Detection of Strangers Based on Dog's Sound

Anisha Rachel John, Anita H.B

Abstract*: Nowadays, people having a pet at home are increasing. Usually, dog is the favorite pet animal for most of the people in the world. Dogs are more capable of identifying strangers in the surroundings than humans. The proposed work identifies the strangers based on the barking sound of the dog. In this anticipated work, multiple features are extracted from the dog's barking sound using Fast Fourier Transform and Statistical based methods. The classification is done using Naïve Bayes classifier. The dataset contains 770 barking audio files of 8 dogs. Whenever known and unknown person comes home, the sounds of the dogs are recorded. The classification result for identifying the stranger is 79.1094%.

***Index Terms*: Autocorrelation, Fast Fourier Transform (FFT), NavieBayes, Sound Classification**

I. INTRODUCTION

Sound is a vibration that travels through a medium. Humans can only hear sound waves as distinct pitches when the frequency lies between about 20 Hz and 20 KHz. Animals have different hearing ranges.

In present world, pets are quite common at home. Usually dog is the pet that everyone prefers to have. The importance of dog at home is companionship, stress reduction and health benefits, service animals and security. If the dog sound is analyzed, it will help in identifying strangers. This can reduce robbery at home. It can also be used for investigation in crime. The anticipated work is a novel idea to detect strangers by using the dog sound. The database is created using the sound box kept near the kennel.

The barking sound of dog is recorded when strangers and known person come home for creating the database. When people come home, immediately timings are noted down and later accordingly sound files are cropped. The sound files are cropped using ProTools. When known person comes near to the kernel that is considered as normal sound. The proposed work can be updated and used for home automation.

ProTools is a digital audio workstation used in wide range of sound recording and helps to crop sounds. ProTools can perform many functions at a time. This is used in variety of industries that works with sound.

II. LITERATURE REVIEW

Sound is one of the major parts of our life. It is impossible to think of a world without sound. Sound processing is wide area of research which is categorized into two sub areas; speech processing and sound processing.

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A. Sound Processing

Sound is a vibration occurring in a medium such as solid, liquid or gas. The paper [1] demonstrates an application of digital signal processing techniques in identifying the individual cows and also evaluates their condition using a very low-cost hardware. Fast Fourier Transform (FFT) is used to detect the type of sound. The paper [2] deals with the challenges faced on managing very large amounts of animal recordings and only half of the entire recordings are digitalized. The authors have compressed the animals recorded sounds in the datasets, as the database size is increasing eventually. The researchers have classified widely used animal sound features like Mel-frequency cepstral coefficients (MFCC) or LPC using Support vector machine (SVM), NN and LVQ. All classifiers yielded satisfactory results. Using SVM classifier, the results accuracy was more than 90% of the animal sounds present in the database [3]. Sound produced by different types of birds is another important study, in order to save those birds which are at the verdict of extinction. The paper [4] recognizes the sound of bird species using decision tree topology in the SVM classifier which enables the weighing of features. Using the descriptive parameter model the accuracy is 75% and while using MFCC model the accuracy of 100% has been achieved. The [5] author analyses the animal vocalizations using spectrograms which identifies the signatures of repetition, modulations, transients and non-linear behavior of animal with help of Gaussian (MAP) classifier and K-Nearest neighbor Classifier. After extracted the features, the audio file is being compressed to MPEG file. In [6] authors have classified the animal sounds using five different classification methods which are based on the data mining domain. According to the climate change, the sound produced by animals also varies. The better rate of accuracy is obtained using sequential classifier than using the non-sequential classifiers. The authors have classified the animal sound to find the animal behavior and it's activity in unusual ways prior to the occurrence of the natural disaster**.** Preliminary results obtained shows that the MFCC and SVM is used for features extraction and features classification respectively [7].

B. Speech Processing

Speech is the communication done by humans or animals. Each species has different sound modes. Each sound mode is identified using art feature extraction and GMM (Gaussian mixture models) is used for classification in order to determine the bird species [8]. The paper [9] demonstrates a method to recognize the in harmonic and transient bird

sounds. The feature extraction is done using wavelet decomposition and recognition using supervised classifier like MLP or unsupervised classifiers like SOM. 96% of accuracy is achieved using MLP.

The paper [10] demonstrates the tool which gives earlier warnings compared to the farmer monitored situations. It has presents five different cases to analyze the reliability of respiratory distress in pigs.

Based on the animal sound, the author has detected whether animal has diseases or not. The researcher describes the technique and benefits of Automatic Speech Recognition [11].

In [12] the coconuts are classified based on the quality using SVM classifier. The authors have created coconut sound files dataset by dropping the coconut on a granite slab from a constant height of one foot. Features are extracted using Fast Fourier Transform (FFT) and statistical features. SMO, Dagging and NavieBayes classifiers are used to classify the sound.

The paper [14] briefs on some of the commonly used features in speech recognition like pitch, mfcc which are associated with specific task. The researchers deal with the emotions of human beings by speech recognition. The features extracted using MFCC and classified by Multiple SVM. The result is more accurate for non-linear kernel SVM [15].

III. IMPLEMENTATION

The proposed work aims at classifying the dog's sound. The sound box kept near to the kennel. Whenever the strangers (ST) or known person (NL) for the dog enters home, then immediately time is noted. The recorded dog's sound is cropped according to the noted time. The features are extracted from the cropped sound files. The Naïve Bayes classifier is used for classification. The proposed work classifies the person entered home is a stranger or known person based on the sound file. This can be used for various applications.

A. Data Collection

Dataset consist of a unique collection of recordings. The concept of the proposed work was to classify animals on the basis of sound. So the Sound box recoder is used to record the sound. Recorder kept near the kennal for 15 days for a dog. In this anticipated project 8 dogs were used.

The timings are noted down whenever strangers entered the home. Later, the sound is cropped based on noted timings. Each sound file is of 1-2 mintues.

The sound file is cropped using the protool software. Protool tool is used to crop the sound. While recording the sound, the sound will have both left and right part, where one part of the sound is unwanted noises. These unwanted noises are cropped out.

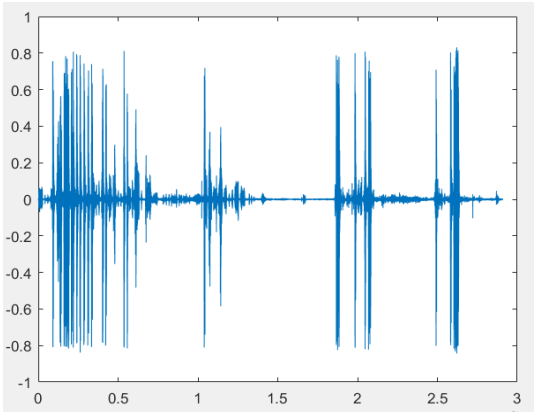

Fig.1.(a) Dog's sound file when known person entered home

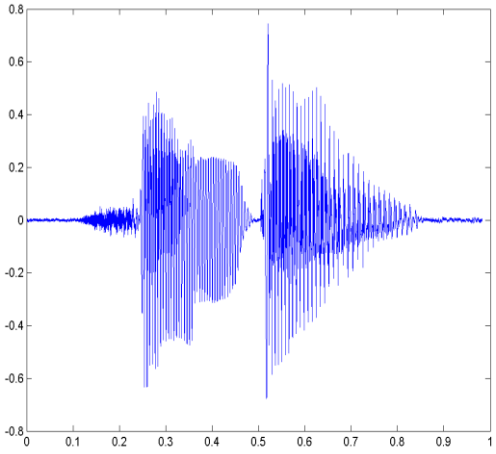

Fig.1. (b) Dog's sound file when strangers entered home

The dataset contains 770 recordings of 8 dogs which are recorded for 15 days. Dataset is created based on two scenarios. Sounds are recorded with in 44000Hz. The recorded stereo sound converted into mono-sound.The naming convention used in the dataset as NL for the normal sound and ST when strangers entered home. There are 658 NL and 112 ST sound files.

B. Environmental Setup

The sound box is kept near the kennel for recording the sound of dog. The sound is cropped after removing the unwanted noise from the environment. Sound is cropped with respect to the time noted.

C. Method Description:

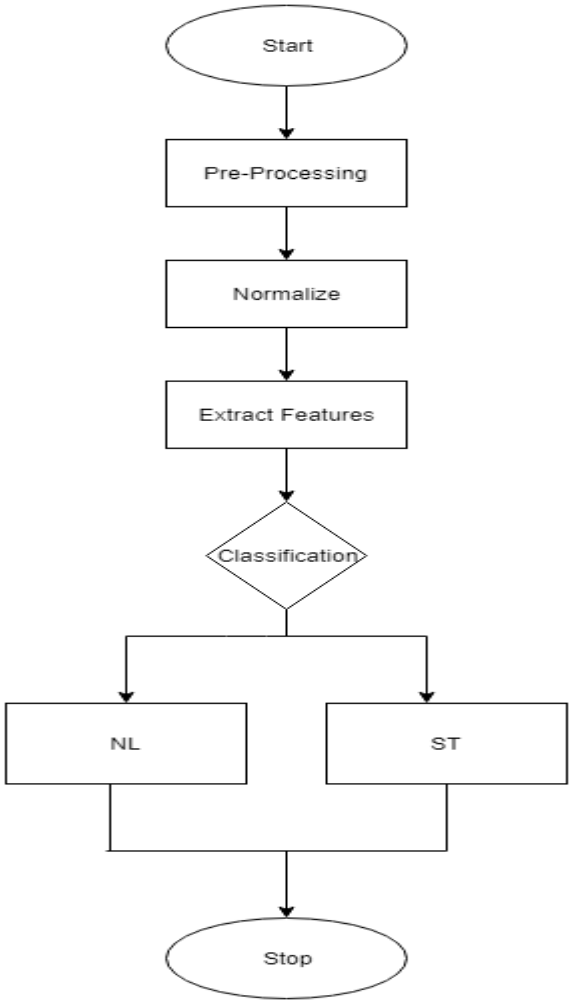

Fig.2 method description

D.Feature Extraction

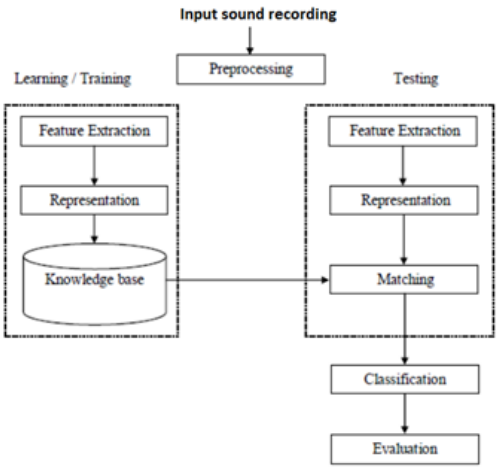

Fig.3 Feature Extraction Procedure

Each cropped audio file is of 1-2 minutes. The unwanted sound part is removed and normalized. Sound files are divided into 2 scenarios.

The feature extraction is done using MATLAB. The sound file is converted to suitable numerical form for feature extraction. The highest amplitude, minimum frequency and maximum frequency of sound is considered as features. Amplitude of sound is the strength and level of sound pressure. The maximum height of the wave is called its amplitude. Max-value of a sound is the maximum frequency of the sound wave. Min-value of a sound is the minimum frequency of the sound wave.

Fourier Transform is applied to convert the sound file into fourier domain. In this domain standard deviation and mean is calculated. Fast Fourier Transform(FFT) is an algorithm to convert the sound and images in sine and cosine wave format, also the signal wave over a period of time.

Function Fast Fourier Transform (FFT) implements transforms for given vectors of length N by

$$X(k)=\sum_{j=1}^{N} x(j)\omega_N^{(j-1)(k-1)}$$

Autocorrelation of the signals are also considered as feature. Autocorrelation is a random process which correlate the values of the function in a time. Autocorrelation is also known as serial correlation.

$$R(s,t)=\frac{E[(X_t-\mu_t)(X_s-\mu_s)]}{\sigma_t\sigma_s}$$

Where X – value
(s,t)- time interval
μ-Mean
σ- Variance.

Totally five features are extracted and stored in the vector for classification. These extracted features are stored in spread sheet. Stored features are fed to the weka tool for classification. Weka is the tool that analyses features using inbuilt algorithms and classifiers. It gives classification result using various inbuilt classifiers. The Naïve Bayes classifier is used for classification. Naive Bayes gave highest accuracy for the proposed work. This is a machine learning algorithm which works on the basis of Bayes theorem.

E. Algorithm

Input: Sound Signal
Output: Feature vector
Method:
Step 1: Transform the extracted audio file into suitable numerical forms of data for feature extraction.
Step 2: Find highest amplitude in the signal.
Step 3 : Find Minimum and maximum value of the sound frequency of the signal. This forms 2 Features
Step 4: Apply FFT and calculate the Standard deviation and Mean. This forms 2 features.
Step 5: Calculate Autocorrelation of the signals.
Step 6: Store extracted five features in a database.

F. Experimental Results

The performance of the proposed algorithm for detecting the strangers based on dog's sound is evaluated by using the dataset obtained as described Database section.

The below table shows the results obtained using Naive Bayes classifier. Naive Bayes classifier gave the encouraging result of accuracy as 79%.

So based on the dog's sound the strangers can be detected. By increasing the size of the dataset and using hybrid classifiers the results can be improved. RMS Error is the difference between the predicted value and the actual value. It is also known as Root mean square deviation. The value should be non-negative or a value of zero is perfect for the data.

RMS

Errors=$\sqrt{(predicted\ value - actual\ value)^2 \div N}$

Relative Absolute error is the total absolute error, where absolute error is the difference between the measured value and the actual value. Root Relative Squared Errors is the calculated mean absolute errors divided by the errors of the zero classifier.

Table 1 NavieBayes-Classifier output

Errors	Percentage
Root mean squared error	0.3951
Relative absolute error	34.8738
Root relative squared error	79.1094

From the data of table, it is clear that dog's sound can also be used for detecting strangers.

IV. CONCLUSION

The proposed works uses dog's sound to identify whether the person enter home is a stranger or not. The recordings are then deciphered in MATLAB. Features are extracted from the dog's sound files. The statistical and frequency-based features are extracted. Naïve Bayes classifier is used for classification and obtained encouraging result of 79%. This is novel method to detect strangers based on the dog's sound. This can be used in various applications like home automation. The proposed method accuracy can be improved by increasing the size of the dataset. Weka tool is used for classification.

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