Predictable and distinguishable morphing of vibrotactile rhythm

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oliverschneider.ca/macaronmix
haptic experience
design
design ecosystem

Schneider, O., MacLean, K., Swindells, C., Booth, K. *Haptic experience design: what hapticians do and where they need help.* IJHCS 2017.
design ecosystem

have

sophisticated hardware
insightful psychology

bottleneck: content creation

must connect to

applications:
diversity in hardware, users, needs

Schneider, O., MacLean, K., Swindells, C., Booth, K. Haptic experience design: what hapticians do and where they need help. IJHCS 2017.
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design ecosystem

Manipulate
morphing
Morphing in Periodic Tactile Signals.
EuroHaptics 2009.

Triangle

25% Morph

50% Morph

75% Morph

Square
we use vibrotactile sensations as our test case
Algorithms

parent 1

simple crossfade

morph

parent 2
simple crossfade
simple crossfade
simple crossfade
simple crossfade
Algorithms

- **parent 1**
  - simple crossfade
  - morph
  - dynamic-time warping

- **parent 2**
feature-based morphing
dynamic time warping
dynamic time warping
dynamic time warping

Select your mixing algorithm:
Dynamic Time Warping

Quick Mix:
0% 25% 50% 75% 100%

load waveform 1
Wave 1
load waveform 2
Wave 2

100%

0%

parent 1

child

parent 2
dynamic time warping

Select your mixing algorithm:
Dynamic Time Warping

Quick Mix:
0% 25% 50% 75% 100%

load waveform 1
Wave 1
100%

load waveform 2
Wave 2
0%

parent 1
child
parent 2

Amplitude
Criteria

1. Predictable

*Morphs must have some perceptual resemblance to both parents.*

2. Distinguishable

*Morphs must be perceptually distinguishable from both parents.*
Random Noise
Two Pulses

Three Pulses

Random Noise
Study 1: Predictability
multidimensional scaling
N=12

study 1 results

Crossfade

Two pulse

Three pulse

Dynamic Time Warping

Random noise

Two pulse

Random noise

Three pulse

N=12
Study 2: Distinguishability
study 2 setup

just-noticeable difference
staircase procedure:
two-up, one-down
study 2 results

staircase procedure
N=9
staircase procedure
N=9

study 2 results
study 2 results

Increasing Task Difficulty

staircase procedure
N=9

mix percentage

participant ID
overall results

Cross-fading is not predictable $\rightarrow$ tends towards random noise.

DTW is predictable $\rightarrow$ parent properties are preserved.

DTW is distinguishable $\rightarrow$ behaves sensibly when parents are distinguishable.
so...what about our example?
MacaronMix

Select your mixing algorithm:
Dynamic Time Warping

Quick Mix:
0% 25% 50% 75% 100%

Load waveform 1:
Wave 1
100%

Load waveform 2:
Wave 2
0%

Wave 1 Result Wave 2

Amplitude

0 200 400 600 800 1000 1200 1400 1600 1800 2000

hapticdesign.github.io/macaronmix/
Summary

We present a platform for haptic morphing:

- a new algorithm for vibrotactile morphing based on dynamic time warping
- a blueprint for studying perceptual morphs with criteria and experiments
- an extendable, online tool to create morphs and develop new algorithms
design ecosystem
Current work

**modalities:**
- tactile actuators
- motion profiles
- force feedback
- shape/texture

**applications:**
- animation
- customization
- design tools
- research
thanks!
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