Autowah: a dynamic audio filter on a TMS320VC5510 DSK

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With the WAH effect a musician can change the timber of the sound moving a pedal. The AUTOWAH can properly filter the signal, with no human action. An envelope filter figures the frequency to enhance it and send it to a bandpass. It enhances the right frequencies at the right time. *It's a simple smart filter.*

The envelope filter is a rectifier and an RC lowpass. It is designed in continuous time and than digitalized: so that only one parameter has to be set, $RC = 0.3$, instead of two. RC set filter's delay. Here is the difference equation:

$$y_n = b \cdot |x_n| + b \cdot |x_{n-1}| - a \cdot y_{n-1} \tag{1}$$

where

$$b = \frac{T}{2 \cdot RC + T} \qquad a = \frac{2 \cdot RC - T}{2 \cdot RC + T}. \tag{2}$$

NB: a and b are found with Tustin's algorithm.

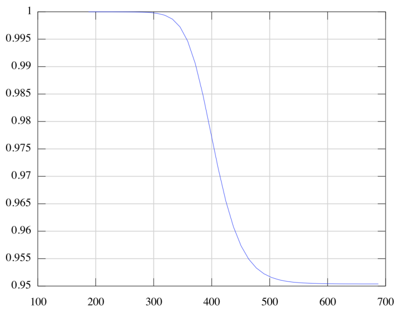
For the bandpass, a simple II^o IIR filter centered in Ω_0 is used. Here is the difference equation:

$$y_n = A^2 \cdot x_n - A^2 \cdot x_{n-2} + 2A \cdot c \cdot y_{n-1} - A^2 \cdot y_{n-2} \tag{3}$$

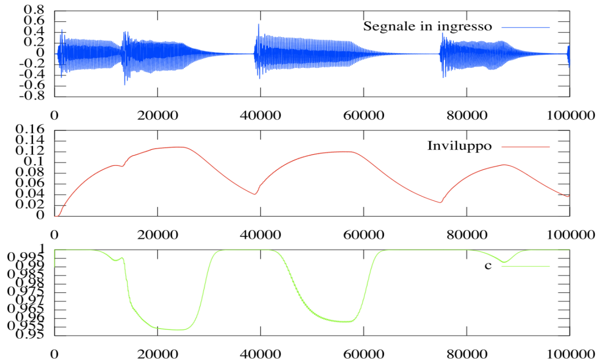
where $A = 0.9$. The parameter that connects the units of the filter is

$$c = cos(\Omega_0) = cos(2\pi \cdot \frac{f_0}{f_s}) \tag{4}$$

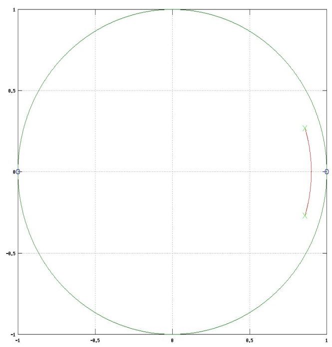
where f_s is the sample rate and f_0 a $tanh$-shaped function of the envelope. As the DSP is good for multiplying and accumulating, it is better to give to it pre-computed values in array instead of having the $tanh$ calculated by the DSP. A 39-long array is used.



Look-up table: c versus *envelope*



Example of *input*, *envelope* and c versus *sample*



Poles of the bandpass while c decreasing

While I was debugging my code I needed to use the LUT periodically just to try its output values with no input: I left this part in the main code because it sounded good. Several distortions came out too, so I included a strong preamplifier in the end of my work. These effects together make a nice bass synth.

A variable $corr$ is used to correct the output volume and is updated through the program when different effects are switched on.

The header $CONTROLLI.H$ contains four parameters that can be changed through a watch window and three bool variables, connected to de DSK switches.

Also read $main.c$, $lut.h$ and $filtro.h$ for more details and explanations.

The whole work has been done on the TMS320VC5510 DSK board using Code Composer Studio 3.1 in IPL2, Image Processing Lab, DI^3 (former DEEI), University of Triest.