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A Hierarchical Stratagem for Classification of String Instrument

Arijit Ghosal, St. Thomas' College of Engineering & Technology, Kolkata, India
Suchibrota Dutta, Royal Thimphu College, Thimphu, Bhutan
Debanjan Banerjee, Sarva Siksha Mission, Kolkata, India

ABSTRACT

Automatic recognition of instrument types from an audio signal is a challenging and a promising research topic. It is challenging as there has been work performed in this domain and because of its applications in the music industry. Different broad categories of instruments like strings, woodwinds, etc., have already been identified. Very few works have been done for the sub-categorization of different categories of instruments. Mel Frequency Cepstral Coefficients (MFCC) is a frequently used acoustic feature. In this work, a hierarchical scheme is proposed to classify string instruments without using MFCC-based features. Chroma reflects the strength of notes in a Western 12-note scale. Chroma-based features are able to differentiate from the different broad categories of string instruments in the first level. The identity of an instrument can be traced through the sound envelope produced by a note which bears a certain pitch. Pitch-based features have been considered to further sub-classify string instruments in the second level. To classify, a neural network, k-NN, Naïve Bayes' and Support Vector Machine have been used.

KEYWORDS

Chroma, Classification, Co-Occurrence Matrix, Instrument Classification, Note, Pitch

INTRODUCTION

In India several kinds of string type instruments are being employed since ancient times. This work takes care of complexity of classification of string instruments. To develop applications related to music and instrument classification, audio indexing, audio retrieval a good quality audio classification is essential. In recent past some advancement in the field of audio retrieval, audio classification is observed because of improvement of research in area of data mining as well as signal processing.

The oldest identified instrument classification system was identified as Chinese in the time period of the 4th century B.C. The system has discriminated different instrumental devices based on materials they are created. Aftermath, researchers are trying to propose fine instrument discrimination system. They have suggested several models but unfortunately none of those is accepted worldwide as a standard benchmark to fulfill the requirements of different applications. Hence, classification of instrument is an open research area. Researchers have successfully classified instruments into string, woodwind, percussion, keyboard, etc., but less work has been done for sub-classification of instruments. In this work, string instruments have been sub-classified without using Mel Frequency Cepstral Coefficients (MFCC) which is a first-rate aural feature but excessively used. A hierarchical approach is adopted here to classify string instruments. Initially string instruments are categorized into

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plucking, bowing and striking followed by further sub classification of plucking, bowing and striking type string instruments. The work is organized in the following way: previous works done related to classification of instruments is described in after introduction section. Proposed scheme is described in next section. The next section reflects investigational outcomes along with comparative analysis.

ASSOCIATED RESEARCH ACTIVITIES

Canvassers have paid efforts on several aural traits to discriminate instruments. Haralick (1992) has suggested a method for extraction of statistical features in the meadow of processing of images. These statistical features are very useful and they may be utilized in other domains too. Most of these works have used MFCC. A spectral trait for musical gadget categorization has been used by Agostini et al. (2003). Centroid bandwidth, pitch, skewness as well as zero crossing rates have been used by them. Peeters (2003) has proposed his own algorithm named IRMFSP for large database of musical database. Spectral features were also been explored by some researchers like Zhu et al. (2004). They have used spectrum of instruments. Their work was limited to jazz, pop and rock instrumentals only. Kaminskyj and Czaszejko (2005) have been able to classify mono type musical instrumental sounds with the help of 6 traits - cepstral coefficients, constant Q transform frequency spectrum, multidimensional scaling analysis trajectories, RMS amplitude envelope, spectral centroid and vibrato. Algorithms for automatically categorization of musical instrumental sounds have been proposed by Benetos, Kotti and Kotropoulos (2006). Hierarchical scheme was ventured by Essid et al. (2006). Support Vector Machine or SVM has been used there. They have used spectral features like MPEG-7 audio features, cepstral traits for example Mel Frequency Cepstral Coefficients or MFCC, temporal traits like autocorrelation coefficients and ZCR, wavelet traits, perceptual traits for example sharpness and loudness.

Hidden Markov Model (HMM) has been employed by Sinith and Rajeev (2007) while dealing with classical music of South India. Instruments are divided into wide-ranging types for example brass, string, percussion and woodwind by applying MPEG-7 audio features, perceptual features and Mel Frequency Cepstral Coefficients by Deng (2008). Gunasekaran and Revathy (2008) have worked with fusion of multiple classifiers. They have worked with temporal, perceptual, spectral, statistical and harmonic features. A 37-dimensional feature set based on MFCC as well as perception-based features has been used by Senan et al. (2009) while working with Malay musical instruments. Western and Chinese musical instruments were classified into 3 wide-ranging groups – percussion, wind as well as string using SVM based approach by Liu and Xie (2010). Kumari et al. (2010) have worked with musical instruments of North India for example: flute, dholak, sitar, mandar and bhapang. They have used a combination of MFCC and spectral features to design their feature set. Polyphonic instrumental signals were dealt with Barbedo and Tzanetakis (2010, 2011).

Wavelet and MFCC based hierarchical scheme were suggested by Ghosal et al. (2011) to categorize instrumental devices in wide-ranging groups like String, Woodwind, Percussion and Keyboard. But they have not explored further sub-classification of instruments. Grindlay and Ellis (2011) have dealt with music having polyphonic in nature. Müller and Ewert (2011) have employed Chroma Toolbox of Matlab. Impact of selection of traits and classifiers on classification accuracy has been observed by Chandwadkar and Sutaone (2012) aiming to recognition of musical instrumental devices. Chandwadkar and Sutaone have applied an amalgamation of spectral traits and Mel Frequency Cepstral Coefficients in their feature set. Nadgir and Joshi (2014) have worked with spectral, temporal and MFCC based features. Gaikwad et al. (2014) has applied Principal Component Analysis (PCA) on the combination of spectral traits and cepstrum features to classify Indian classical instruments. To design spectral traits the authors have used spectral range and amplitude together with MFCC. Probabilistic Latent Component Analysis (PLCA) has been used by Arora and Behera (2014) to recognize instruments. Dandawate et al. (2015) have classified Indian instrumental music-based Raga like Bhairavi, Bhairav, Yamanand Todi Raga. They designed their feature set using temporal features. Abeber and Weib