Calcium Signal Analyser Vamp plugin documentation

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1 Description

The Calcium Signal Analyser is a Vamp plugin for the detection and characterization of transients in noisy signals. It is adapted for the analysis of calcium signals measured using confocal microscopy.

2 Copyright

The Vamp architecture is a feature extraction system developed at Queen Mary University of London (see more information at: http://www.vamp-plugins.org/).

3 About this release

This is release 2.

4 License

5 Pre-requisites

Several host applications (i.e. applications from which the plugin can be launched) exist for Vamp plugins such as Sonic Visualiser [1] [2], or Audacity [3]. One of them should be installed before installing the plugin. The batch tool Sonic Annotator [4] can also run Vamp plugin[1].

In the following, Sonic Visualiser will be used as a host application to describe the plugin's functioning.

6 Installation

To install the plugin on a Win32 system (Windows XP, Vista), copy the files:

vamp-calcium-signal-analyser.dll
vamp-calcium-signal-analyser.cat (optional)
vamp-calcium-signal-analyser.n3 (optional)

into the folder "C:\Program Files\Vamp Plugins\" (if the directory does not already exists, then create it).

To install the plugin on a Apple OS/X operating system, compatible with both PPC and Intel hardware, copy the files:

vamp-calcium-signal-analyser.dylib
vamp-calcium-signal-analyser.cat (optional)
vamp-calcium-signal-analyser.n3 (optional)

to either:

/Library/Audio/Plug-Ins/Vamp/ (for the plugin to be available to all users), or
$HOME/Library/Audio/Plug-Ins/Vamp/ (for the plugin to be available to you only).

7 Parameters

The Calcium Signal Analyser plugin has the following input parameters:
- the peak-picking sensitivity S which can vary in the range 0 - 100 % by steps of 1%;
- the peak-picking offset threshold (δ) which can vary in the range 0 - 1 by steps of

[1] However, the current version of Sonic Annotator is not adapted to process files sampled at very low sample rate such as 3 Hz. Indeed, the data is processed with blocks of 16384 samples by default (whereas a typical calcium signal only contain 1000 samples).

0.05;
- the duration (D) of the median filtering window which can vary in the range 2 - 100 s by steps of 0.1 s.

If the sensitivity S is too low, some peaks can be missed, but the number of false positives (non-relevant detected peaks) is reduced. Hence, low values of the sensitivity S will lead to a higher precision (measure of exactness), but a lower recall (measure of completeness). Conversely, high values of the sensitivity S will lead to a lower precision, but a higher recall.

The effect of the offset threshold (δ) is opposite to that of the sensitivity S. If δ is too low, the number of false negatives (relevant peaks not detected) will be reduced, but the number of false positives will be increased. Hence, low values of δ will lead to lower precision but higher recall, and high values of δ will lead to higher precision, but lower recall.

The duration D of the window should be longer than the transients' durations not to create additional peaks within the transients during the median filtering process, but not too long to smooth the noise efficiently.

8 Outputs

The Calcium Signal Analyser plugin has the following output parameters:
- the smoothed detection function (SDF), i.e. the detection function after signal conditioning and adaptive thresholding / Type: two-dimensional vector (the first dimension corresponds to the time labels and the second dimension to the data values);
- the peak times (PT), i.e. the time positions in seconds of the peaks / Type: one-dimensional vector;
- the peak onsets (PO), i.e. the start times in seconds of the peaks / Type: one-dimensional vector;
- the peak frequency (PF), i.e. the frequency of the peaks in Hz / Type: one-dimensional value;
- the mean interpeak interval ($MIPI$), i.e. the mean time interval in seconds between peaks / Type: one-dimensional value.

9 Use of the plugin with Sonic Visualiser

9.1 Load a file

In order to load an audio file in Sonic Visualiser, go to the File menu, and then click on Import Audio File. Then, select the WAV file to analyse.

9.2 Feature extraction using a transform

In oder to process the loaded file, go to the Transform menu, then choose e.g., Analysis by Plugin Name, select the Calcium Signal Analyser plugin, select one of the five outputs (smoothed detection function, peak times, peak onsets, peak frequency, mean interpeak interval). In order to obtain several outputs, the same process has to be repeated.

9.3 Optional manual corrections

The editing tools of Sonic Visualiser allows us to modify the outputs (layers) manually: e.g., remove or add a new peak time. In order to see the values associated to a given layer, go to the Layer menu, and then Edit Layer Data. Peaks which are manually added appear with the label 'New Point' in the peak times Layer Data. Note that the manual modifications performed on the peak times do not induce a recalculation of the peak frequency and mean interpeak interval parameters. If manual corrections are performed, these parameters would need to be recomputed in a post-processing stage.

9.4 Exportation of the results

Once the peak detection is performed, the results can be exported (e.g., in a CSV text file) for further analyses. For this purpose, go to the File menu, and then Export Annotation Layer.

10 Sonification

Sonic Visualiser can provide an auditory feedback of the peaks localized by the plugin. Other types of sonification can be made by post-processing the data. Some sound examples are provided at the address given in reference [5].

11 Credits and references

The Calcium Signal Analyser Vamp plugin has been developed within a Queen Mary University of London Bridging the Gap project between the School of Biological and Chemical Sciences (Dr Rachel Ashworth) and the School of Electronic Engineering and Computer Science (Dr Katy Noland, Dr William Marsh, Dr Mathieu Barthet). It is based on previous works made at QMUL's Centre for Digital Music by Christian Landone, Chris Duxbury and Juan Pablo Bello.

References

[1] C. Cannam, C. Landone, and M. Sandler. Sonic Visualiser: An open source application for viewing, analysing, and annotating music audio files. In *Pro-*

ceedings of the ACM Multimedia 2010 International Conference, pages 1467–1468, Firenze, Italy, October 2010.

[2] Queen Mary University of London. Sonic Visualiser. `http://www.sonicvisualiser.org/`.

[3] Audacity. `http://audacity.sourceforge.net/`.

[4] Queen Mary University of London. Sonic Annotator. `http://omras2.org/SonicAnnotator`.

[5] M. Barthet and K. Noland. Calcium Signal Analyser: Sound examples. `http://isophonics.net/content/calcium-signal-analyser`.