Musical Instrument Identification Using SVM , MLP& AdaBoost with Formal Concept Analysis.

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***Abstract*— Musical instruments are consist of wide variety of domain so manual classification of these instruments is difficult and challenging task. To make the process of classifying musical instrument easy and less dependent on human supervision given system is designed. There are some algorithm are available for classification tsk from which we uses SVM, MLP and AdaBoost for better result. This system mainly designed for automatic classification of musical instrument using SVM, MLP and AdaBoost classifiers. Formal Concept Analysis technique is also applied to show relationship between musical instruments and their attributes. This system is evaluated with SVM, MLP and AdaBoost classifiers which show that AdaBoost gives better result than SVM and MLP.**

Keywords—Support Vector Machine (SVM); Multi Layer Perceptron(MLP); AdaBoost; Formal Concept Analysis (FCA)

I. INTRODUCTION

Musical instrument classification is very important task for musical information retrieval system. As a domain of musical instrument is becomes very wide. Musical instruments have different characteristics including their physical aspects. The task of classifying musical instruments is very complex and many problems remain unsolved. For instance, few attempts have been made on a musical content which involve more than one musical instrument playing at a time. The human ability to distinguish between musical instruments from large data has been a subject of investigation for a number of years [1][10].

Automatic musical instrument recognition is a crucial subtask to solving problems in structured coding, automatic musical signal annotation, and musicians' tools and also provide useful information in other sound source recognition areas, such as speaker recognition [4][3].

A grouping of several different but related sizes or types of instruments forms the family of musical instruments. Hornbostel-Sachs musical instrument classification system, are based on a hierarchy of instrument families and family relationships are not always clear-cut. A brass instrument is a musical instrument which produces sound by of air in a tubular resonator in sympathy with the vibration of the player's lips. There are several factors involved in producing different pitches on a brass instruments. Slides, valves or keys are used to change vibratory length of tubing, string instruments or chordophones are musical instruments that produce sound from vibrating strings when the performer plays or sounds the strings in some manner. Aerophones are a family of instruments that use a vibrating column of air to produce sound [4].

Classification of musical instruments has many problems due to Multidimensional nature of musical instruments i.e. one instrument can belong to more than one instrument family. [2].

This system is designed to solve the problems in musical instrument classification by using the Support Vector Machine, Multi-Layer Perceptron and AdaBoost classifiers. Formal Concept Analysis is applied to represent the relationship between intends and extends where intend shows the musical instruments and extend shows the attributes of musical instruments [13][6].

For Music Information Retrieval by using supervised approach for instrument identification, AdaBoost algorithm is often used by researchers because it is the most famous boosting algorithm

This system has divided into three parts I) Creation of dataset II) Classification of musical instrument i) Using SVM ii) Using MLP iii) Using AdaBoost III) Analysis of result.

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As we know classification of musical instruments is challenging task, so the proposed system is designed to make it easier by using classifiers. First the input is given to the system which is audio file then it processed for extracting the output which is name of musical instrument. Ihen it uses the SVM, MLP and AdaBoost classifier. Each classifier is trained and tested for best result.

In support vector machine, first the classes of musical instruments is created, each class contains the musical instrument with their attributes. Each class is seperated by maximizing the margin between classes. SVM is trained for the musical instruments and tested across the dataset [20]. In case of MLP it is trained the given input from dataset after training mlp first propagate the input through all neural network and return the output ,bias function is use for necessity. Activation is occurs for neuron for given input and then returns the output. Here the activation function is sigmoid (tanh) is used. AdaBoost is used to improve the performance of system which have more accuracy.

II. RECENT CONTRIBUTION

In this section we includes some of the recent contribution in the area of Musical Instrument Classification.. Many researchers use the different classifiers to solve the problems in musical instrument classification algorithms for the development of suitable intrusion detection system. So here we are discussing some of them which is based on neural network concepts.

Sefki Kolozali, Mathieu Barthet, Gyorgy Fazekas, Mark Sandler et.al. presents preliminary work on ontology designing for musical instruments. This paper also provides the investigation of heterogeneity and limitations in existing instrument classification schemes. In this paper author implemented two instrument taxonomies based on H-S system in OWL[5].

James Bergstra, Norman Casagrande et.al. present an algorithm that predicts musical genre and artist from an audio waveform in Aggregate Features and AdaBoost for Music Classification. They uses the ensemble learner AdaBoost to select from a set of audio features that have been extracted from segmented audio and then aggregated which proved to be the most e□ective method for genre classification at the recent MIREX 2005 international contests in music information extraction, and the second-best method for recognizing artists[6].

Slim ESSID, Gael RICHARD and Bertrand DAVID have proposed study on the use of hierarchical taxonomies for musical instrument recognition on solo recordings. Both a natural taxonomy (inspired by instrument families) and a taxonomy inferred automatically by means of hierarchical clustering are used to build a hierarchical classification scheme based on Support Vector Machine classifiers and an efficient selection of features from a wide set of candidate descriptors. The classification results of each taxonomy are compared and analyzed [7].

Keith D. Martin and Youngmoo E. Kim present musical instrument identification: A pattern-recognition approach. In this paper they applied statistical pattern-recognition technique to the classification of musical instrument tones within a taxonomic hierarchy. They uses data set which included examples from the string , woodwind, and brass families. Their experiments simulating results shows that fisher projection method resulted in successful classifiers at all levels of the taxonomy [8].

III. ALGORITHM STUDY

Interest in musical instrument classification is increased in few years. In this domain number of different algorithms and techniques are used. From these of some tehniques we used some algorithms and techniques for this system development. These are as follows :

A. Multi Layer Perceptron

MLP that is used for classification of musical instruments, consist of two input neurons in first layer and hidden layer consist of six neurons with one output neuron. MLP uses with batched back proposition algorithm [12].

B. Support Vector Machine

SVM is strong classification algorithm due to the simple in structure and it requires less number of features. Support vector machine is supervised learning technique for classification and regression. SVM currently considered the most efficient family of algorithm in domain of machine learning .Support vector machine is trained with dataset of musical instrument. During the training of SVM feature extractor unit converts each input value to feature set and these feature sets capture basic information about each input. And these sets are used for classify the feature unit[11][9].

C. AdaBoost

AdaBoost is an ensemble method which constructs a classifier in an iterative fashion. This classifier was originally

designed for binary classification, and by using several different strategies it was extended to multi- class classification. In this system we use the AdaBoost classifier [10].

IV. METHODOLOGY

Automatic music classification is an area of research that have been received a great deal of attention in now a days because it is very difficult for human and computers to categories the music. There are very rarely, precise, clear and consistent heuristics in delineating the musical qualities and characteristics of each category. It is very difficult to defining and implementing measurement of musical similarity.

It is important to build computer systems to classify instruments because many of the internet search sites, for example AltaVista, Lycos, are evolving from purely textual indexing to multimedia indexing. It is estimated that there are approximately thirty million multimedia files on the internet with no effective method for searching their audio content.

The aim of this is to classify the musical instruments automatically. The given system is designed around the classifiers namely Support Vector Machine, Multi Layer Perceptron and AdaBoost and result is evaluated for each classifiers. The goal of system is as follow:

i) Musical instrument classification.
ii) Analysis of system using SVM, MLP and AdaBoost classifiers.

System design is shown in fig. 1 which contain the input, dataset formulation, formal concept analysis, application of classifiers, result analysis for each classifier

A. *Input Unit*

Input which given to the system is the audio file. first audio file is submitted to the system to identify the musical instrument i.e. output of system.

B. *Dataset formulation*

Dataset formulation unit designed to perform the task to check the input and store it into dataset with their appropriate attributes. This unit is designed to choose correct class label for a given data input. For example if input given to the system is 'piano' then it store it with attributes 'Vibrating string' and 'Sound initiation process: Struck'[1]. Dataset contained the value records of musical instruments with their attributes.

C. *Selection of Classifier*

Then the classifier is selected for the training. Training is performed using the dataset which contains the musical instruments with their attributes. System process the audio file and returns the returns the appropriate name of musicl instrument using java MIDI library. Selected classifier is trained from the dataset. classifiers extracted the features from the dataset which includes the instruments and their attributes. In case of MLP it creates the neural network. For the SVM, model of SVM is created from the LibSVM. Required parameter are selected to create the SVM. It uses the RBF kernel with three degree.

TABLE I

RELATIONSHIP BETWEEN INSTRUMENTS AND SET OF ATTRIBUTES

JavaScript Framework	Vibrating string	Sound initiation process: Bowed	Sound initiation process: Struck
Cello	1	1	-
Piano	1	-	1
Violin	1	1	-

D. *application of classifiers*

Upon the dataset formulation classifiers are applied. Each classifier is trained and tested across this dataset.

E. *Classification output*

Output of the system is the name of musical instruments for the audio file. Classification output shows the classification result of each classifier which is used to find out best classifier that improves the system performance. Classification output is in the form of correctly classified instances out of total instances, which gives the accuracy of system and incorrectly classified instances which shows error of system.

After finding the classification output for all three classifier analysis is across their result.

Figure 1. shows the flow of execution of developed system in which we give the input to the system i.e. audio file which is processed by system and returns the name of musical instrument as output. Dataset is created by system automatically. One of the classifier is selected from three

classifier and they are trained and tested separately. These classifier returns the correctly classified instances and incorrectly classified instances which decides the accuracy ad error of classifiers. Each classifier shows the correct result for given input audio file and returns the name of musical instrument as output.

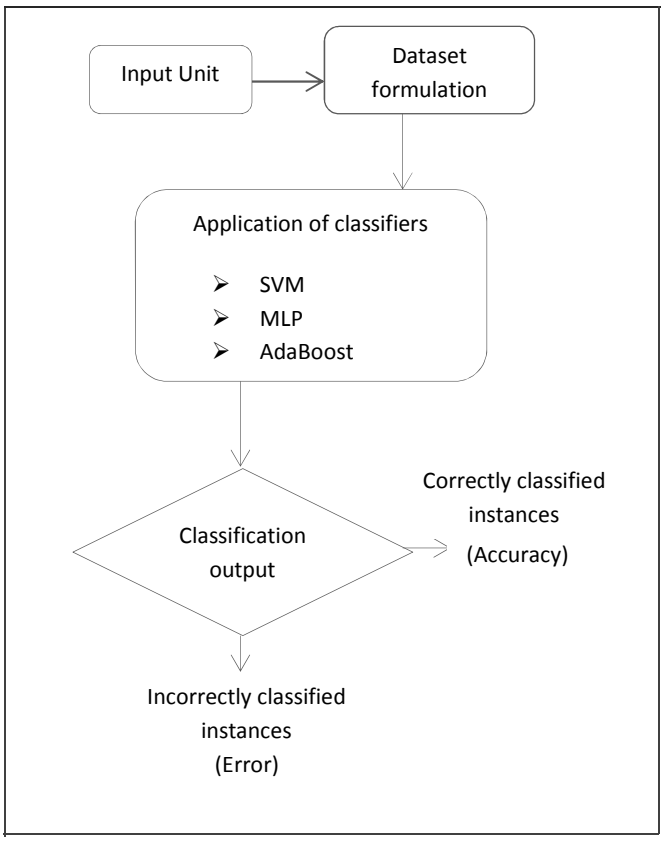

Fig. 1 System Overview

V. EXPERIMENTAL RESULTS

Experiment is performed by using three classifiers. SVM, MLP and AdaBoost classifiers are trained and tested with these dataset. The experimental result is calculated for each classifier on dataset.

We did the experiment by using training and testing phase of classifier on dataset . We got the results in terms of precision, recall, accuracy, error. Accuracy defines the correctly classified instances .Table II shows the experimental result on dataset .

$$Accuracy = \frac{Correctly\ classified\ instances}{total\ instances}$$

Error is calculated in terms of incorrectly classified instances out of total instances.

$$Error = \frac{Incorrectly\ classified\ instances}{total\ instances}$$

TABLE III
EXPERIMENTAL RESULTS ON DATASET

Classifier	Accuracy	Error	Precision	Recall
MLP	57.55%	42.45%	0.45	0.57
SVM	86.05%	13.95%	0.81	0.89
AdaBoost	90.12%	9.88%	0.94	0.95

Fig. 2 presents the graphical representation of result that is evaluated for classifiers. From this figure we can compare the result. It is observed that AdaBoost is better classifier for musical instrument classification. AdaBoost is more accurate than other two classifiers.

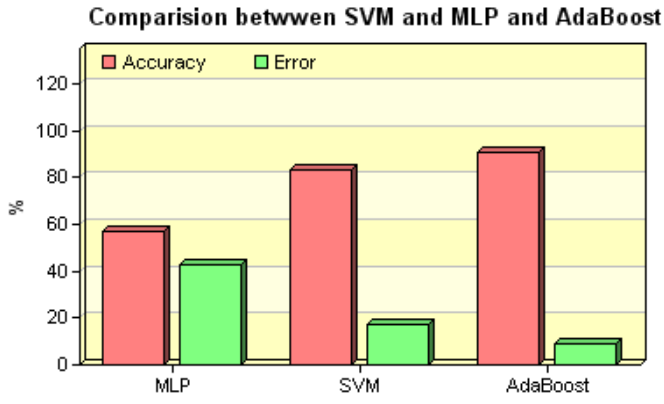

Fig. 2 Evaluation of classification result

Now we can say than AdaBoost is better for classification task because of its more accuracy and less error.

VI. CONCLUSION

We are designed and implemented musical instrument classification to overcome the problem in existing classification technique using three classification techniques. First classification is based on multi layer perceptron ,second classification is based upon support vector machine and third classification is based on AdaBoost classifier. By observing the experimental results we found that AdaBoost classification gives more accuracy and less error rate than other classsifier.

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