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FFT AUDIO SPETRUM WITH BIRD RECOGNITION

Dr. Devika B[1], Samhitha Prakash[2], Soundarya S[3], Tejashree N[4], Sowmya A M[5]

Associate Professor, Department of ECE, K.S Institute of Technology, Bengaluru, India[1]

Electronics and Communication Engineering, K.S Institute of Technology, Bengaluru, India[2-5]

Abstract: In this study, we present a novel approach for recognizing bird species using Fast Fourier Transform (FFT) analysis of audio spectra. Traditional bird recognition methods often rely on complex feature extraction techniques and machine learning algorithms. Our method simplifies this process by leveraging the FFT to convert audio signals into frequency domain representations, which are then analyzed to identify distinct spectral patterns associated with different bird species.

We employ FFT to transform recorded bird songs into frequency spectra, which are then used to generate a comprehensive audio fingerprint for each species. This approach enables us to capture the unique frequency characteristics and temporal variations of bird calls with high precision. By comparing these fingerprints with a pre-established database of known bird calls, we are able to classify and recognize bird species with high accuracy.
Our system is tested across various environments and recording conditions, demonstrating robustness and reliability. The results indicate that FFT-based audio spectrum analysis is a powerful tool for avian acoustic monitoring and can be integrated into real-time bird recognition applications. This method not only streamlines the recognition process but also enhances the scalability and accessibility of avian monitoring systems, making it a valuable contribution to ornithology and bioacoustics research.

Keywords: Fast Fourier Transform (FFT), audio spectrum analysis, bird recognition, acoustic monitoring, avian bioacoustics.

I. INTRODUCTION

In recent years, the field of bioacoustics has gained significant attention due to its potential in wildlife monitoring, conservation, and research. One of the critical aspects of bioacoustics is the ability to accurately classify and identify bird species based on their vocalizations. This task involves analyzing complex audio signals produced by birds, which can be challenging due to the variability in vocalizations across different species and environments.

The Fast Fourier Transform (FFT) is a mathematical technique that transforms audio signals from the time domain into the frequency domain. By doing so, FFT allows for a detailed examination of the frequency components present in an audio signal, providing valuable insights into its spectral characteristics. This transformation is particularly useful in the field of bird classification, where understanding the frequency patterns of bird calls and songs is essential for accurate species identification.

II. LITERATURE PAPER

[1]. Karthik Yadav, Suyash Dabral, Satvik Vats, Vikrant Sharma, Vinay Kukreja has proposed " Developing a Model for Bird Vocalization Recognition and Population Estimation in Forest Ecosystems". Bird audio recognition, particularly identifying specific species based on their vocalizations, holds significant potential in various fields. From environmental studies to wildlife monitoring and even conservation efforts, accurate identification of bird species can provide critical insights into biodiversity, population trends, and behaviour patterns. However, traditional methods of bird identification often rely heavily on field guides and human observers, which can be time- consuming, subjective, and prone to errors. This study introduces a novel model designed to identify the Capuchin bird voice among others.

It can aid in the early detection of rare or endangered species, monitor changes in bird populations over time, and even inform strategies for habitat conservation. Furthermore, this technology could also be integrated into smartphone apps or IoT devices, enabling everyday citizens to contribute to bird surveillance and conservation efforts. In conclusion, the development of this bird audio recognition model represents a significant step forward in harnessing the power of machine learning for environmental research and conservation.

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[2]. Mengqiang Gou, Bo Liu , Zhiyao Zhao has proposed The study of "Bird Sounds Recognition Algorithm Using a Time Delay Neural Network ".Bird monitoring is an effective method to investigate and research the environmental health status. Traditional bird monitoring relies on labor- intensive manual methods while computer vision monitoring is constrained by the environment and is not suitable for all bird monitoring scenarios. This paper proposes a time delay neural network- based bird sounds recognition algorithm that builds a dataset, extracts audio features and uses an enhanced time delay neural network for training to achieve efficient bird sound recognition. The algorithm was then tested on the collected audio data and proved to be effective.

[3]. Samparthi Kumar, Hari Kishan Kondaveeti, M Yasaswini Reddy has proposed "Automatic Bird Species Recognition using Audio and Image Data: A Short Review." Studies related to bird species identification, movements, and behavior are important for protecting the environment and measuring biodiversity, especially for ornithological research and conservation. Researchers have conducted extensive research on automated bird recognition using images, videos, and audio recordings for biological studies, environmental monitoring, and bird detection and localization. Various approaches have been developed using machine learning, computer vision, and deep learning models. This review examines the current state of automatic bird recognition methods, including sources of data, models, and performance, as well as their limitations, research gaps, and future directions.

[4]. Shivam Mishra, Rumpa Ghatak, Vishal Kumar Singh, Shivam Kumar Singh, Anisha Mahato has proposed "Bird Call Recognition using Acoustic based Feature Selection approach in Machine Learning".The recognition of bird calls has been a challenging task in the field of bioacoustics. With the advancement of machine learning algorithms, automatic bird call recognition has become an active research area. In this paper, acoustic feature selection is used which involves the extraction of relevant features from audio recordings of bird calls. Then different classification algorithms are explored for the recognition of the bird calls. Evaluation of the approach is done on a dataset consisting of recordings from multiple bird species and compared it with other state-of-the-art machine learning algorithms. This research has the potential to contribute to the conservation of bird species and their habitats by enabling the efficient monitoring of bird populations. The data is classified into four different classes (namely Astfly, Bulori, Warvir and Woothr). All of which is found in the depths of Amazon Rainforest.

[5]. Samruddhi Bhor, Omkar Domb, Rutuja Ganage, Hrushikesh Pathade, Shilpa Khedkar has proposed "Automated Bird Species Identification using Audio Signal Processing and Neural Network".
Now a days bird population is changing drastically because lots of reasons such as human intervention, climate change, global warming, forest fires or deforestation, etc., With the help of automatic bird species detection using machine learning algorithms, it is now possible to keep a watch on the population of birds as well as their behavior. Because manual identification of different bird species takes a lot of time and effort, an automatic bird identification system that does not require physical intervention is developed in this work. To achieve this objective, Convolutional Neural Network is used as compared to traditionally used classifiers such as SVM, Random Forest, SMACPY.

The foremost goal is to identify the bird species using the dataset including vocals of the different birds. The input dataset will be pre-processed, which will comprise framing, silence removal, reconstruction, and then a spectrogram will be constructed, which will be sent to a convolutional neural network as an input, followed by CNN modification, testing, and classification. The result is compared with pre-trained data and output is generated and birds are classified according to their features (size, colour, species, etc.)

[6]. Jinglu Si, Yunfei Xiao has proposed "Design of Music Spectrum Display Based on LED". With the development of information technology, light emitting diode (LED) display screen is widely used in many fields of production and life, such as bus stop reporting, road condition indicator board, building lighting, traffic signal light and KTV music wall. The frequency domain analysis of signal provides a new analysis method for studying the function and characteristics of signal, which is widely used in scientific research and production practice.

The emergence of DSP chip and fast Fourier transform (FFT) algorithm provide a unified, economic and monolithic solution for signal frequency domain analysis. Taking the music signal as an example, this paper designs a set of music spectrum display based on LED lattice, so that people can have a more in-depth understanding of the time-domain and frequency-domain representation of the audio signal. In this design, STC12C5A60S2 is used as the processing chip, combined with audio input, sampling, FFT algorithm, A/D conversion, LED display and other functional modules, based on hardware design and software design as the core, to complete the LED display of audio signal spectrum. Through the system function test, the system runs stably, can display the spectrum and its changes of music signal accurately in real time, and meets the expected design requirements.

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[7]. Niyati Jain, Medini Kamble, Amruta Kanojiya, Chaitanya Jage, has proposed "Implementation of Bird Species Detection Algorithm using Deep Learning".

Automatically identifying what types of the bird is present in the sound recording using the monitor reading. To distinguishing automatic birds based on their sound patterns.This is useful in the field of ornithology for studying bird species and their behavior based on their sound. Proposed method will be used to distinguish birds automatically using different sound processing methods and mechanical learning methods based on their chirping patterns. We propose a sequential model for audio features within a short interval of time. The model will be used Mel Frequency Cepstral Coefficients to extract features from the audio files and presented it in the model. The proposed work classifies the data set containing three species of bird, and outperform support vector machines.

III. METHODOLOGY

To analyze bird sounds using Fast Fourier Transform (FFT) for audio spectrum analysis, the process begins with recording the audio signal of the bird calls. This signal is then digitized into discrete samples for computational processing. FFT is employed to convert these time-domain samples into the frequency domain, allowing for the visualization of the spectrum of frequencies present in the bird's call. By examining the frequency components and their amplitudes, one can identify unique spectral patterns that correspond to different bird species. This method involves segmenting the audio into manageable frames, applying window functions to reduce spectral leakage, and then performing FFT on each frame to extract frequency information. The resulting frequency spectra are analyzed to identify distinguishing features of the bird calls. This approach can be enhanced with machine learning algorithms to automate species classification based on the identified spectral patterns, making it a powerful tool for ornithologists and researchers in bird sound analysis.

a. BLOCK DIAGRAM

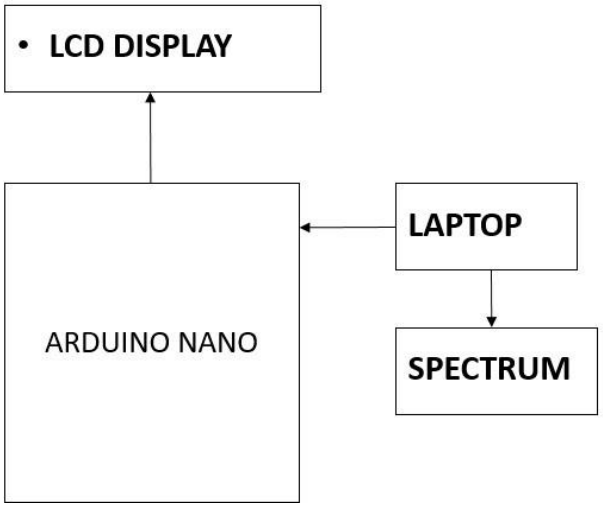

Figure 1: It represents the block diagram of FFT
Audio Spectrum Bird Recognition

b. WORKING

The Fast Fourier Transform (FFT) is a mathematical technique used to analyze the frequency content of audio signals, including bird calls. The process begins by recording and digitizing the bird sound into a sequence of discrete samples. These samples represent variations in air pressure over time, capturing the sound wave in a digital format. FFT transforms this time-domain signal into the frequency domain, revealing the different frequencies and their corresponding amplitudes present in the bird's call. This transformation is performed by dividing the audio into small, overlapping segments or frames, applying a window function to each frame to minimize spectral leakage, and then computing the FFT for each frame. The result is a frequency spectrum that shows how the energy of the bird call is distributed across various frequencies. Machine learning algorithms can further enhance this process by training models to classify bird species based on their unique spectral signatures, allowing for automated and accurate bird call identification from audio recordings

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c. FLOWCHART

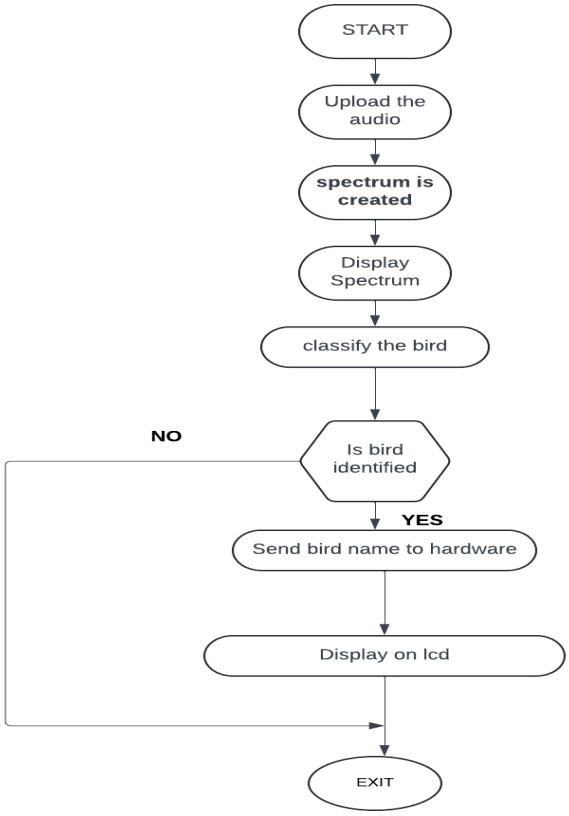

Figure 2: It represents the flowchart of FFT Audio Spectrum With Bird Recognition.

IV. RESULTS

The prototype of the proposed system is shown in Figures.

Fig1: Hardware connection with LCD (on state)

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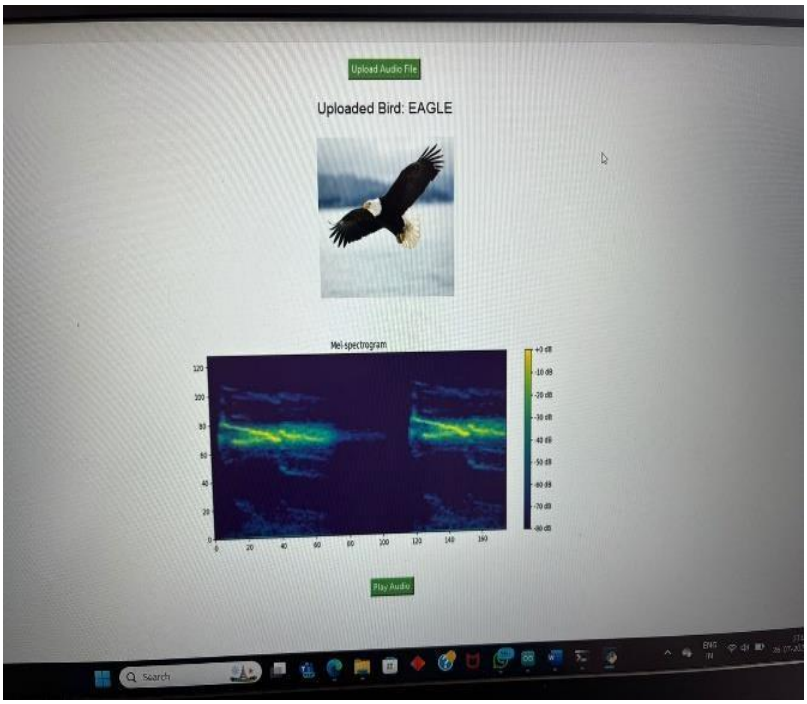

Fig 2. Output – with bird classification and Spectrum

Fig 3. Bird is recognized and displayed on LCD

V. APPLICATIONS

1. Conservation Efforts
2. Wildlife Research
3. Citizen Science
4. Environmental Monitoring
5. Ecotourism
6. Agriculture and Pest Control

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