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A Novel Automated Method for The Detection of Strangers at Home using Parrot Sound

Febin Antony, Anita H.B

Abstract: ***The sound produced by parrots is used to gather information about their behavior. The study of sound variation is important to obtain indirect information about the characteristics of birds. This paper is the first of a series in analyzing bird sounds, and establishing the adequate relation of bird's sound. The paper proposes a probabilistic method for audio feature classification in a short interval of time. It proposes an application of digital sound processing to check whether the parrots behave strangely when a stranger comes. The sound is classified into different classes and the emotions of the birds are analyzed. The time frequency of the signal is checked using spectrogram. It helps to analyze the parrot vocalization. The mechanical origin of the sound and the modulation are deduced from spectrogram. The spectrogram is also used to check the amplitude and frequency modulation of sound and the frequency of the sound are detected and analyzed. This research and its findings will help the bird lovers to know the bird behavior and plan according to that. The greater understanding of birds will help the bird lovers to feed and care for birds.***

Index Terms:*, Crest Factor, Dynamic Ratio, Fourier transform, NavieBayes, Sound Analysis..*

I. INTRODUCTION

Sound Analysis performs automated recording, analysis of bird vocalization and is used to record and manage audio signals on a time period. The basic analysis includes segmentation of vocal sounds and calculation (in real time) of acoustic feature (e.g., amplitude, pitch, frequency and modulation). The features are used to summarize the spectral structure of vocal sounds. Using the given data, the efficiency of handling birds' and their well-being could be enhanced. This analysis can be used in the zoo or any bird caring places using any IOT devices. There are several powerful automatic parameter measurement options which can further accelerate investigations. Among the parameters that can be measured automatically are time duration, dominant frequency, and start-end frequencies. The software can also be used or configured for subsequent automated call classification. Additionally, various statistical outcomes can be derived from these parameters. The paper deals with a technical method for processing the sounds of parrots.

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* Correspondence Author
Febin Antony, Perusing MSc computer science from CHRIST (Deemed to be University), India. He had received BSc CMS degree from the Sacred Heart Collage, India in 2017.
Anita H.B, Associate Professor in the Department of Computer Science at CHRIST (Deemed to be University). She has received PhD from Gulbarga University, India, in 2014.

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To make this method useful it is assumed that a common Personal Computer should be used, along with a normal sound card and a low budget electronic mic, with suitable software (Pro Tools). Use sound cards that are low in price but which gives excellent frequency response curves. Automatic classification of audio signals will be a major challenge in this field. Several authors have proposed Common microphones are tuned for human hearing range (20-20000 Hz) it has to be verified that the vocalization of the species to be monitored is within this frequency range. different algorithms to arrange and analyze the data on the basis of separate algorithms. Most of the proposed systems use combination of different stages of processing. The first stage is the analysis of the obtained waveform and extraction of some features from the obtained waveform. The process of extraction of the features will result in a huge figure of information that is to be reduced on the basis of signals. The next stage will be the classification of given audio signals based on the extracted features. It will show the relation of birds (parrots) sound with their behavior. The usage of features is proposed for the general audio classification. The classification of audio signals that are based on a set of features that are not correlated is easier than that of other features with correlations. The low-level signals are used for general audio classification of varying audio signals. The simple audio signal classification example will show the difference between speech and music. A simple audio signal will include clean speech processing, speech which includes music processing, noisy-speech processing, telephonic speech, music processing, silence and noise removal or cancellation. The detected sound frequency will be analyzed and these analyzed sound signals will give the output. This paper will help the birds' caretakers to know about the bird's behavior and plan accordingly. The proposed system uses MATLAB for feature extraction and WEKA tool for classification.

Audio signal processing is an arrangement of audio signals by adding some audio effect which will also be responsible for removing noise. Audio signals are represented electronically in an analogue or digital format and the sound signal processing may occur in either domain. The analog signals operate on the electrical signal directly, whereas digital signal processor operates mathematically on the digital representation of that signal.

Audio Signal Characteristics

The sound signal arises from variations of pressure of air falling on the eardrum. The human auditory system is responsive to the audio waves in the frequency range of 20 Hz - 20 kHz since the frequency lies below the intensity and dependent on "threshold of hearing". The audio signal intensity range is 120 dB which shows the range between any two objects or medium.

The sound is captured with the microphone where the waveform of the air pressure variation of the microphone is around the field. Using sampling and quantization of the microphone, digital signal is obtained. The sound frequency of 40 kHz or above is recommended to capture the audible frequencies using a suitable recorder. A 44.1 kHz is the perfect quality of audio signals and a sampled audio signal is digitized to 16-bit length. The sound signals are classified into noise, speech, music, artificial sounds and environmental sounds. A group of sound signals will vary the sounds in nature with specified information that is coded in an atomic sound. For example, speech can be considered as a pattern of nodes which is viewed in the form of tablets or phone and music In **spectrogram,** a spectrum is represented pictorially with the frequency of sounds or any other signals where the signals vary with time. Sonography, voiceprints, or voicegrams are also sometimes called as spectrograms. Spectrograms are mainly used in fields like speech processing, music recognition, sound segmentation, sonar, seismology. To phonetically identify spoken words and to analyse or identify the various signals of animals and birds, spectrogram is used. The spectrogram is obtained by Fourier transform, spectrometer and band-pass filters

In **Animal communication,** an individual or a group of animals (sender) transfer information to an individual or a group of other animals (receiver) that will affect the current behaviour or future behaviour of the receivers. The information is sent intentionally or unintentionally as a courtship display or the transfer of a sense of smell from predator to prey. The information gathered is transferred to the viewer or the audience of different receivers which receives the signals. With the study in disciplines of animals or birds including animal cognition, behaviour, neurology, and sociology will help to grow animal communication. The use of symbolic names of animals, emotional expression based on animal feelings, learning and sexual behaviour are the aspects of animal behaviour.

A signal in animal communication states that if an information sent from the sender changes the behaviour of the one who receives the information, then the information is known as a "signal" and it will predict for a signal to maintain the population, the one who sends and the one who receives the information will usually receive some benefit from the interaction. The production of the signals by senders and the response of receivers are thought to coevolve. The signals often contain more than one mechanism, e.g. auditory and visual, and the information should be known for the behaviour of both the sender and receiver.

Auditory

Vocalization is used by most of the animals for animal communication. The mating rituals, conveying food location sources, warning call for other animals if a strange thing occurs and social learning are the purposes of vocal communication. In most animals and birds, during mating rituals, males perform calls against other males and to signal the females about the mating rituals.

II. LITERATURE SURVEY

A. Sound Processing

The sound is a vibration that passes through the medium such as liquid, gas and solid. Processing the sound is known as sound processing. In the paper, "Managing Animal Sounds-Some Challenges and Research Directions" [1], manages the recorded sound of animals, and if the recorded sound is too heavy, the arrangement of the sound and compress the datasets of animal for further purposes. The automatic detection of bird sounds in a noisy environment. Around 165 different birds are taken for the database. The classification used is Gaussian mixture model and results were highly accurate [2].

The paper "Automatic Identification of Bird Species from the Recorded Bird Song Using ART Approach" is about the automatic detection of birdsong. The birdsong is recognized and analyzed. The features extracted are mel-frequency cepstral Co-efficients(MFCC), Linear Predicition Cepstral Co-efficient(LPCC) and TDMFCC, and these features give high accuracy to the datasets. The authors recorded the songs for a fixed time and then analyzed [3]. The authors [4] identified the bird species after hearing their sound. The identification is done using the supervised learning. Using different classifier, the result is obtained. The bird species are obtained from the sound they produced and from the recording the sound is analyzed and detected.

The paper [5] "Wavelets in Recognition of Bird Sounds", describes on recognizing inharmonic and transient bird sounds efficiently. Around 80% of accuracy is obtained. Each sound has been segmented and arranged into a database and then classified.

B. Speech Processing

Speech processing is the analysis of the sounds that are produced by some living organism. The authors Anagha Sonawane, M.U. Inamdar, Kishor B. Bhangale describe how human sound can be used to analyze their emotions. The paper deals with speech recognition or automatic speech recognition. The features used are mel-frequency cepstral coefficients (MFCC) and the classification used is support Vector Machine (SVM) with linear and nonlinear [6]. In the paper "A Novel Approach to Classify Coconuts Using Audioception" [7] authors has done the quality testing of coconut based on sound. Here the coconuts are dropped from reasonable heights and sound produced upon impact is recorded for creating a database of coconut sounds. The sound is classified by the features of Fast Fourier transform FFT and some classifiers such as Sequential minimal Optimization(SMO), Dagging and NavieBayes are being used to detect and analyse the sound. The paper [8] "Speech Features: A Survey" details with the automated speech recognition. The computer-driven words can be in the form of readable text. From the study, it is clear that Automated Speech recognition is done using features like pitch and MFCC. The authors Preeti Saini, Parneet Kaur details with Automatic Speech Recognition using mel-frequency cepstral coefficients (MFCC).

Using the feature of mel-frequency cepstral coefficients (MFCC) the speech recognition is easier and the result is more accurate for the database [9]. The paper [10] "An Efficient Speech Recognition System" deals with the development of an efficient speech recognition system using different techniques. The authors mainly use mel-frequency cepstral coefficients (MFCC) features in MATLAB. Most of the research work that has been mentioned above has uses mel-frequency cepstral coefficients (MFCC) and Fast Fourier Transform (FFT) features to get the accuracy correct for the dataset. The authors Lie Lu, Hong-Jiang Zhang, and Hao Jiang, describes the segmentation of the audio files which are already recorded. The authors first analyze the data and then segment the data for further purposes. They have also worked on the unsupervised speaker recognition. Approximately 90% of the recorded audio files have to be segmented correctly [11]. In the paper [12] "Speech Recognition System: A Review", a recognition system of speech is proposed. The accuracy of Speech Recognition Systems remains one of the most important research challenges, and day by day the challenges are increasing. The datasets go through preprocessing, feature extraction and classification, and then the results are analyzed. Understanding the sound is the form of speech processing. Each sound of different species has a different sound. Identifying the songs of a bird is done using art feature extraction. The descriptor is used to detect the songs and each is segmented to different parts [13].

III. IMPLEMENTATION

The proposed work is used to classify and analyze the parrots' sound. Parrots' sound is recorded and cropped according to the noted time. Further features are extracted from the ropped sound file. This classification helps to detect if strangers are present near to the parrot. So this can also be used in home automation to detect strangers.

A. Database Collection:

The dataset consists of a unique collection of recordings of parrot sounds in different timings and scenarios. The proposed work is to classify the parrots sound and analyse the sound. Using the sound box the parrots' sounds are recorded for 15 days and 8 different parrots are used for the same. Here the 3 different scenarios that are considered for recording are mentioned below.

1. When the person near/ around the parrot is known
2. When it is talking with the known person
3. When the stranger comes near the parrot

The recorded sound is cropped using the noted time and all the scenarios which are mentioned above. The sound is recorded in stereo sound in 44000Hz and then it is converted into mono sound. The sound has both left and right part sound. The file is stored in MP3 format and each file contains 1 minute to 2 minutes.

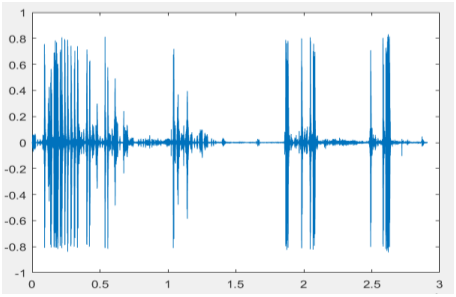

Fig 1(a)Audio File of Normal Sound

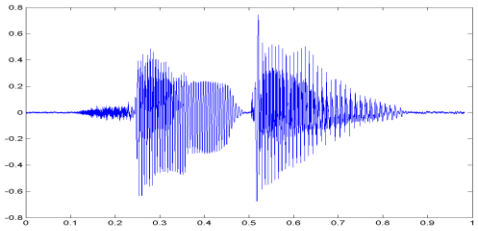

Fig 1(b) Audio File of Stranger Sound

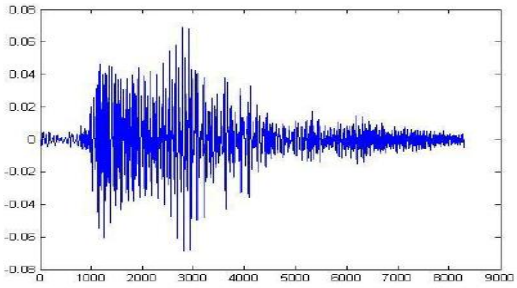

Fig 1(c) Audio File of Talking Sound

Naming Convention used in the dataset:

NL - Normal sound
ST - Strangers.
TK - Talking sound.

Table 1.1 Number of sound files based on scenario

Types	NL	ST	TK
Parrots	472	118	29

B. Environmental Setup

The sound box is placed near the place of parrots. From the recorded sounds, the sound is then cropped by avoiding the unwanted noise or the disturbing noise. Cropping is done for creating the database for all the three scenarios. All the files in the database are minimum duration of 1minute to maximum of 2 minutes. The file which contains the unwanted noise from the environment is not considered.

C. Method Description:

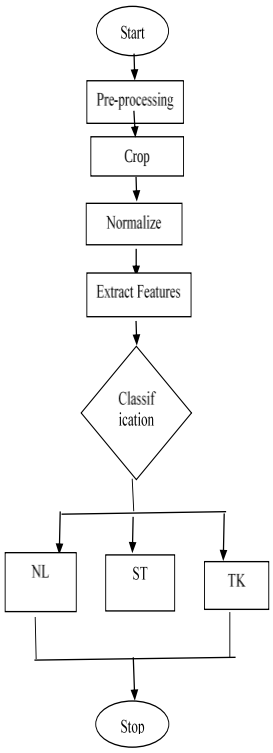

Fig 2 workflow

D. Feature Extraction

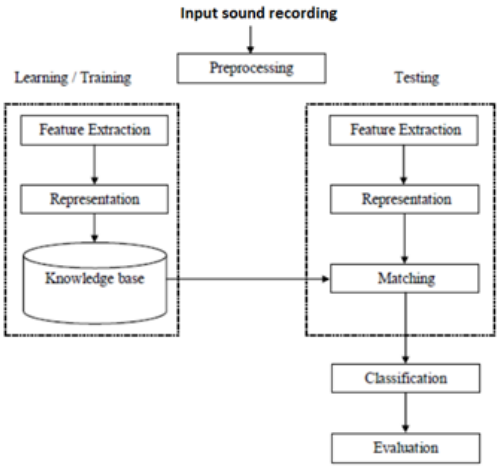

Fig.3 Feature Extraction Procedure

Feature extraction is done using MATLAB and the features extracted are mean, FFT, Standard deviation of FFT, Dynamic ratio and Crest Factor of each sound file. Each audio file is extracted with features separately and each sound file has 3 scenarios. The extracted features are fed into the Weka tool and by using the Navie Bayes classifier, the classification is done. **NavieBayes classifier** is a machine learning algorithm based on the Bayes theorem with strong independence assumption between the features. It is also knows as simple Bayes and independence Bayes. Fourier transform is a mathematical function which separates components such as time and frequencies. This is also known as a generalization of the Fourier series.. Fourier transform is basically the sine wave and cosine wave. The Fourier transform is defined by

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

E. Algorithm

Input: Recorded Audio Signals
Output: Feature extraction
Method:
Step 1: Normalize the audio signals to a standard form.
Step 2: Apply FFT and compute the standard deviation and mean of the FFT signal to get two features.
Step 3: Compute Dynamic Ratio of the signal and Crest Factor of the signal to get two features Total of 4 features are extracted. The extracted features are considered and classified using Navie Bayes for all three scenarios classification. The Output is depicted in the table 4.1. The scenarios taken are normal sound of the parrots, talking and when stranger is near the premises of the parrot.

Table 4.1 Naive Bayes-Classifier output

Errors	Percentage
Root Mean Squared error	0.423
Relative absolute error	72.9254
Root relative squared error	106.2595

Root Mean Squared (RMS) Error is the regression line which predicts the average value associated with given value where regression line is the best which describes the behaviour of the set of data. It is also known as Root mean square deviation.

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.

IV. CONCLUSION

The proposed methodology uses the concept of sound analysis of parrot's sound. Results show that the parrots sound differs from its normal sound while talking and is based on its familiarity with the humans. The anticipated work can be used to detect the presence of strangers in a particular place based on the parrot sound. This is innovative idea, as per the knowledge, no one has detected strangers based on the parrot sounds. The feature extraction is done using MATLAB and the classification is done using the Weka tool. FFT, Dynamic ratio and crest factor of the signals are features extracted from the parrot sound files. NavieBayes classifier is selected from the Weka tool to classify the sound.72.9254 % of result obtained from this method.In future this can be improved by increasing the dataset size and using hybrid classifiers. It can be concluded that the parrots make different sounds based on the various situation. This analysis can be used in the zoo or any bird caring places using any IOT devices.

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AUTHORS PROFILE

Febin Antony perusing MSc computer science from CHRIST (Deemed to be University), India. He had received BSc CMS degree from the Sacred Heart Collage, India in 2017. His research interest is machine Learning, Sound Processing.
Email: febinantiny1996@gmail.com

Dr. Anita H. B is working as Associate Professor in the Department of Computer Science at CHRIST (Deemed to be University). She has received PhD from Gulbarga University, India, in 2014. MCA degree from Indira Gandhi National Open University in 2003. Her research interest is Image processing, Sound processing and Machine Learning. She has published many papers in international and national conference and published two Book chapters in Springer Link, India. Also, she has published many research papers in International journals. Email: anita.hb@christuniversity.in