent to the serial port of the Arduino board. The computer reads the detected bitmask through a USB port and processes it using an algorithm written as PHP script that takes care of making the conversion between that bitmask to the alphanumeric characters and/or some symbols.

Later on, characters can be interpreted following different grammars for different tasks. For instance, they can be interpreted as regular braille characters, as dedicated structures to accomplish rules of braille music notation or even as characters that can be treated with a specific grammar, which was actually the present case. It was used here a grammar of a language called Mustaq (www.mustaq.org). This language is dedicated to represent music as text, taking advantage of stenographic notation.

3. Discussion

It was possible to input text and music with the proposed solution but many problems were faced and thus some future developments, modifications, tweaks and tests are still needed, as much as further suggested improvements discussed here. Bellow are an itemized discussion on each separated items to make it easier to individually emphasize some relevant points of this prototype.

<u>Handle diameter</u>: it was used a PVC pipe measuring 40mm in diameter; increasing and decreasing this number may lead to a more comfortable device.

<u>Handle material:</u> for the sake of affordability and simplicity, not mentioning resistance and durability at a very light weight, PVC was the option of choice. It is easy to mould, perforate and cut, besides being also washable.

<u>Handle shape:</u> PVC pipes are cylindrical (with parallel walls), maybe it would be useful to try other more ergonomic shapes, something like a pistol grip.

<u>Pushbutton type:</u> the pushbuttons used in this implementation were a bit little, causing the need of more finger pressure to operate them then if they were larger.

<u>Input alternatives:</u> there are still many other alternatives to get gestures from the musician as an input. It could be used a hall effect sensor as related by [Manzolli 1993] in his doctoral thesis. It is also possible to use a webcam to capture musician gestural like the one related by [Fornari 2012]. But pushbuttons give more tactile and pleasant feedback. Voice commands could also be further employed.

<u>Number of pushbuttons:</u> maybe another good improvement to this proposed hardware could be to enlarge the amount of pushbuttons, maybe one or two more for

each thumb or little finger, which could be used as a shift key like SHIFT, ALT, ALTGR and CONTROL keys commonly present in regular keyboards.

Feedback: two free and open source softwares were used to bring audible feedback. The first one was Audacity (http://audacityteam.org/) for recording and editing a wave file containing speech of musical terms. Then Sox (sox.sourceforge.net), to play those pieces of recorded audio, Sox can produce musical notes in many different timbres like sine wave, plucked instruments, etc, providing sound as tones and speech.

4. Conclusions

In this paper we presented a research on the use of a physical interface to input texts into computers. In this approach the focus was on speeding up music notation using a direct way to write 6-dot braille cells.

One of the main advantages of this proposed hardware is the fact that it doesn't interfere with screen readers, once it is a dedicated hardware. All inputs are beforehand filtered with a dedicated software that can interpret incoming information in different ways and translate them before the screen reader takes control. Braille cells have different meanings according to the context where they are used. A same cell can be a letter “D” or a number “4” or maybe a musical note (C as a quarter note), just to mention some ambiguity, but there many more specially for representing music.

The use of two separated handles provided freedom for hands, arms and shoulders. The musician has all the keys under the fingers, making writing easier.

Some softwares such a*s Braille Fácil* (http://intervox.nce.ufrj.br/brfacil/) or Delius (http://sourceforge.net/projects/delius/) that use a computer keyboard to input braille texts reported hardware conflicts or no operation depending on the brand of the keyboard. These softwares try to use a regular keyboard to represent each dot of a braille cell with a key, thus sometimes keys must be pressed together and they are not recognized correctly. The hardware proposed here has zero conflicts once Arduino runs smoothly on Windows, Mac and Linux operating systems.

Whilst in this experiment the syntax was very specific for music, this interface can be used to directly introduce braille text or braille music in a very cheap way.

Further and detailed informations on the building of this hardware can be found at http://www.nandopenteado.com/posts/braille-handles/

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