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Classification of Musical Instruments Sound Using Pre-Trained Model with Machine Learning Techniques

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Abstract **- Classify the musical instruments by machine is a challenging task. Musical data classification becomes very popular in research field. A huge manual process required to classify the musical instrument. This proposed system classifies the musical instruments using GoogleNet which is a pretrained network model; SVM and kNN are the two techniques which is used to classify the features. In this paper, to simply musical instruments classifications based on its features which are extracted from various instruments using recent algorithms. The performance of kNN with SVM compares in this proposed work. The musical instruments are identified and its accuracy is computed with the classifiers SVM and kNN, using the SVM with GoogleNet 99% achieve as a high accuracy rate in classifying the musical instruments. In this system sixteen musical instruments used to find the accuracy using SVM and kNN.**

Keywords: **GoogleNet, Feature Extraction, k-Nearest Neighborhood (kNN), Musical Instrument Classification (MIC), Support Vector Machine (SVM)**

I. INTRODUCTION

Musical instrument essentially converts energy supplied by the player into sound waves with characteristics that to a large extent are controllable by the player. The basic characteristics of the tones produced are pitch, loudness, duration and timbre. One of the basic functions of the musical instruments is to produce tones of the desired pitch. Depending on the type of vibrator, most of the musical instruments can be classified under three categories. In wind instruments the vibrator is an air column, as in flute. String instruments, such as the violin, use the vibrations of strings. In percussion instruments, the vibrator is a rod, as in chimes or a surface like the membrane of a drumhead. This classification is based essentially on the sections of a symphony orchestra, and certainly does not cover all instruments. Depending on other specifics, musical instruments are classified into sub categories. A wind instrument can be classified as a reed instrument or brass instrument [1]. Classification refers to the process of assigning a class label to a given observation. This observation is typically described as numerical vector that represents some features of the observation. In the case of musical analysis systems, the features are computed from the raw audio signal by means of signal processing techniques. Regarding the classification techniques, k-NN is the most-often used and one of the best performers in this kind of problem. LDA is sometimes suggested as another 'default' method to be included in comparative studies but unless prior feature selection and projection is properly done, it cannot complete with SVM and GMMs [2]. The proposed system is used to classify the sound of the musical instruments automatically with the classifier SVM and kNN and the features extracted by Google Net. The block diagram of the proposed system is shown in fig. 1.

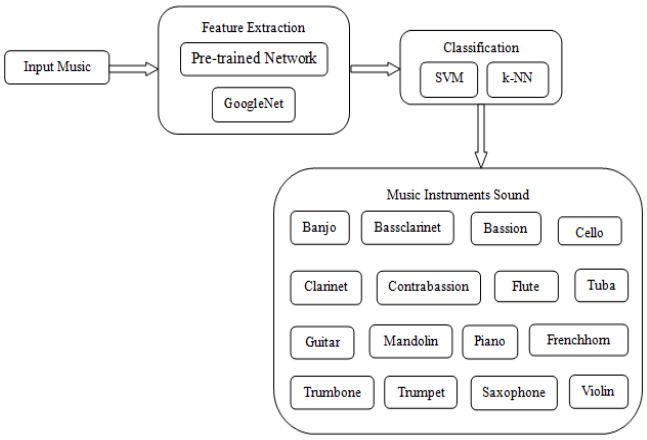

Fig.1 Block diagram of the proposed system

Commonly there are many musical instruments; some of them are used for classification in this proposed work. Totally 16 musical instruments from four different families such as piano from keyboard, bassoon, clarinet, bass clarinet, contrabassoon, saxophone and flute from woodwind, cello, guitar, banjo, mandolin and violin from string, trombone, tuba, french horn and trumpet from brass family. 1284 music samples were collected from various online musical instrument databases.

II. LITERATURE REVIEW

In [3] the audio such as advertisement, cartoon, music, sports, news and movie were classified using SVM and RBFNN with LPC, LPCC and MFCC as features. The classification performance of RBFNN is slightly higher than SVM classifier. In [4] instrument recognition system is proposed to classify the isolated musical instrument using six features with 19 musical instruments using kNN

classifier, it gives good accuracy in instrument recognition, in instrument family recognition and sustain/impulsive instruments. Audio signals such as advertisement, cartoon, movie, news, songs and sports are classified using AANN and GMM classifier and the features are extracted using LPC, LPCC and MFCC. In this proposed system the performance of AANN is better than GMM [5]. In [6] the musical instrument is classified using deep convolutional neural network, the accuracy of this proposed system yield high compared to existing algorithms. Scene recognition using Deep CNN with GoogleNet model is proposed in this work, the result of this work gives good accuracy [7]. In [8] qualitative analysis of Googlenet and Alexnet for Fabric Defect Detection is proposed in this paper, the performance of GoogLeNet is the good than AlexNet on various parameter including accuracy, time, dropout, and the initial learning. In [11] handwritten Chinese character recognition proposed by using the two CNN architectures HCCR - Alexnet and HCCR - GoogLeNet to achieve recognition accuracy. HCCR – GoogLeNet gives better result when compared to HCCR – Alexnet in this proposed work.

III. FEATURE EXTRACTION

A. Google Net

The Inception modules are used to construct the Google Net architecture. Google Net (Inception Layer) consists of 22 layers, 1 x 1, 3 x 3 and 5 x 5 Convolutional layer with the output filter banks that concatenated into a single output vector forms the input of the next stage. The Parallel Max Pooling layer provides another option to the layer. In [10] qualitative analysis for fabric defect detection using AlexNet and Google Net, Google Net yields good results compared to AlexNet.

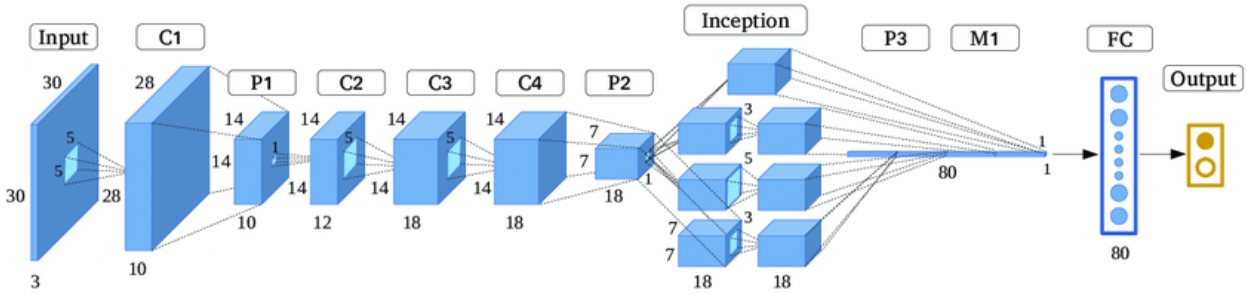

Fig.2 Google Net architecture

IV. CLASSIFIERS

A. Support Vector Machine (SVM)

SVM is also called as support-vector networks in machine learning. SVM is a supervised learning models associated with learning algorithms which is used to analyze the data for regression and classification analysis. In classification problems, SVM algorithm is used frequently to classify the classes. In this SVM algorithm, each data item plot as a point in number of features, with the value of each and every feature is the value of the particular coordinate. Classification performs by finding the hyper-plane to differentiate two classes. Fig. 3 shows the SVM process.

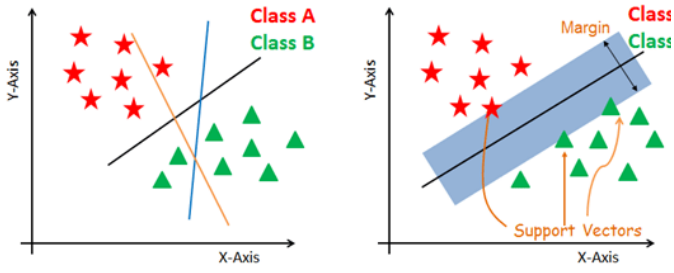

Fig.3 Process of SVM

B. K-Nearest Neighbor (kNN)

KNN algorithm is very simple and easy-to-implement the supervised machine learning model which is used to work out both regression and classification problems. First the data loaded, k initializes to the selected no. of neighbors, the distance calculated between the data, the distance added and the index in an ordered collection, then sort the distances of the ordered collection and the indices from least to leading by the distances. Pick the k entries first from the sorted data, get the labels from the elected entries of k, the mode of k labels will return for classification problem. Fig.4 shows K-Nearest Neighbor (kNN).

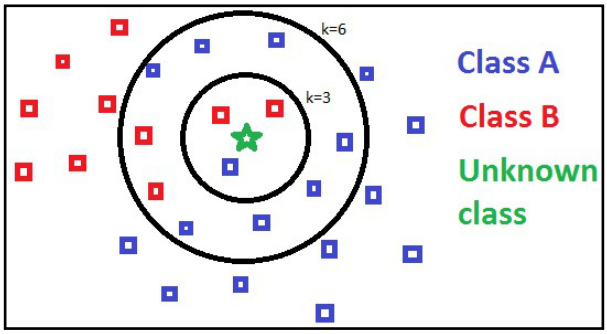

Fig.4 K-Nearest Neighbor

V. PROPOSED WORK

Each and every music samples are converted into spectrogram images with the size of 610 x 450, the spectrogram images resized as 28 x 28 for Google Net as input to extract the features. The first is the convolution layer contains the activation function with 20 feature map and the image size is 28 x 28. In the first max pooling the feature map remains unchanged and the image size is 14 x 14. In the second convolution layer, 50 feature map has been obtained. The image size is unchanged and the feature map unchanged and the image size is 7 x 7. The outputs of these pretrained models are given as input to SVM and kNN classifier to classify the musical instruments. The system classifies by assigning each instrument as a class; one class compares the rest of the classes. The Precision, Recall, F-Score and Accuracy are calculated using the confusion matrix. The block diagram for music instrument classification shows in fig. 5. For this proposed system, 75% of the samples used for training and 25% for testing.

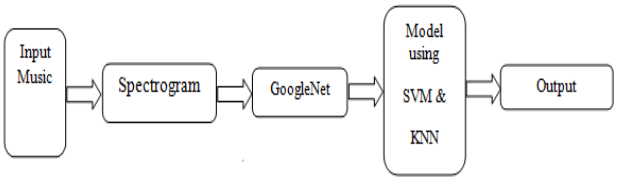

Fig. 5 Block Diagram for Musical Instrument Classification

VI. EXPERIMENTAL RESULTS

A. Dataset

The music dataset collected from various website such as RWC database, MINIM-UK, musicbrainz.org, NSynth and IRMAS with different duration.

16 musical instruments from various musical instrument families with 1284 samples were collected for this research.75% of samples were trained and 25% tested in this proposed system.

B. MIC using Google Net with SVM

In the proposed work the features were extracted by GoogleNet and the SVM classifier to classify the musical instruments.

The accuracy of the musical instruments Banjo, Bassclarinet, Bassoon and Cello gives 97 %, Clarinet, Contrabassoon, Flute, Frenchhorn, Guitar, Mandolin, Piano and Saxophone gives 98 % and finally Trombone, Trumpet, Tuba and Violin gives 98 %.

The overall accuracy of the proposed system is 97%. Fig. 6.1 shows the classification of musical instruments using GoogleNet with SVM.

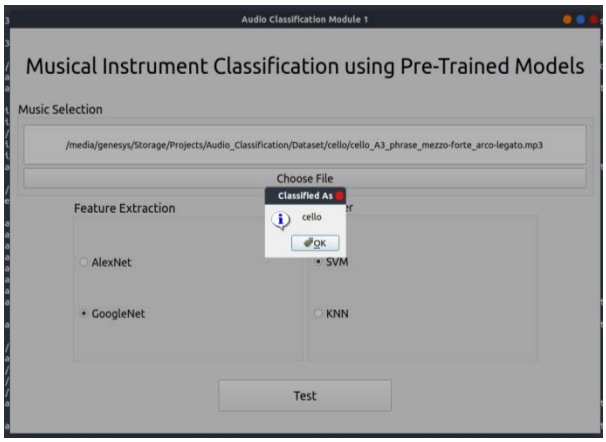

Fig. 6.1 MIC using GoogleNet with SVM

C. MIC using GoogleNet with kNN

In the proposed work the features were extracted by GoogleNet and the SVM classifier to classify the musical instruments. The accuracy of the musical instruments Frenchhorn, Contrabassoon gives 97 %, Bassoon, Clarinet, Saxophone, Trumpet gives 98 % and finally Cello, Trombone, Bassclarinet, Flute, Mandolin, Violin, Banjo, Guitar, Piano and Tuba gives 99 %. The proposed system gives the overall accuracy of 98%. Fig.6.2 shows the musical instruments classification using GoogleNet with kNN.

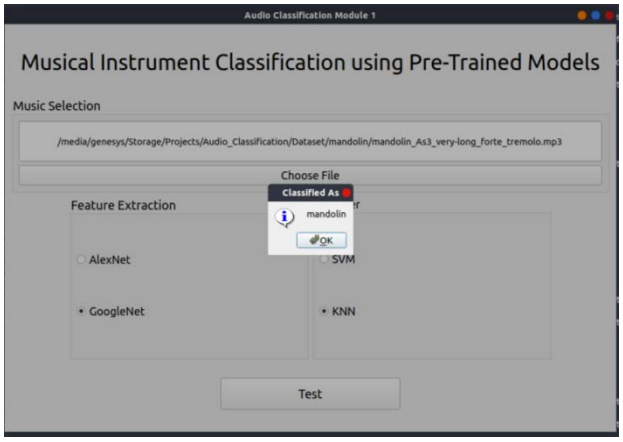

Fig. 6.2 MIC using GoogleNet with kNN

VII .PERFORMANCE MEASURES

The Accuracy, Recall, Precision and F-Score are calculated with the help of confusion matrix. The MIC using GoogleNet with SVM the accuracy is 99 % and MIC using GoogleNet with kNN the accuracy is 98 %. In this work, SVM gives better result than kNN using pretrained models. The Accuracy, F-Score, Precision, Recall are calculated using the following formula.

Precision = TP / (TP + FP)
Recall = TP / (TP + FN)
Accuracy = (TP + TN) / (TP + TN + FP + FN)

TABLE I PRECISION, RECALL, F-SCORE AND ACCURACY OF MIC

Feature	Classifiers	Precision (%)	Recall (%)	F-Score (%)	Accuracy (%)
Google Net	SVM	94.7	94.39	94.54	99.37
	kNN	88.38	86.19	87.27	98.16

The table I shows the performance measures of the proposed MIC. The overall accuracy and comparison of the proposed work is shown in Fig. 7.

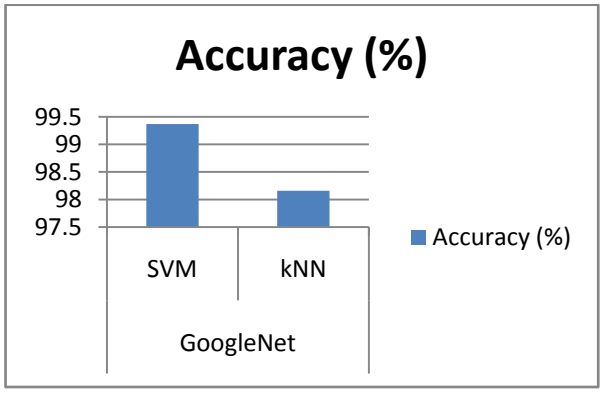

Fig. 7 Accuracy comparison of proposed work

VIII. CONCLUSION

In this proposed work, sound of musical instrument classified automatically using GoogleNet to extract the features and the classifier such as SVM and kNN are used to classify. The experiment result shows the music classification very effective and yields high accuracy rate of 99 % using SVM with GoogleNet. In future more number of music classes with different classifiers can be used for classification.

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