AN APPROACH TO REDUCE ELEPHANT DEATH FROM TRAIN ACCIDENT

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ABSTRACT: Train Elephant Conflict (TEC) is one of the major issues across the world which affects both human and elephant. A recent research indicates many elephants and other animals die due to train accidents mostly at night time. Despite railway authorities instructing the drivers to reduce the train speed in forest areas, there has not been much reduction in elephant death from trains. The surveillance and tracking of elephants are difficult due to their size. The proposed system automatically detects the elephants with their sound that are diverse in the field. The input to the proposed system is the acoustic wave generated by the elephants. The acoustic wave receptors are placed on the path of the elephant. Raven pro 1.5 software is used to analyze the acoustic data and to improve signal enhancement, robustness to detect in noisy situations. Using MATLAB software the recorded acoustic waves are filtered to reduce the environmental noise recorded with actual sound of the elephant then the filtered sounds are tested for recorded spectrogram patterns stored previously in the system. On successful match of the sound of the elephants, SMS will be sent to the forest officials, station master and train operator. This paper helps to prevent the elephant death from train accidents.

Keywords: Train Elephant Conflict (TEC), Elephant, Sound, Acoustic sensor, MATLAB (MATrix LABoratory).

1 INTRODUCTION

During a past few years, the railway tracks running through preserved forest areas have been widened which enables the trains to run faster. Movement of cargo and passenger trains through forest areas have also increased in the previous years. As a result of this, elephants and other animals face serious problems such as shortage of food and water, which force them to cross railway tracks frequently. Movement of elephants into human habitual areas is also a matter of serious concern now-a-days [1]. Elephants create major train accidents which results in loss of lives. The death score of elephants near railway track in Hosur has hit the newspapers recently. The tracking of elephants is the only solution to decrease these accidents but it is not that much easy to track because of their varied size and nature of movement. To protect the elephants from accidents, a mechanism is needed to alert authorities when the elephant are moving towards railway tracks. This would be possible by placing acoustic sensors in railway tracks. These acoustic sensors are used to capture the elephant trampling sound. Elephants communicate with each other elephant by low-occurrence sounds which commute distances of all kilometers. The approximately common elephant invite is the roar, which extends directed toward the infrasound band. The roar is a harmonic sound mutually an integral occurrences in the range of 15-35Hz and a term between 0.5 and 5s. A typical roar by the whole of a valuable Signal-to-Noise Ratio (SNR) [2] [3]. The sensual detection of elephants by their calls is currently the approximately promising clear towards an early warning position that is efficient to recognize the reality of elephants during large distances. The large variety of noise sources detail in the wild convolute technical experiment methods. As a show, no course of action exists so fully that is ready to handle in the field [3]. So appropriately research on acoustic examination of elephant calls has addressed fully selective tasks, a well-known as the concern of elephants by their calls and the experiment of particular call types, e.g. roar types. The automated detection of elephant calls, which is the essence for the farther mentioned tasks, has simply been investigated. This paper focuses on the working of the acoustic sensors in detecting elephant sound and alerting authorities.

There are several researches on elephant sound and tracking taking place around the world. Some of the research works are discussed below:

Matthias Zeppelzauer et.al [3] has proposed an automated acoustic detection system for free-ranging elephants which helps to detect the elephant sound that is robust to the different noise resources in the field. A data set of recorded sound under normal field situation. The result shows a detection rate of rumble 85.7% and a false-positive rate of rumble 14.2% on a database and the method helps to achieve the robustness of the detector.

Matthias Zeppelzauer et.al [4] has proposed the imagine noise release of elephant vocalizations: verification for two roar production types. Sound image techniques (an acoustic camera) to verification roar of five confined African elephants throughout spatial partition and consequent connection position. The results illustrate that the female elephants in our investigation created two individual types of roar vocalizations support on sound pathway variation: a nasally- and an orally-emitted roar and African elephants may be changing sound pathway to actively vary sound area duration according to circumstance and call for more investigating the purpose of formant accent in elephant vocalizations.

Nirmal Prince & Sugumar [5] have proposed a method for detecting and tracking of elephants along the forest border area using vocalization. Spectral energy threshold and pitch occurrence are used for detecting the presence of elephants in an environment. The system is completely automated and is saws a false alarm. The study area is in Coimbatore forest division.
Chinthaka Dissanayake et.al [6] has proposed a method for detection of elephant localization using an acoustic sensor network. They also present the effect of Signal to Noise Ratio (SNR) on the detection of vocalization signals. The result show adverse effect of impact on temperature on the accuracy of source localization is error. Therefore noise reduction will enhance the performance of the system.

II SURVEY OF ELEPHANT DEATH IN TRAIN ACCIDENT NEAR HOSUR

Krishnagiri and Dharmapuri districts of Tamil Nadu are in Hosur and Bangalore railway divisions respectively. The Forest division falls in Eastern Ghats division and the area around Anusonai village has been declared an elephant reserve due to death of a large number of elephants. The forest division contains roadways and railway lines (Fig 1 & 2).

Many elephant accidents occur in the railway route. The occurrences of such accidents has brought to the fore the deadlock and the absence of coordination between the Forest Department and the Railways with regard to the protection of animals from the trains plying on Hosur-Kelamangalam-Rayakottai-Dharmapuri route [7][8][9]. 85 km distance from Hosur to Dharmapuri. In 2013, a five-year-old male jumbo was reportedly thrown 300 meters away in the impact, while another five-year-old female got caught under the train’s wheels and was dragged nearly 500 meters before the train was brought to a halt. Both the pachyderms were killed on the spot.

List of elephant death in past 24 months in Hosur[7][8][9]

1. 5 elephants were killed by a moving train near Anusonai village near Kelamangalam, while they tried to cross the railway track. Elephants were killed in similar accidents between Kelamangalam and Hosur, as officials failed to put up warning boards for train drivers about elephant crossing even after the first accident in the area.
2. Elephants were killed by electric shock near Ayyur during the month of May, when they came to drink water in a lake.
3. For a similar reason, a Makna elephant died near the same area during the month of November 2013.
4. In a similar incident, another elephant was found dead near Makaraajakadai during the month of July last year.
5. For yet another similar reason, another jumbo was found dead near Kembakarai forest area during September last year.
6. Two elephants were declared dead for undisclosed reasons near Javalagiri during the month of August (2014).
7. This year (2015), for the very first time in this area, an elephant was killed due to rash driving on NH7.

The number of elephant deaths due to train accidents in 2015. Roads and railway a line connecting the villages in elephant crossing regions there exits frequent accidents when elephant cross the path.

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Fig 1: Map of study area showing the road way of Krishnagiri to Dharmapuri

Fig 2: Map of study area showing the railway way of Krishnagiri to Dharmapuri
III METHODS

Using acoustic wave receptors can help to tracking elephant sound. An acoustic sensor along with the hardware devices is used to record and store the sound in the database. The recorded sound is classified into two categories 1) Noisy elephant sound 2) Noiseless elephant sound. In the Noisy elephant sound, there is some possibility of noise like car, air etc.

We distribute the input calling directed toward all of a sudden audio frames and standardize each qualified signal into the Fourier realm absolute by FFT. Since the energy of elephant roars is regularly concentrated little 500Hz we brought force to accept up on the analyzed occurrences range to 0-500Hz [2]. The examination window is fit to 300ms to discover the infrasound components mutually a proficient occurrence evaluation. Temporal smoothness is obtained by a low step period of time between smooth frames of 30ms. Natural sounds, a well known as breeze and drizzle generate large noise which decreases the signal-to-noise ratio (Fig 3). The surroundings noise covers the excellent vocal structures of the roars and makes them difficult to detect. Signal development aims to blow up out of proportion spectrotemporal structure to promote their automatic detection. Sounds like the roar inspire spectral arrangement which approach in regularity as cleanly as in sequential measurement. A easy intra-frame inspection as presented by impending spectral features is not huge for calling improvement as a outcome of it is not consummate to use for single hold trimmings the material arrangement and relations of the propose of importance [2]. In a rater step of call development, we combined temporally hot temperate spectral vectors and characterize a spectrogram. Main workings that create up the spectrotemporal formation of a sound are occurrence curve and spectral peaks.

The recognition of curve and peaks in a spectrogram is transmission to agility to the recognition of boundaries and curve in images [10]. A great approach for the detection of a well-known structure is the process tensor which describes the conception inclines and is regularly used for boundary and curve detection. We fit the practice tensor to the spectrogram to gain spectrotemporal structures and to enlarge the signal-to-noise ratio. The method tensor has been turn spectral declaration [2] [10] in for the recognition of local characteristic points. In measure to we apply the structure tensor to motivate a weighting filter that is direct the full spectrogram. (Fig 4) Note, that in measure to this movement does not encourage additional detection thresholds. The formation tensor is derivative from the inclines of a representation [12]. In our case the input illustration is a logarithmized spectrogram G with elements G(e, q) along time e and occurrence q. For each element G(e, q) in G we calculate the ascent \( \nabla e(e, q) \) and \( \nabla q(e, q) \) from the partial derivative along time and occurrence as follows:

\[
\nabla e(e, q) = \frac{dG(e, q)}{de} = G(e, q) - G(e + 1, q),
\]

\[
\nabla q(e, q) = \frac{dG(e, q)}{dq} = G(e, q) - G(e, q + 1),
\]

the tensor T at position (e, Q) is created from the ascent and is defined as:

\[
T(e, q) = \left( \begin{array}{c}
\nabla e(e, q)^2 & \nabla q(e, q) \\
\nabla q(eq) & \nabla q(eq)^2 
\end{array} \right)
\]

Where \( \nabla eq(e, q) = \frac{dG(eq)}{d(eq)} = \nabla e(e, q). \nabla q(e, q) \)

The tensor characterizes the limited ascent construction for an exacting position(e, q). Since the computation of the tensor depends only on nearest elements from G, the tensor is prone to noise. To make the tensor more robust, the ascent are first smoothed along the time and occurrence axis by a two dimensional Gaussian Filter of bandwidth w and duration d. The standard variation of the filter is \( \sigma \sqrt{w/d} \). A tensor that results from the smoothed incline of a larger neighborhood represents larger and more salient structures.

The eigenvalues \( \lambda_1 \) and \( \lambda_2 \) of the tensor are well suited pointer for the report of the limited incline arrangement. Since D is a symmetric matrix, the eigenvalues can be calculated as track:

\[
\lambda_1, \lambda_2 = \frac{1}{2} \left( \nabla e^2 + \nabla q^2 \pm \sqrt{(\nabla e^2 - \nabla q^2)^2 + 4\nabla eq^2} \right)
\]

The eigenvalues gives instruction about the provincial organization at a given position (e, q). If \( \lambda_1 > \lambda_2 \), then \( \lambda_1 \) performs the quantity of difference along the incline and \( \lambda_2 \) symbolize the amount of variation orthogonal to the incline. If a pure frame is found, \( \lambda_2 = 0 \) and \( \lambda_1 > \lambda_2 \). If both eigen value are identical, \( \lambda_1 = \lambda_2 \), the primary arrangement is rotational symmetric. If the equally eigenvalues are zero the essential structure is uniform.

From the eigenvalues we calculate the coherence c which is a joint measure that implements the amount and variety of arrangement at a given position. The coherence at a position (e, q) is defined as:
The coherence is 0 for absolutely isotropic structures, 1 for ideal ends, and approximate for identical structures. Note, that the previous case does frequently not happen since spectrograms show barely absolutely identical areas in practice. Since the coherence computed structure, we utilize the consistency as a weighting filter for the spectrogram. The improved spectrogram \( \hat{G}(e,Q) \), is computed as:

\[
\hat{G}(e,Q) = \hat{G}(e,Q) \cdot k \cdot (c(e,q) + 1).
\]

Where \( k \) manages the strength of the weighting (structure amplification) [2]. The default value for \( k \) is 1. In this case the main possible weight is 2.

The possibility of tensor filtering. The input spectrograms in string 1, the equivalent circumstances values in array 2 and the improved spectrogram in understanding 3 (Fig 4 & Fig 5). The information verifies that the uniqueness gives huge weights to edge-like constitution and lower weights to approximately identical and isotropic structures. A roar at 35s mutually environment noise in its nearby. The situation is significantly higher in the direction of the roar exact to the edge-like spectral curve. As demonstrate the roar is accentuates in the enhanced spectrogram. For the wideband noise at 4s (label A) the wish is nearly zero. Consequently, the wideband noise is attenuated in the superior spectrogram. Other noise source, a well-known as the low-occurrence impale at 30s (label B) are attenuated as well. The real illustration (best viewed in color) shows a sequence of all of a sudden roar from seconds 1.5 to 12. Again, the circumstances yields the heavy values for the roars mean most hint sources engage lower confidence. The background noise level is reduced entirely the perfect spectrogram and the technique of the roars is preserved well. Strong imply components, a well-known as the labeled C at 5s are attenuated. The mainly sharp noise curve line at 10s (label D) remains right to its edge-like curve. The spectrogram likewise shows that imply of a van engine starting at 16s (label E) at an occurrence of originally 40Hz. Along the particular event curve line higher coherence values are experimental. However, compared to the input spectrogram, to what place the roars and the curve line of the engine had the appearance of has suggestive power, the contests in the respective energies enlarging powerfully afterwards indicate enlargement.

We group the short-time cepstral coefficients to acquire a larger roar and feature illustration. For this purpose even audio frames (8 frames at each subject to position) with a cover of 50% (4 frames) are grouped together. For each apply of aggregated frames we count the mean and variation of each cepstral coefficient overall time.

The detector is not dangerous on the combined features [2]. The chosen classifier is a linear scalar vector machine (SVM). The linear SVM is selected, as a result of it present helpful outcome even for little training sets, has abandoned a few parameters to guarantee, and exhibits an outstanding generalization ability merit to its low complex decision boundary. Additionally, the linear SVM has outperformed at variance classifiers (allowing more complex decision boundaries) in lead-in experiments. For detection, we fit the harmless classifier on the verify database, which has not been employed around training. The detection is performed for window sizes which appear that of the aggregated features.

Fig 4: Spectrogram improvement. The SNR in soundtrack is considerably improved.

Fig 5: Spectrogram improvement. Regions with rich arrangement, such as roar are improved.
A. NOISE CANCELLATION

A sound \( e \) is transmitted around a channel to a sensor that besides receives a noise \( n_1 \) uncorrelated mutually the whole of the sound (Fig 6) (Jashvir Chhikara & Jagbir Singh)[11]. The primary input to the canceller is an aggregation of both sound and noise \( e + n_1 \). A second sensor receives a noise \( n_2 \) uncorrelated jointly the sound however correlated at the same time the noise \( n_1 \). This sensor affords the advice input to the canceller. This noise \( n_2 \) is filtered to mean an output \( y \) especially as conclude a similarity of \( n_1 \). This output of the adaptive filter is decrease the primary input \( e + n_1 \) to perform the system output \( z = e + n_1 - y \). If the traits of the channels some distance and huge which the noise and sound became transmitted to the primary and reference sensors are acknowledged. It might theoretically be possible to design a permanent filter [11]. The filter output could then be detected from the primary input, and the system output would be the sound alone. However the characteristics of the communication paths are improbability and are not of a tense nature, because of which the use of a fixed filter isn’t always viable. The reference input is planned via an adaptive filter which automatically adjusts its secure impulse response. The association is qualified over an algorithm. The filter can operate under changing conditions and may readjust itself continuously to reduce the inaccuracy sound. The practical objective in noise cancelling system is to carry out a path of action output \( z = e + n_1 - y \) specially the pleasant exit in the curtains upshot square to the sound \( e \). This future is experienced via feeding the system output back to the adaptive filter and adjusting the filter through, algorithm over used to minimize total system output capacity. In an adaptive noise cancelling system, this system output constitutes the error sound for the adaptive method.

Prior knowledge of the sound \( e \) or of the noises \( n_1 \) and \( n_2 \) would be necessary before the filter could be designed to produce the noise cancelling sound.

Assume that \( e, n_1, n_2 \) and \( y \) are statistically stationary and have zero means. Assume that \( s \) is uncorrelated with \( n_1 \) and \( n_2 \) and suppose that \( n_2 \) is correlated with \( n_1 \). The output \( z \) is

\[
z = e + n_1 - y \quad (1)
\]

Squaring, we obtain

\[
z^2 = e^2 + (n_1 - y)^2 + 2z(n_1 - y) \quad (2)
\]

Taking expectations both side of equation (2)

\[
k[z^2] = k[e^2] + k[(n_1 - y)^2] + 2k[e(n_1 - y)]
\]

Realizing that \( e \) is uncorrelated with \( n_1 \) that output \( y \) is

\[
k[z^2] = k[e^2] + k[(n_1 - y)^2] \quad (3)
\]

The sound power \( k[e^2] \) will be unaffected as the filter is adjusted to minimize \( k[z^2] \). Accordingly, the minimum output power is

\[
\text{min}[z^2] = k[e^2] + \text{min}[(n_1 - y)^2] \quad (4)
\]

When the filter is adjusted \( e_0 \) that is \( k[z^2] \) minimized, therefore is \( k[(n_1 - y)^2] \), also minimized. The filter output \( y \) is then a best least squares estimate of the primary noise \( n_1 \). Moreover, when is minimized, is also minimized, since, from (1),

\[
z - e = n_1 - y \quad (5)
\]

Adapting the filter to minimize the total output power is thus causing the output \( z \) to be a best least squares estimate of the sound \( e \). The output \( z \) will contain the sound \( e \) plus noise. From (1), the output noise is given by \( (n_1 - y) \). Since minimizing \( k[z^2] \) minimizes \( k[(n_1 - y)^2] \) minimizing the total output power minimizes the output noise power. Since the sound in the output remains constant, minimizing the total output power maximizes the output sound to noise ratio. From (3) the smallest possible output power is

\[
k[z^2] = k[e^2]
\]

When \( k[(n_1 - y)^2] = 0 \)

At \( y = n_1 \) and \( z = e \).

Minimizing the output power causes the output sound to be perfectly noise free.

IV RESULT AND DISCUSSION

Elephants produce a broad range of sounds from very low-occurrence roars to higher occurrences snorts, barks, roars, cries etc. The input is taken from an acoustic sensor and the result of the sound from elephant. Different elephant call types and the recorded elephant audio samples are taken from the website for analysis. The gather databases d1 include total hours of permanent wildlife recordings and bounded frequent calls of elephants. This is the mainly complete d1 estimate so far for elephant recognition. A database represented by only 300 audio structures and which is collected from online [12]. After gathering the sound and it is analysed in Ravenpro software. If any noise is identified with the help of adaptive filter algorithm reduce the noise, and stored in the database. Acoustic sensors are placed in crucial area and it helps to detect the elephant sound. The detected sound is compared
with d1 if it is match alert will be send to station master, forest official, and railway master acoustic sensor capture entire sound of the environment and stored in separate database. Separate database is checked by operator for 2 days once. If any newly elephant sound is arrived and it is checked with Ravenpro software and stored in database 2.

The audios taken are implemented by using MATLAB. (Fig 7) shows the conversation of elephant sound into wave containing noise. After identification noise (Fig 8) should be reduce using adaptive filter (Fig 9).

Fig 7: Elephant Voice Converted into Wave

Fig 8: Voices with Noise

Fig 9: After Removing the Noise
CONCLUSION
In conclusion, the result of work provides solutions for Train Elephant Conflict (TEC). The system can be implemented in railway border areas. The system is completely automatic; Elephant vocalizations and algorithm have presented been with practical details. The spectrotemporal method for signal enhancement based on the structure tensor strongly improves the robustness of the detector in noisy situations. The proposed algorithm helps to reduce the noise from the input which is done by Raven Pro 1.5. The models are implemented with MATLAB. After sound detection, the sound is compared with the database of record. Alerts will be sent the station master, the train operator and the forest officers to enable than to take necessary actions. This system has been meticulously tested through the various stages of the project and found to be efficient compared to the existing system.

REFERENCE