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Note Onset Detection using Sparse Over-Complete Representation of Musical Signals

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Abstract *Music is the language of the universe*, as it is used and performed by many people. The scientific and technical challenge of making machines understand music is known as music information retrieval or more recently semantic audio. A particular challenge addressed in the present work is to achieve machine understanding of one specific property of this language, namely *note onsets*. These are time instants that represent transients in a musical signal, i.e., when a musical note is played in a melody. Note onset detection is a special case of the more general problem of acoustic event detection. Machine understanding of note onsets is crucial for many applications such as automatic music transcription, adaptive audio effects and audio information retrieval. The proposed method for note onset detection is based on a *sparse over-complete representation of musical signals*. In this representation a musical signal segment is projected onto an over-complete dictionary that consists of two classes of atoms: steady-state and transient atoms. By imposing sparsity in the signal representation, note onsets are highlighted by segments requiring a relatively high number of transient atoms. A complete testing platform has been developed to be able to analyze preliminary results and investigate the accuracy and efficiency of the proposed method. The testing platform allows to model the musical signal synthetically, to mix different notes from different instruments to be used in the analysis and to apply the projection and detection algorithms on the test signal. All of those tasks are made generic to be able to compare many implementations of the method. The results stemming from the analysis of simple cases are promising and are giving high detection probability with low false-alarm probability. We have also identified important simulation parameters and their optimal ranges have been studied. Finally, we also suggest some ideas for future work.

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