

pitch-shifter

Grame

name	pitch-shifter
version	1.0
author	Grame
license	BSD
copyright	(c)GRAME 2006

1 Equations of process

This program calls a *process*, which mathematical description follows.

1. Input signal : $x(t)$

2. Output signal :

$$\begin{aligned} y(t) = & (1 - s_3(t)) \cdot ((s_4(t) - s_5(t)) \cdot x(t - \text{int}(\text{int}(1 + s_5(t)) \wedge 65535)) \\ & + x(t - \text{int}(s_5(t) \wedge 65535)) \cdot (0 - r_1(t) + p_3(t) - s_5(t))) \\ & + s_3(t) \cdot ((r_1(t) - s_1(t)) \cdot x(t - \text{int}(\text{int}(s_2(t)) \wedge 65535)) \\ & + (s_2(t) - r_1(t)) \cdot x(t - \text{int}(s_1(t) \wedge 65535))) \end{aligned}$$

3. User interface elements :

(a) user sliders :

$$\begin{aligned} \text{"shift (semitones)" : } & u_{s1}(t) \in [-12, 12] & (\text{default value} = 0) \\ \text{"window (samples)" : } & u_{s2}(t) \in [50, 10000] & (\text{default value} = 1000) \\ \text{"xfade (samples)" : } & u_{s3}(t) \in [1, 10000] & (\text{default value} = 10) \end{aligned}$$

4. Parameter signals :

$$\begin{aligned} p_1(t) &= 1 + u_{s2}(t) - 2^{0.0833333 \cdot u_{s1}(t)} \\ p_2(t) &= \frac{1}{u_{s3}(t)} \\ p_3(t) &= u_{s2}(t) - 1 \end{aligned}$$

5. Internal signals :

$$\begin{aligned}
 s_1(t) &= \text{int}(r_1(t)) \\
 s_2(t) &= 1 + s_1(t) \\
 s_3(t) &= \min(p_2(t) \cdot r_1(t), 1) \\
 s_4(t) &= u_{s2}(t) + r_1(t) \\
 s_5(t) &= \text{int}(s_4(t))
 \end{aligned}$$

$$r_1(t) = r_1(t-1) + p_1(t) \pmod{u_{s2}(t)}$$

Listing 1: process

```

1 declare name      "pitch shifter";
2 declare version   "1.0";
3 declare author    "Grame";
4 declare license   "BSD";
5 declare copyright "(c)GRAME 2006";
6
7 //
8 // very simple real time pitch shifter
9 //
10
11 import("music.lib");
12
13 transpose(w, x, s, sig) =
14     fdelay1s(d, sig)*fmin(d/x,1) + fdelay1s(d+w,sig)*(1-fmin(d/x,1))
15     with {
16         i = 1 pow(2, s/12);
17         d = i : (+ : +(w) : fmod(.,w)) ~ -;
18     };
19
20 pitchshifter = vgroup("Pitch Shifter", transpose(
21                                     hslider("window (samples)", 1000, 50, 10000, 1),
22                                     hslider("xfade (samples)", 10, 1, 10000, 1),
23                                     hslider("shift (semitones)", 0, 12, +12, 0.1)
24                                     )
25 );
26
27
28 process = pitchshifter ;

```

Notes :

- $\forall s(t) \in \mathbb{S}, s(t < 0) = 0$.
- $\forall x \in \mathbb{R}$,

$$\text{int}(x) = \begin{cases} \lfloor x \rfloor & \text{if } x > 0 \\ \lceil x \rceil & \text{if } x < 0 \\ 0 & \text{if } x = 0 \end{cases} .$$

- The middle dot operator "·" denotes multiplication in formulas.
- Warning: symbolic names eventually used inside bloc-diagrams have NO direct relation with signal names used in formulas (" $x(t)$ ", " $y(t)$ ", ...).
- Signals naming conventions:
 - * $p_i(t)$ denote parameter signals (running at "block rate"),
 - * $r_i(t)$ denote recursive signals (delayed as $r_i(t-d)$),
 - * $s_i(t)$ denote stored signals (running at sampling rate),
 - * $x(t)$ denotes an input signal,
 - * $y(t)$ denotes an output signal,
 - * $u_{si}(t)$ denote user interface signals of sliders.

Documentation generated with Faust 0.9.9.6doc2 on 2009/11/09.
<http://faust.grame.fr>