# Study of Audio Descriptors for Specific Musical Instrument Identification in North Indian Classical Music

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**Abstract:** *Music is an art form, social or cultural activity whose medium is sound and silence. The common elements of music are pitch (which governs melody and harmony), rhythm (and its associated concepts tempo, meter, and articulation), dynamics (loudness and softness), and the sonic qualities of timbre and texture (which are sometimes termed the "color" of a musical sound). Music is performed with a vast range of instruments. Various instruments like tabla, harmonium, flute or violin are used in north Indian classical music. Researches have been made in recent past to identify type of musical instruments and singer voice. In this paper we have studied audio descriptors for musical instruments that appears to human ears as similar with respect to Timber.*

**Keywords:** Timbre, Audio Descriptors, MPEG 7 standards, Music Information Retrieval (MIR), MFCC, North Indian Classical Music, Musical Instruments, Flute.

## 1. Introduction

Specific musical instrument identification is one of the most rarely researched applications of Music Information Retrieval (MIR) research. In past few decades, Singer Identification [4], Gender identification of Singer [5], Speaker recognition [6], Music Melody Extraction, Music database indexing are the some of the application areas of MIR research. For this kind of applications the basic requirement is to extract the necessary useful information for the piece of an audio file and manipulate or to represent that information in some useful way. Researchers have used these features in different ways.

There are various ways to classify musical instruments using timbre [7]. These methods use typical aspects of a musical instrument such as the way in which instrument is used, its physical properties, the means by which music or sound is produced by the instrument, the frequency production range of the instrument etc. There are several aspects such as cultural background, geographical places and religious rituals that decide the usage of an instrument. The instruments are classified in Indian music are classified based on the material used and the property of resonance applied on the design of an instrument. The typical classification of musical instrument in Indian music is into classes of wind instruments (Flute), string instruments (violin, sitar), brass instruments (Trumpet, Cuba, Saxophone), percussions (Tabla, Mridungam) and resonating supplementary instruments (Tanpura, Ghatam).


**Figure 1:** General Indian Musical Instruments

In this research, we propose to identify specific musical instrument based on the classification of musical instruments from the sound generated through them. For example ten flutes are played, and then we should identify the specific number of flutes among all the flutes played. We are considering Monophonic music for this research.

Audio Descriptors are characteristic features or special attributes of the audio segment under consideration. Each sound possesses unique audio attributes. These attributes are necessary for analysis of the sound. The attributes that are represented by these audio descriptors uniquely defines the sound. There are approximately fifty-two main audio descriptors that have been classified into different taxonomies [8].

With the advancements in the computational capabilities of MatLab, there are various parallel developments in the supportive toolboxes that speed up the research, [2], [3], [4] to name a few. These toolboxes possess strong functions to correctly separate musical information and process it for further applications. Mainly, the research in this field is categorized into voice and instruments.

In this paper, we propose to use a backward approach of recognizing the audio descriptors present in an audio recording that are responsible in deciding the specific instrument, instead of directly generating output of classification of the instrument.

## 2. The Existing System

Any sound is characterized by an entity called as Timbre. In music, timbre also known as tone color or tone quality from psychoacoustics, is the quality of a musical note, sound, or tone that distinguishes different types of sound production, such as voices and musical instruments, string instruments, wind instruments, and percussion instruments. The physical characteristics of sound that determine the perception of timbre include spectrum and envelope [1]. Timbre is multi-

dimensional, fuzzy, undefined, unit less attribute of sound that uniquely identifies it. The typical examples of timbre names are "Soft, Loud, Low, High, Rough, Smooth" etc. Let it be a musical instrument or a singing voice, timbre plays very important role in categorizing the sounds.

In this research, we have considered North Indian Classical Music instrument"s (Flute) solo performances. For a monophonic (that includes single melodic line) instrument identification problem, the voice separation is easier. While for North Indian Classical Music which is Homophonic (single melody line accompanied by background instruments such as Tanpura/Harmonium that is played continuously as the melody progresses) the separation of voice from the background voice is challenging task. The output sound is a mixture of all sounds generated together giving a feeling of harmonious sound which is difficult to segregate into parts or layers. Similar to singing voice there exist timbre for different musical instruments. The North Indian Classical music considers, for example, Flute, Violin, Harmonium, Sarod, Sitar, Santoor, Shehnai, as leading Classical Instruments that are separately played as performing art on stage. These instruments are used in similar way a singer sings a classical raga. From instrument identification perspective a lot of research has been made towards identification of instrument in an orchestra recording, or simple instrument identification by identification of its timbre [9]. The usual categorization or classification of the instruments is done into Flute, Clarinet, Violin, Trumpet etc. or the classification is into woodwind instruments, string instruments, bow instruments etc. Very negligible research has been made into identification of which flute? Which violin? Which trumpet? If, for example, we have five Flutes available, do we have the capability in our system that uniquely identifies the instrument units (physically separate items) into Flute 1, Flute 2, and Flute 3 etc.? Researches, often announce usage of singing voice as a kind of musical instrument by saying that human voice: the most natural of all musical instruments that is most widely used. But on the other side there is less research and applications to detect separate „Unit" (body) of instrument rather than just type of musical instrument. The musical instruments are also characterized by their timbers. The flute sounding husky and used for raga containing minor notes of music are definitely different than the flue sounding divine for raga containing major notes. In this research we have used flute"s performances from North Indian Classical Music. It is to be mentioned here that the classical performances of the musical instruments playing North Indian classical Music are very similar to the performances of classical singers of this kind of music. A classical singer uses Tanpura/harmonium as an accompanying instrument and sings initially long notes contained in the raga. Then, after completion of almost all the notes described by the raga, that prolonged and sung sufficiently, the rhythm starts slowly and then gradually the speed of the rhythm and singing and the rate of change of musical note sung per unit of time increases accordingly. Similar performance is observed with classical performances of musical instruments such as Violin or Flute.

## 3. Proposed Approach or Algorithm

In approach, we propose to have two databases each containing 50 files with .wav format recordings each of 5 sec duration, 16 bit PCM with 11,025Hz sampling frequency. DB1 contains 5 different flute instrument (different units) recordings with 10 samples of each. DB2 contains 5 different 5 different flute (different units) recordings with 10 samples of each. The arrangement of dataset done this way has many purposes to be served. First, the system shall be tested on audio that contains mixture of musical instruments. Second, the performance, importance and role of Timbral audio descriptors [10] can be verified and tested. Then, the comparison of performance of statistical classifiers can be done on the basis of inputs. Also, we wish to confuse the recognition system with respect to, whether it is a Flute or Violin. By this way in DB1 or in DB2, if we have total 10 Flutes and if Flute 7 is recognized as Flute 7 for example, then that means a Flute unit of number 7 has been correctly identified as Flute number 7. Thus by this arrangement of audio input this makes the same system to work as an instrument classifier.

In order to study the audio descriptive aspect of this above stated system a hybrid selection algorithm [11] is applied only on the audio descriptors, described under the taxonomy of timber. As per MPEG standard there are more than 50 audio descriptors and can be classified according to variety of taxonomy depending upon the point of view [8]. In musical instrument identification research [12] taxonomy of audio descriptors is followed that includes following audio descriptors under the title of Timbre in MIRtoolbox. The audio descriptors are: attack time, attack slope, Zero crossing rate, Roll off, brightness, roughness, MFCC (Mel frequency Cepstral Coefficient) and Irregularity. The attack time and slop are not useful for harmonic sound samples hence are neglected giving total 6 audio descriptors including MFCC.

## 4. Conclusion

Specific Musical Instrument identification system can be implemented using hybrid selection algorithm for the selection of audio descriptors, as explained in MIRTOOL box. Two classifiers can be used to identify the contributing audio descriptors and then to test the identification accuracy.

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