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Disaster Prediction System using Unusual Animal Behaviour

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Abstract: This project proposes an efficient realization of deep learning, which monitors the conspicuous behaviour of animals in disaster-prone areas and alerts the authorities just in case of any uncertainty. This project entails monitoring animal movement and the use of Convolution Neural Network(CNN), Spectrograms and Mel-frequency cepstral coefficients (MFCC) within the development of animal sound activity detection which is an essential part within the development of earthquake and natural disaster prediction using unusual animal behavior. CNNs are efficient for image classification. Since Spectrograms are 2D inputs that are like images, it is possible that a number of these techniques can transfer over to audio classification.
Keywords: Convolution Neural Network, Spectrograms, Mel-frequency cepstral coefficients, Earthquake, Deep learning

I. INTRODUCTION

Disasters are happening during this world as a phenomenon or anthropogenic activities. Within the past few years, our nation has witnessed many natural disasters like floods, landslides and earthquakes that have caused much harm to human life and properties. Despite the loss incurred on properties and human life, available data shows that before the occurrence of those natural disasters animals, do migrate to higher levels and show abnormal behaviour en bloc before these events. This overwhelming evidence signifies that animals have abilities to predict natural disasters.

Today we are challenging the idea that natural disasters uncontrollable and unpredictable hazard to life and property. Scientists have tried to estimate their locations. Before any disasters, nature offer their signals through various travellers i.e. animals, plants, wind, climates etc. and therefore alarm world. Among these messengers, animals gave marked visible signals by their dynamic traditional behaviours.

Earthquake, landslide, Tsunami occurrences are some among the numerous tragic natural disaster which causes irretrievable financial, human and physical losses in various parts of the planet.

The Alaska earthquake in 1964, the 1973 Hawaii earthquake, the 22 December 1996 earthquake in Oman, the Bam Earthquake in Iran in 2003, the Sumatra Earthquake in 2004 and the Japan earthquake in March 2011 are a number of the calamities that have besieged man within the recent past.

In a related case, the very big tsunami triggered by a magnitude 9 of northern Sumatra Island on December 26, 2005, rolled through the Indian Ocean, killing over 150,000 people. It was revealed that relatively few animals were found dead. Similarly, in Colombo Wildlife, officials in the state expressed surprise that they found no evidence of large-scale animal deaths from the tsunamis, indicating that animals might have sensed the wave coming and fled to higher ground.

Various methods are proposed for natural disaster predictions, these include the employment of Satellite image, Radio communication technique, Prediction using earth precursor geophysical phenomena and signals etc. With the assistance of machine learning as a preliminary stage, the utilization of bizarre animal behaviour for the prediction of impending disaster is discussed during this paper.

II. SYSTEM DESCRIPTION

A. Architecture

The System mainly composed of Classification Module and Application Module. Application Module supports live Audio Streaming and Video Streaming simultaneously. The sound events that are obtained through Audio Streaming are fed into the Classification Module which is deployed on Flask Application. The separate audio clips were used to train Neural Network and as well as in the Classification Module.

The Live Video Streaming of the animal is verified by the user. If any unusual activity is detected, an alert is produced. The system architecture works on the MFCCs of the input audio frames and it demonstrates its effectiveness in Audio classification achieving high accuracy. Fig.1 shows the System model architecture.

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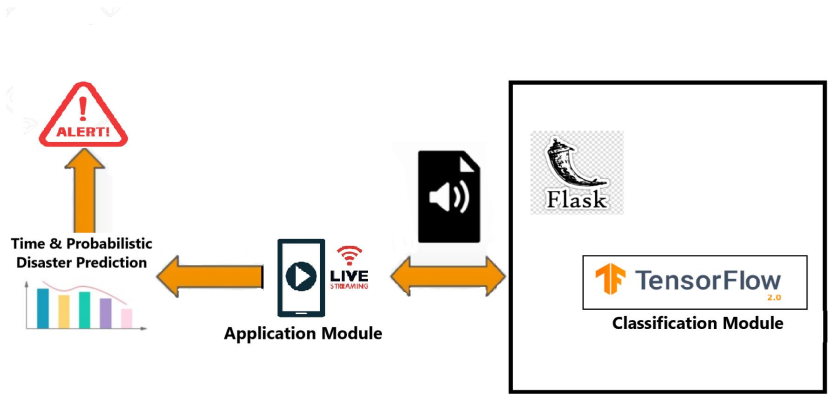

Fig. 1 System Model Architecture

1) *Data Collection:* We have build a data sets of the audios samples collected from the nearby areas. It consists of 1010 WAVE audio files, each of which lasts for seven seconds. The data set has been separated into two categories, Warning and No Warning for the Howling sound and other types (Barking, Growling, Panting, Snorting, Sneezing, Yelping) of the sound of the dog.

B. Classification Module

1) Audio Preprocessing:

a) Digital Sound: In Audio Classification, the predictive models work on audio (digital sound). Physically, the sound is a variation in pressure over time. To process the sound with machine learning, it must be converted to a digital format. Digital sound can be stored uncompressed(Eg in .wav format). Fig. 2 shows the waveform of an audio.

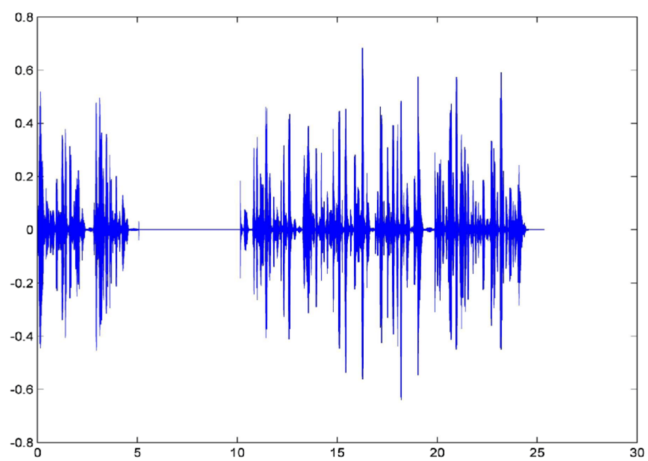

Fig. 2 Waveform of an audio

b) Mel-Filter Cepstral Coefficients (MFCC): The Mel scaled filters are commonly used for audio classification. The spectrogram that results for applying a Mel-scale filter-bank is often called a Mel-spectrogram. Mel-Filter Cepstral Coefficients (MFCC) is a feature representation computed by performing a Discrete Cosine Transform (DCT) on a mel-spectrogram. As a spectrogram image is the visual representation of the frequency spectrum of a signal, deep learning methods used to perform feature extraction and classification from spectrogram images. Fig 3 shows the MFCC coefficient of a audio signal.

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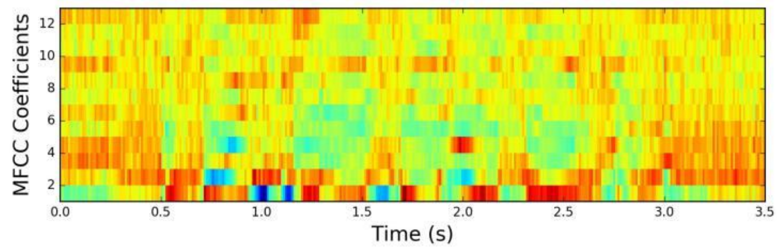

Fig. 1 MFCC Coefficient of a audio signal

2) *Convolution Neural Network(CNN)*: A Convolutional Neural Network (CNN) is a neural network that uses convolutional layers in addition to (or instead of) fully-connected layers. The first framework for CNN was built in the early 90s. LeNet-5 was the first Convolutional Neural Network developed to classify handwritten digits. The performance of LeNet-5 was much better than the existing techniques at that time. The first layer in CNN is a convolutional layer, which tries to acquire knowledge about the underlying features of the image. The next layer is the pooling layer which tries to minimise the dimensionality of the feature map. The pooling layer gets the feature map from the convolutional layer. The last layer in a convolutional neural network is the classification or prediction layer. Fig. 4 shows the CNN architecture and Fig. 5 shows the pre-proccessing and training of audio data.

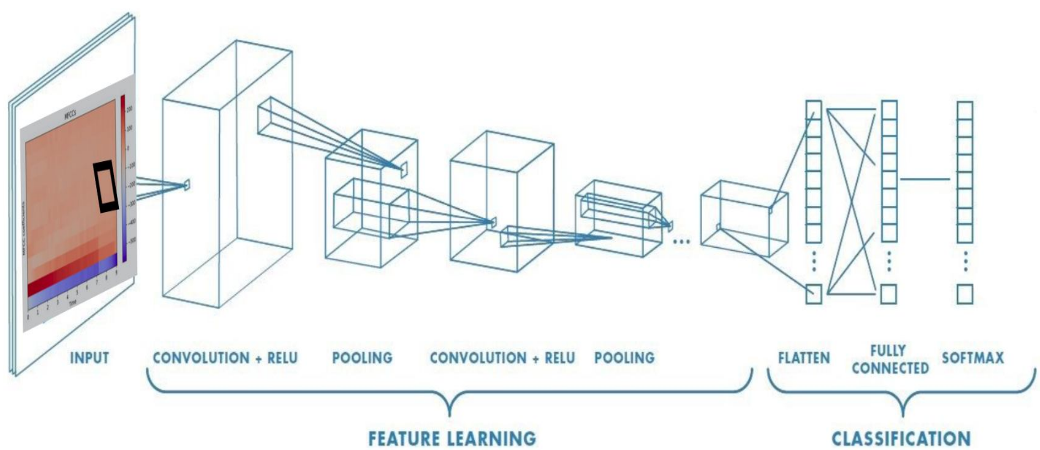

Fig. 4 CNN Architecture

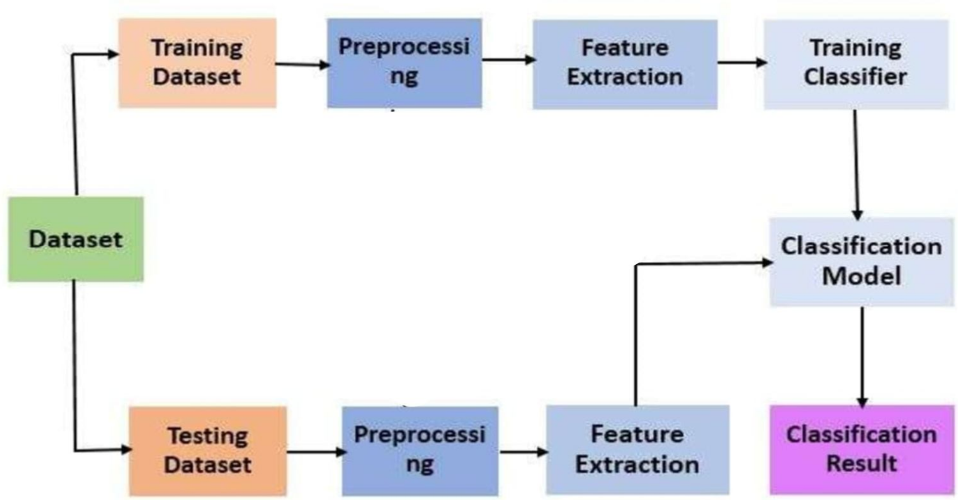

Fig. 5 Deep Learning Pre-processing & Training for audio data

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C. Application Module

Application Module is responsible for Audio Streaming and Video Streaming of the animal. It is an application which every user can log in with their ID and password and the application allows the user to monitor their pet's behaviour. If they found anything unusual in behaviour they can report that through the application.

III. SYSTEM REQUIREMENTS

A. Flutter

Flutter is an open-source UI software development kit that allows developers to develop both Android and iOS apps using a single codebase.

B. Anaconda IDE

Anaconda is the standard platform for Python data science that is useful for creating Machine learning Applications.

C. Tensor Flow

It is a mathematical computation library for training and building Machine Learning and Deep Learning models with a simple to use high-level APIs.

IV. EXPERIMENTAL ANALYSIS & RESULTS

1) *Initial set up of the Application Module:* The users have to first sign up into the application which registers the user onto the database. The user mobile is linked with another Phone by a channel name which lively captures the visuals and audio of the animal. Fig 6 shows the Application Module set up and linking.

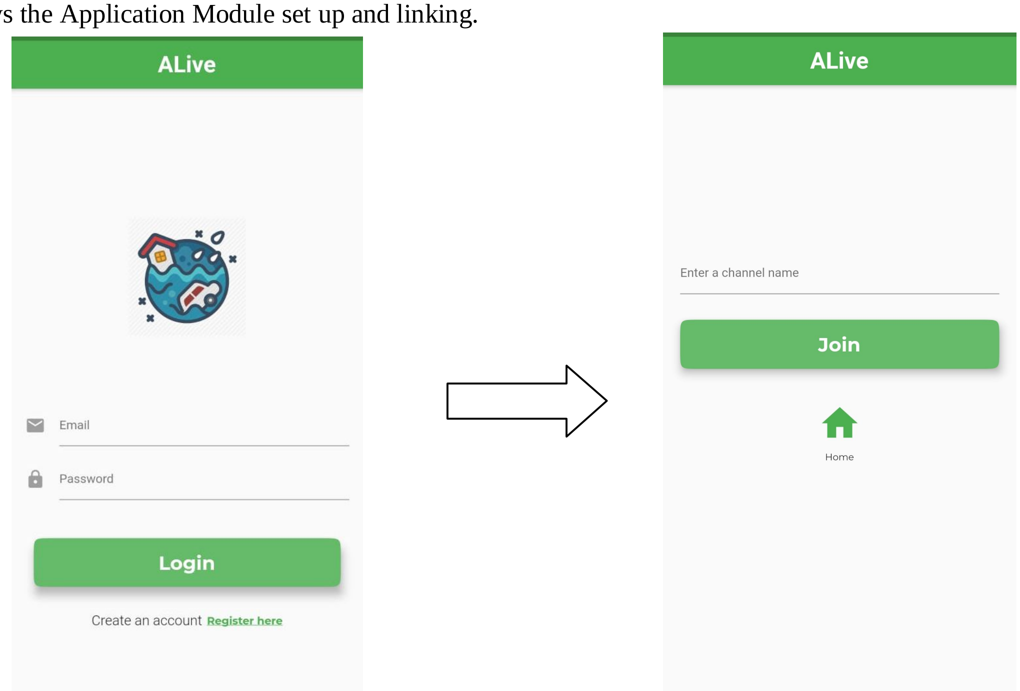

Fig. 6 Initial set up of application module

2) *Prediction by the Flask Server:* The audio captured by the application module is sent to the classification module which uses trained CNN model to classify and return the label. As Convolutional Neural Networks (CNNs) are attractive for Audio recognition tasks, we have implemented a convolutional architecture with three convolutional layers and the extracted MFCC coefficients are fed into this model. The key layers of the model are Convolutional (Conv) layer (multiple convolution filters to get different features), Pooling layer (down-sampling by taking the max operation to scale back the number of parameters and computation within the network and hence control overfitting), Dropout layer (only keep a neuron active with some probability p, or set it to zero otherwise to manage overfitting), and Fully-connected (FC) layer (make the ultimate softmax prediction). The dataset is split into train, validation and test sets for training. After Training, we have obtained an accuracy of 99.8%. Summary of our CNN architecture is given in the Fig.7.

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 300, 11, 32)       320
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 150, 6, 32)        0
_________________________________________________________________
batch_normalization (BatchNo (None, 150, 6, 32)        128
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 148, 4, 32)        9248
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 74, 2, 32)         0
_________________________________________________________________
batch_normalization_1 (Batch (None, 74, 2, 32)         128
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 73, 1, 32)         4128
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 37, 1, 32)         0
_________________________________________________________________
batch_normalization_2 (Batch (None, 37, 1, 32)         128
_________________________________________________________________
flatten (Flatten)            (None, 1184)              0
_________________________________________________________________
dense (Dense)                (None, 64)                75840
_________________________________________________________________
dropout (Dropout)            (None, 64)                0
_________________________________________________________________
dense_1 (Dense)              (None, 2)                 130
=================================================================
Total params: 90,050
Trainable params: 89,858
Non-trainable params: 192
```

Fig. 7 Summary of CNN model

The label predicted by the CNN model is returned through Flask server. If the predicted label is WARNING, an alert message is sent to the corresponding user's phone indicating alert, otherwise not. It is shown in Fig. 8 and Fig.9.

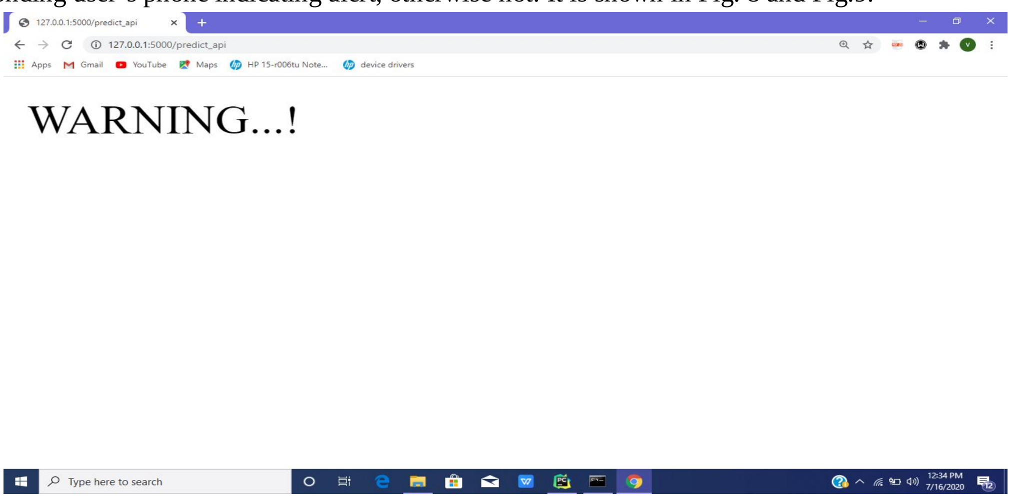

Fig. 8 Flask Application

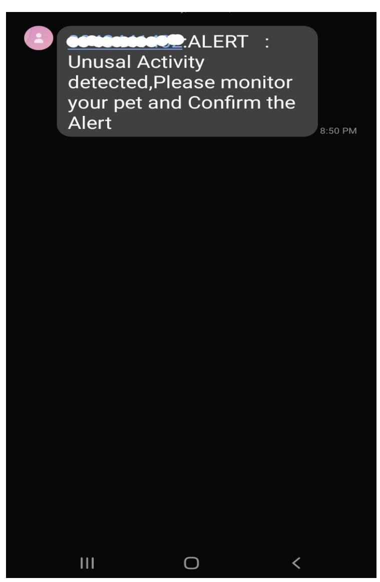

Fig. 9 Alert message to the user phone

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3) *Monitoring by the user and Confirmation:* The user when receives the message, monitors the animal movements through the Video streaming module in the Application. If the animal behaviour looks suspicious to the user, then the user will send an alert description through the application The alert is been sent to the respective authorities for further action. It is shown in Fig 10.

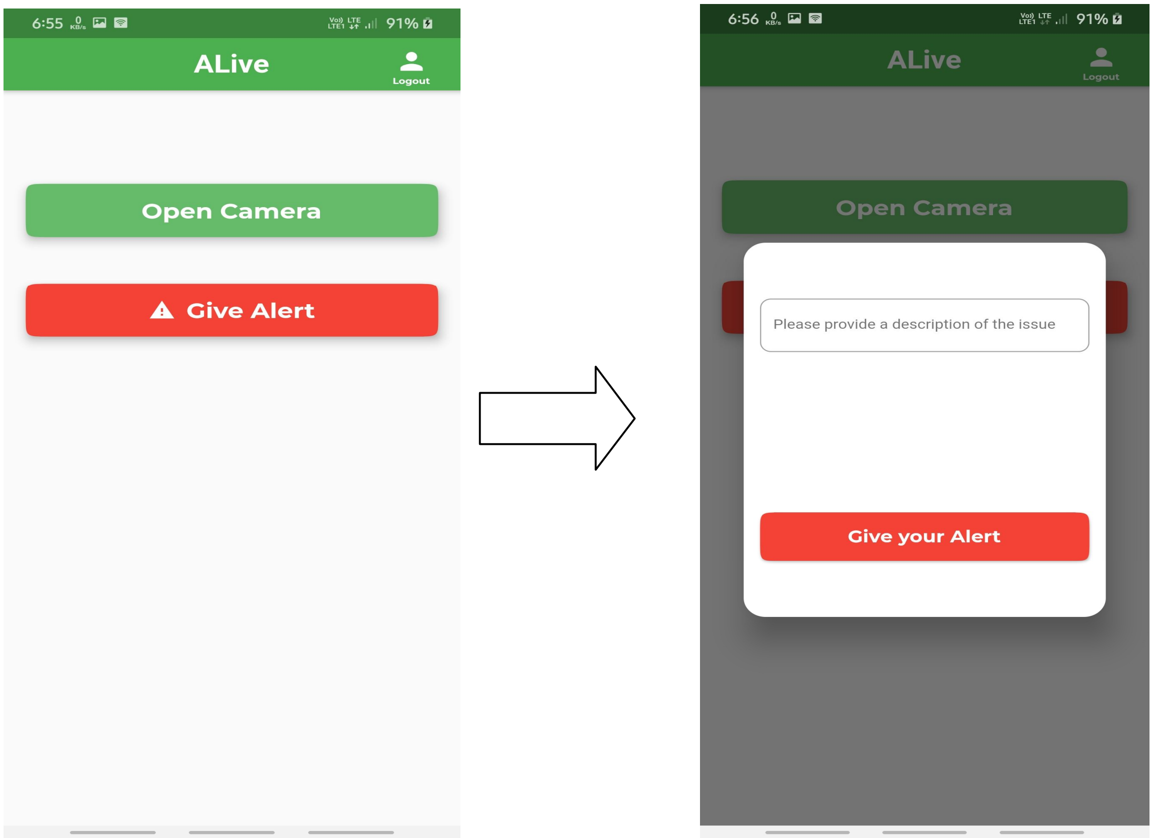

Fig. 10 Alert message to the user phone

V. RELEVANCE

Good predictions and warnings save lives. With only some minutes notice of a tornado or flash flood, people can act to guard themselves against injury and death. Predictions and warnings may reduce damage and economic losses. When notice of an impending disaster is issued well beforehand, as it can for a few riverine floods, wildfires, and hurricanes, property and natural resources is protected.

By predicting upcoming calamities like flood, earthquakes etc the govt could take measures to cut back its the impact on local communities.

In today's world, the term Machine Learning is sort of synonymous with application areas like robotics, image recognition and self-driving cars, but it is not well utilized within the areas like disaster prediction. Our project contributes more towards the sector of machine learning because it explores the relevance of Machine Learning in core engineering domains that handle real physical, chemical or biological system.

VI. CONCLUSIONS

Natural disasters kill more people on a global scale than wars and It is virtually impossible to prevent natural disasters. Hence our focus should be placed on decreasing the severity of the impact they have on every aspect of our lives. By this project, we proposes a more timely prediction than existing disaster prediction system. Our project aims to minimize the effects of a disaster by establishing early detection systems that allow for global advance warning to be given to national and global communities.

VII. ACKNOWLEDGMENT

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