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| **Author contact** | your email mina.mounir@esat.kuleuven.be<br>your phone number *+ 32 (0) 16-327848* |
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# Note Onset Detection based on a Spectral Sparsity measure applied to Strings Instruments

Mina Mounir and Toon van Waterschoot
Department of Electrical Engineering (ESAT), KULeuven, Belgium,
{mina.mounir,toon.vanwaterschoot}@esat.kuleuven.be

***Abstract*— Being the atomic component for a melody's time dimension, the detection of note onsets is gaining a growing interest in the arising research fields music information retrieval (MIR), machine listening and music processing. We propose a new note onset detection algorithm NINOS$^2$ exploiting the spectral sparsity difference between different parts of a musical note. Added to the outstanding performance of NINOS$^2$ when applied to automatically annotated guitar melodies and chords progression [1], the proposed algorithm consistently outperforms the state-of-the-art LogSpecFlux (LSF) for the sustained-strings group of instruments crossing the 50% F1-score border. We also propose an additional performance measure to assess the relative position of detected onsets w.r.t. each other.**

## I. METHOD SUMMARY

In this article, we present NINOS$^2$, an algorithm that proposes a new pre-processing and reduction function steps for calculating a smooth Onset Detection Function (ODF) – a highly subsampled version of the original music signal having distinguishable amplitude peaks at time instants where onsets appear [2] – making it easier for the peak picking step to identify the onsets.

For the pre-processing, the subset of low-energy frequency coefficients – traditionally filtered out as they were considered as noise to the detection process – is selected for the ODF calculation. Moreover, NINOS$^2$ exploits the difference in spectral sparsity between the transient and the following steady-state component of a musical note when calculating the ODF noted ℵ(i):

$$\aleph(i) = \frac{1}{\sqrt[4]{J}} \frac{\|Y_i\|_2^2}{\|Y_i\|_4}. \qquad (1)$$

where $Y$ is the pre-processed frequency magnitude spectrum, $i$ is the frame index and $J$ is the count of selected coefficients. It is an energy and inverse-sparsity measure as onsets are usually accompanied by an energy increase and they mark the start of transients which are spectrally less sparse than the steady-state part of a note.

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## II. EXPERIMENTAL RESULTS

We ran the experiment on a variety of strings instruments: guitar, violin, viola, cello, …etc. The dataset is generated and automatically annotated as described in [1]. Table I and Fig.1 show a snippet from the result. In Fig.1, onsets ground-truth are marked with vertical squares, true positives are marked with circles while false positives with x marks.

TABLE I. PERFORMANCE COMPARISON (BEST-F1 SCORE)

| *Instruments group* | *NINOS$^2$* | *LSF* |
|---|---|---|
| Plucked Strings | 0.9861 | 0.9828 |
| Sustained Strings | 0.5724 | 0.4878 |

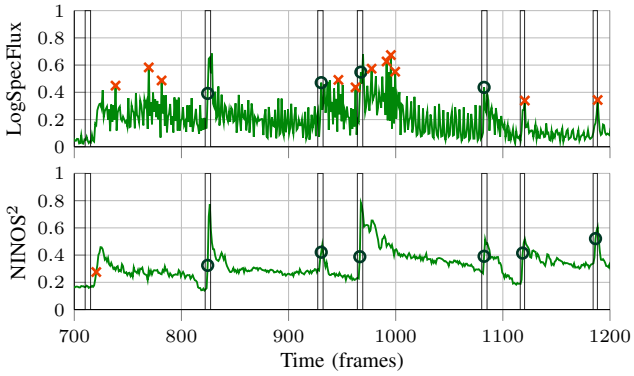


Figure 1. Comparison of ODF's and Detections for a *Cello*.

## REFERENCES

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