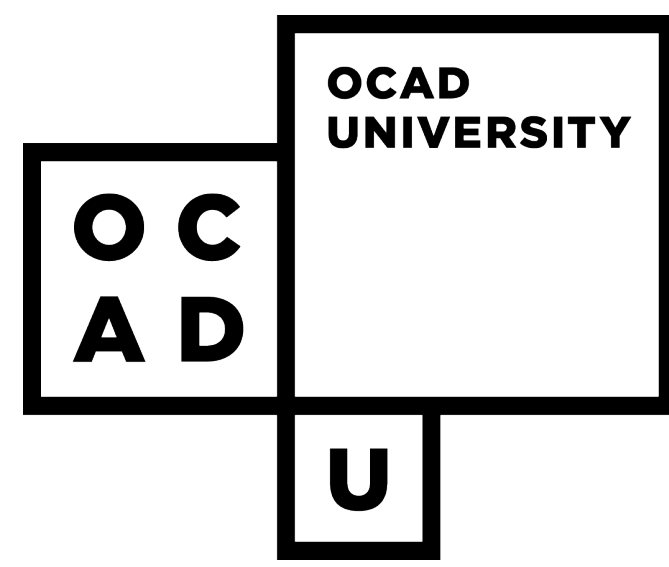


Haptic pattern representation using music technologies

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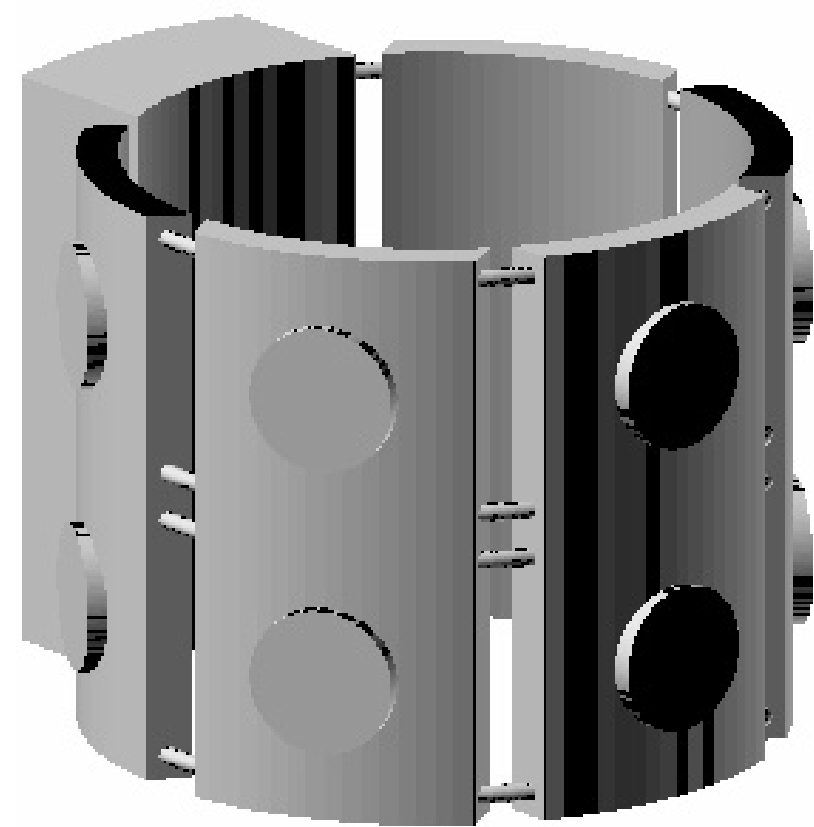
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WE are developing a wrist-wearable, quasi-musical device with vibrotactile arrays, which integrates with a transmedia gaming app on an accompanying smartphone. The main purpose of the wrist device is to register hand gestures and provide clues and notifications for the game player. The vibrotactile arrays also provide pleasant sensual stimulation. We propose that standard musical notation is an appropriate way to program activation patterns for these arrays in a standardized way.

What is the problem?

- How to author interesting and functional vibrating patterns for devices with low resolution *vibrotactile* arrays
- How to align these patterns with the configuration of the device



Vibrotactile band with a 2x5 vibe motor array.

Why do this?

- Notification and stimulation from such bands could enrich trans-media narratives and gaming experiences
- Touch, vibration and rhythm are important sensual modalities
- Authoring rhythmic patterns using music notation is efficient and has a long history

Results

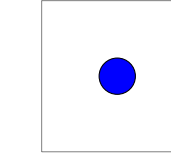
- Standard music notation is typically two-dimensional: x-axis handles time, y-axis is pitch (and z-axis is unused)
- Physical adjacencies of musical instruments are usually not represented in their notation, therefore, authoring for 2D arrays is not straightforward. Multiplication of parts and staves seems the simplest [naive] approach
- Standard music notation provides a nuanced, graphical representation for rhythmic events, which is hugely useful for our purposes.

Acknowledgements

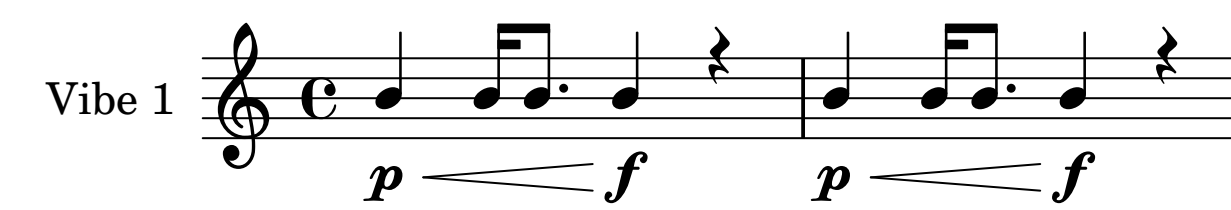
This work has been supported by the International Science and Technology Partnerships Canada Inc (ISTP) on the project *Multi-platform Game Distribution System for Popular and Experimental Technologies* (MGDS-PET) and by grants from the National Sciences and Engineering Research Council of Canada (NSERC). We would also like to thank Xenophile Media Inc., Vicki Clough, Shin-you Hou, Tegan Power, Ryan Maksymic and Takis Zourntos for their help in the development of this project.



Device with no spatial dimension (0D = point)



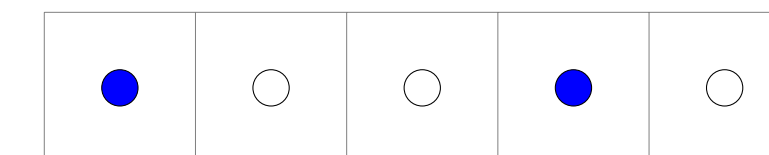
Device with a single vibe motor



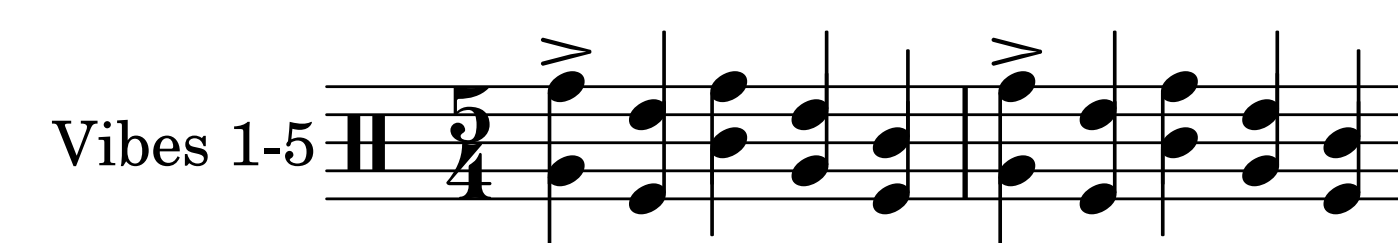
Score for single vibe motor playing a simple 'solo' rhythm

- Time = horizontal axis; rhythmic information as per standard musical notation
- For most vibe motors pitch remains constant, but intensity can vary; Intensity specified by dynamics markings
- Vertical position does not vary (y-axis unused, therefore unpitched notation would also be suitable)
- Information is not very dense (single line score would suffice)
- **NEXT STEP** notate for multiple vibe motors

Device with one spatial dimension (1D = linear) Vertical note position maps to five components



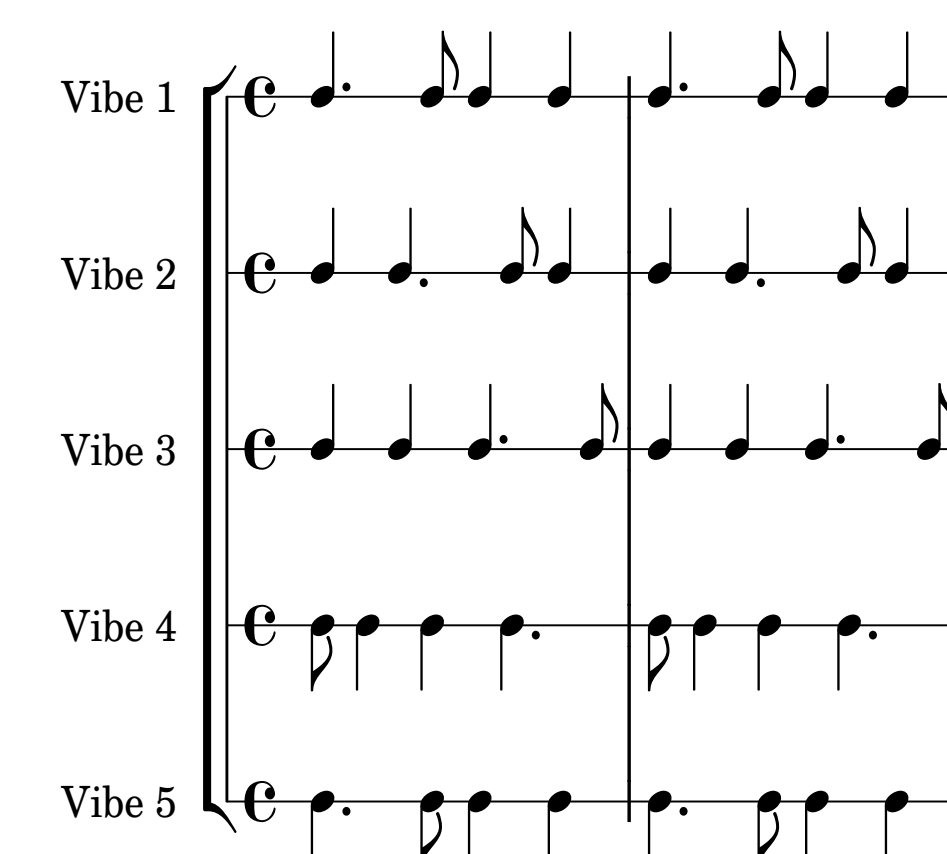
Device with a line of vibe motors.



Score for a linear array of five vibe motors

- Specifies activations for five, independent vibe motors
- Each part occupies one staff line (rests are hidden); for unpitched components yet uses five staff lines
- Vertical staff position specifies vibe motor to activate; top line=1, second line=2, etc; MIDI note \Rightarrow vibe motor
- **PROBLEM** Five unpitched parts on one staff are hard to read, especially if rhythms are complex
- **NEXT STEP** Make notation less dense and more readable

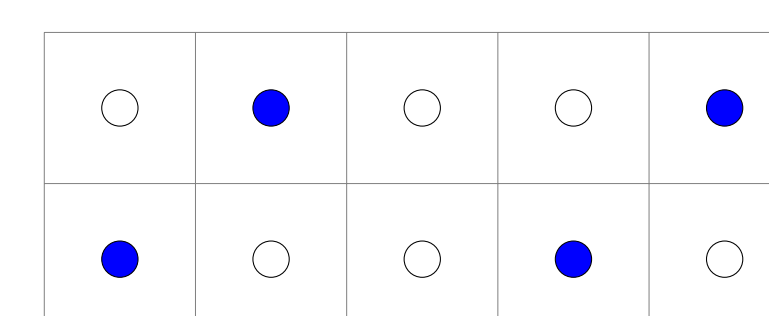
Part numbering maps to five components



Score for a linear array of five vibe motors

- Specifies activations for five, independent components
- Five part single-line staff, rhythmic notation
- MIDI number derived from part number; this maps to vibe motor address
- **NEXT STEP** Make notation suitable for two dimensional arrays of vibe motors

Device with two spatial dimension (2D = planar)



Device with an array of vibe motors



Score where each staff represents one COLUMN of vibe motors



Score where each staff represents one ROW of vibe motors

- Time = horizontal, x-axis
- Ten components need independent addressability
- Either five staves (for columns) or two staves (for rows)