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MUSICAL INSTRUMENT IDENTIFICATION AND STATUS FINDING WITH MFCC

Miss. Karishma Vichare[1], Prof. S. R. Gulhane[2]

[1]Student of Master of engineering (VLSI & Embedded system), Dr. D. Y. Patil College of Engineering, Ambi.
[2]Professor (Electronics and telecommunication dept.), Dr. D. Y. Patil College of Engineering, Ambi.

Abstract — *Identification of the musical instrument from a music piece is one of the popular areas of interest in recent years. In this paper, we present an idea to identify musical instruments from monophonic audio signals by extracting MFCC features. In this work different classifiers are used that are K-Nearest Neighbors (K-NN) and Support Vector Machine (SVM) used to identify the musical instrument name by using feature vector generated in feature extraction process and compare the results from these classifiers in order to check accuracy. We also work on finding the status of musical instrument whether it is playing correct or faulty by observing pitches of sound signals.*

Keywords- *Musical Instrument identification; Music signal; Monophonic; feature extraction; classifiers;*

I. INTRODUCTION

Musical instrument identification is one of the most important aspects in the area of Music Information Retrieval (MIR). The musical instrument identification by machine becomes the area of interest recently as most of the music is available in digital format. The music can be available in various textures like monophonic, polyphonic, homophonic, biphonic, etc. The monophonic texture includes sound of only one musical instrument. The proposed work deals with the identification of musical instrument from a monophonic audio sample where only one instrument is played at a time. Sounds produced by same musical instrument have similar features. This music related features are extracted from sound samples by using different feature extraction methods. There are many methods to extract characteristics or features from audio samples. In our work we are using MFCC feature extraction method. The audio features extracted from sound samples by using same feature extraction method are compared with each other on the basis of some algorithm called as classifier, to find similar sounds. In our system we are working with two different classifiers namely K-Nearest Neighbor (KNN) and Support Vector Machine (SVM) to identify musical instrument.

The purpose of proposed work is to achieve three objectives: (a) to identify musical instrument by extracting MFCC from sound sample, (b) to analyze which classifier can give better identification results and (c) to find out status of identified instrument (whether it is faulty or not). The system for identification of musical instrument from monophonic audio recording is basically performs three tasks: i) Pre-processing of inputted music signal; ii) Feature extraction from the music signal; iii) Recognition.

II. SYSTEM OVERVIEW

Analysis of music data and retrieval has become one of the very popular research fields in recent years. The proposed system of musical instrument identification works with two phases, (i) training phase and (ii) testing phase as shown in figure 1. In training phase, known sound samples are given as input to system. All features are extracted from these samples by using one of the feature extraction methods and placed in a matrix or vector format called as features vector. One classifier is trained by using given features vector for further classification process. In testing phase an unknown sound sample is given as an input to system and related features of music signal are extracted by using same feature extraction method which is used in training phase. These features are then compared with the reference features obtained in training phase and the new signal is then classified by using same classifier. The purpose of our proposed work to find out better classifier, percentage accuracies will be calculated by making all possible combinations of feature extraction methods and classifiers. In first step, the musical instrument sound sample is taken as an input to a system. The database is maintained which contains all different sound samples per musical instruments. Input sample is compared with reference samples to find out the type of instrument.

Many supervised and unsupervised learning techniques have been reported for instrument recognition and retrieval. Two types of learning techniques are Supervised and Unsupervised. Supervised learning technique is provided with a set of examples called the training set. In this target outputs are available and important work is to get the output as close as target output. In unsupervised learning, outputs are finding out in response to inputs only. There are no target outputs available. In proposed system, we are using supervised learning technique.

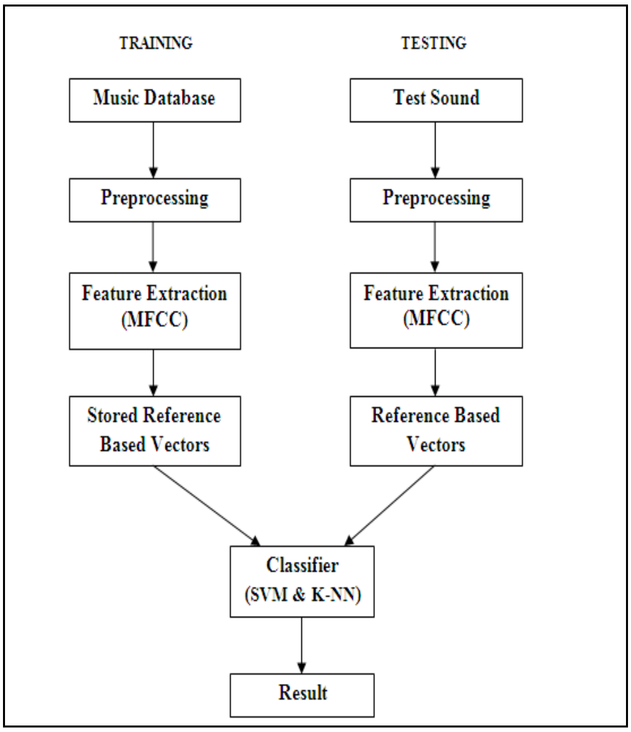

Figure 1. General block diagram of proposed Musical Instrument Recognition system.

In preprocessing step, it contains two steps of reading sounds and noise removal. Noise removal is used o increase the strength of signal and also to increase accuracy of recognition. Pre-processing is used so as to increase the efficiency of subsequent feature extraction and classification stages and hence it can improve the overall retrieval performance. After pre-processing, main part of the project will be done. For different musical instruments different features will be extracted which will be selected after detailed study. In this step, our work deals with MFCC feature extraction method. Basic aim of feature extraction is to reduce the amount of data and to extract the meaningful information from the audio signal for a particular retrieval task. The amount of raw data would be too big for direct processing. When the input data to any classifier is too large that is having much data, but not much information then the input data will be transformed into a reduced set of features referred as features vector. The set of extracted audio descriptors is then used to generate a feature are used to identify the musical instrument. Further in third step, recognition is done with the help of classifiers.

III. SYSTEM DESIGN METHODOLOGY

The proposed work deals with the identification of musical instrument from a monophonic audio sample by using MFCC feature extraction method, two different classifiers and database system. We have given the details of different techniques used in this project work.

A. MEL-FREQUENCY CEPSTRAL COEFFICIENTS (MFCC)

MFCC is one of the most important as well as standard feature among all feature set. MFCCs are a way of representing the spectral information in a sound. Each coefficient has a value for each frame of the sound. MFCC is now being widely used in speech research and speaker identification systems. Figure 2 presents the block diagram for extracting MFCC features. In the sound identification system, the Mel-scale frequency is similar to the perceived frequency, and is the most commonly used simple frequency scale transformation equation, as described below. Let Mel be the Mel frequency and f be the actual frequency.

$$\mathrm{Mel} = 2595 \times \log\left(1 + \frac{f}{700}\right)$$

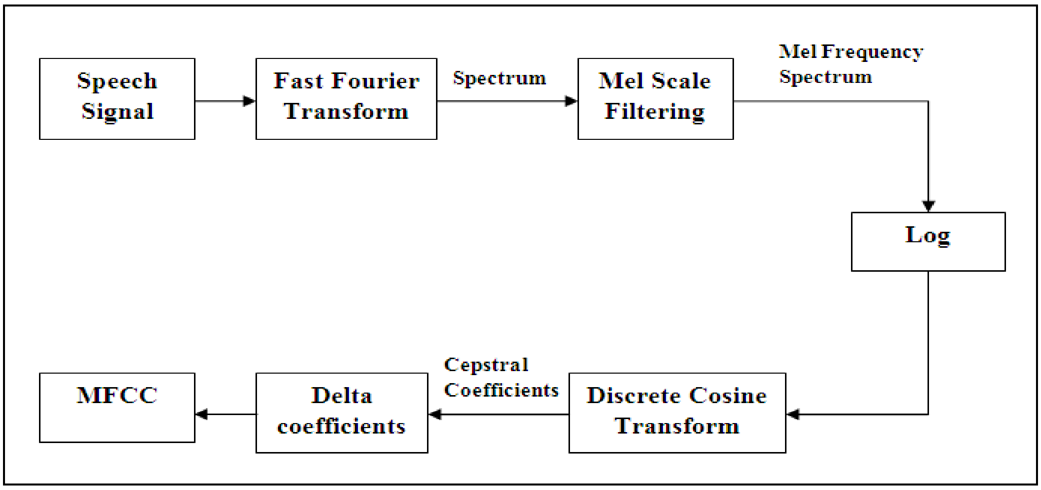

Figure2. Block diagram for extracting MFCC features

B. Database

Database is an organized collection of information organized in such a way that a program can quickly select pieces of data. In our work we have to make a database of audio samples for different musical instruments like piano, sitar, guitar, tabla, etc. Database will be maintained with sound samples of initially twenty musical instruments. In this work we are using in-house database so that we can record any number of data for each instrument. All audio samples are the wave files with same duration and properties. From these samples each are used for training and some samples are used for testing purpose.

C. Support Vector Machine (SVM)

SVM Support Vector Machine i.e. SVMs work on principle of based on some previous training through inputs, using supervised learning techniques to classify data. SVM has been tested for hand writing, face recognition in general pattern classification and regression based applications. Even though having complex hierarchy and design SVM provide good results. The biggest advantage of SVM is easy to train and scale complex high dimensional data as compared to neural networks.

D. K-Nearest Neighbor Algorithm

The K-nearest neighbor algorithm is based on the idea of 'clustering things of the same nature'. In other words, objects of the same category should be closer in distance. It is a type of instance based learning technique and predicts the class of a new test data based on the closest training examples in the feature space. The KNN algorithm is among the simplest of all machine learning algorithms. Figure shows the working process of K-NN algorithm.

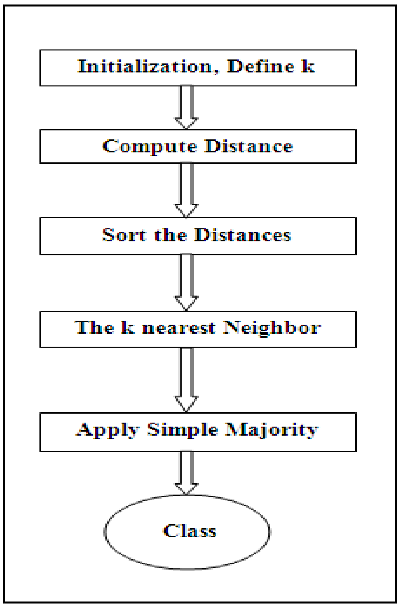

Figure 3. Working process of K-NN algorithm

IV. RESULTS

We have use MFCC for feature extraction and following figures showing some results on input sound signal in the process of converting it into Mel frequency spectrum. Figure 4 shows the input signal waveform which is in the form of sound. Figure 5 shows the effect of pre-emphasis that is nothing but noise removal on input sound signal.

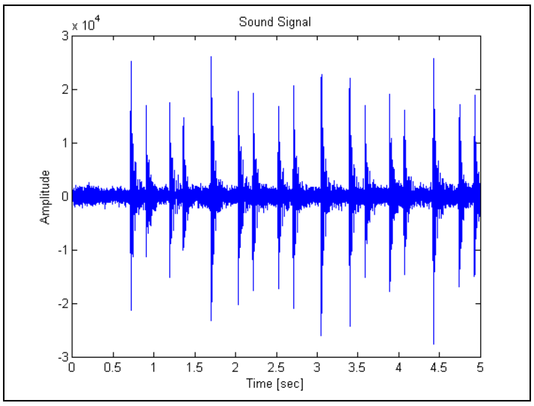

Figure 4. Input sound signal

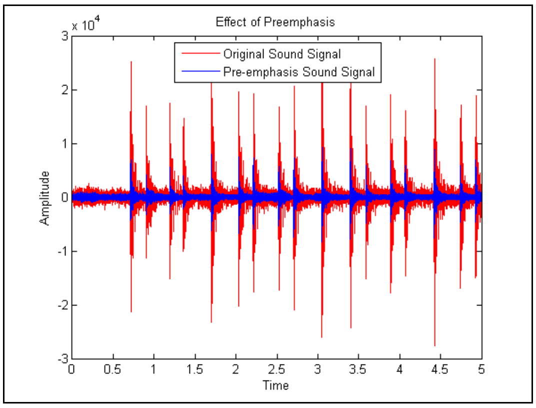

Figure 5. Effect of Pre-emphasis filtering

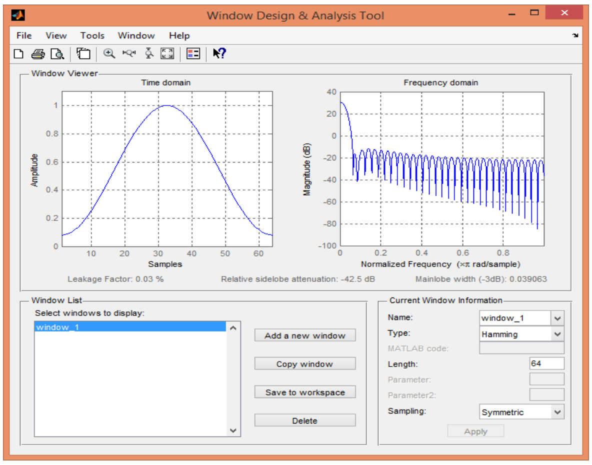

Figure 6. Hamming window

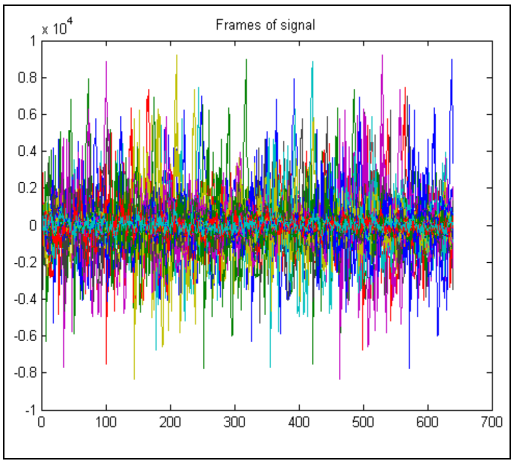

Figure 7. Different frames of signal

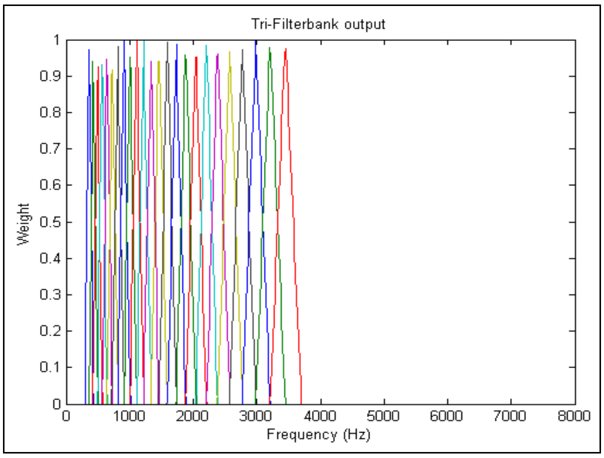

Figure 8. Tri-filterbank signal

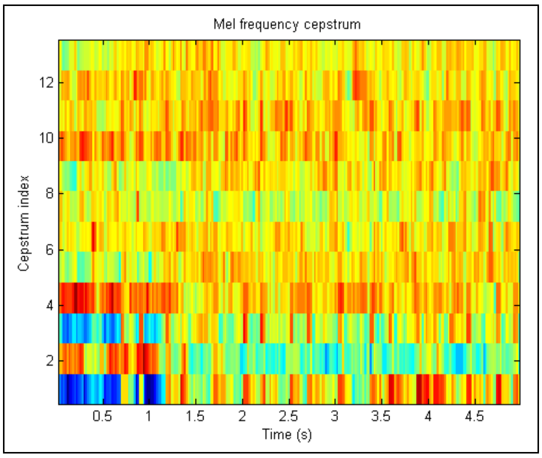

Figure 9. Mel frequency spectrum

Figure 6 shows hamming window with 64 samples. Window processing of sound frame lowers the additional high frequency signals on both sides of the sound frame to highlight major signals at the center of the frame. To better observe sound signal characteristics, we collect a certain number of sampling points of signals for observation. It is referred as framing. Frames are overlapped in the proportion of ½. Figure 7 shows different frames of signal that is the effect of framing. Figure 8 shows tri-filter bank signal. It reduces the frequency scale. Triangular filter bank consist of a number of triangular band pass filters. Discrete cosine transform is used to transform frequency to time domain signal. It results in Mel Frequency Cepstrum as shown in figure 9.

V. CONCLUSION

The proposed system deals with recognition of musical instruments from monophonic audios. The music related features are extracted from audio samples by MFCC feature extraction method. Two different classifiers namely K-Nearest Neighbors (K-NN) and Support Vector Machine (SVM) are used to identify musical instrument from a sound sample. The studies of using MFCC, K-NN and SVM in our system have done by using some references. Database for minimum 20 instruments have done for instrument recognition in initial stage. Overall experiments and results shows that MFCC gives better performance with SVM classifier as compared to K-NN classifiers. The proposed system gives better accuracy in identification of musical instrument and status finding. The future work of this proposed system is to use more audio features, such as PLP or Wavelet Transform and to make instrument recognition for polyphonic music.

VI. REFERENCES

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