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A Prototype Model to Detect Elephants near the Railway Tracks

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ABSTRACT

Artificial Neural Network (ANN) technologies are becoming very popular. It has been used almost in all the research areas. Approach in this paper is to develop an automated expert system to drive away Elephants found near the railway tracks to stop the casualties of these animals on the railway tracks. In this paper, a prototype model has been designed using Geophone Sensors which recognizes the vibrations of the Elephants roaming near the railway tracks. These vibrations are sent to the nearby servers with the help of Arduino. The server runs software based on the ANN model developed here. It detects the exact position of the Elephants present near the railway tracks and raises an alarm to drive them away.

1. INTRODUCTION

Most of the countries of the world are covered by dense forests. Most of the forests are the habitats of the wild animals like Elephants. In a country like India railway tracks are laid through most of the forests. The most of the railway tracks run through the elephant corridors. Absence of effective infrastructure to detect the presence of the elephants crossing the railway tracks leads to the death of these animals. Little work has been done for the proper detection of elephants. Effective automated system can be devised using seismic sensors to detect the presence of elephants crossing the railway tracks.

Work has been done in the detection of animals using acoustic, seismic, wireless sensors etc. [1-3]. Koik and Ibrahim have worked on literature survey on animal detection methods using digital images [4]. Prabhu and Kumar have performed review work on recent advances in Elephant tracking and detection systems [5]. Sharma and Shah have performed overview on different animal detection methods [6]. Prince have worked on the method of spectral energy magnitude and highest pitch frequency generated by elephants to detect them [7]. Sugumar and Jayaparvathy have performed a work on a system based on image feature extraction and migration patterns to detect the presence of elephants [8, 9]. Shaikh et al. have performed a work on image mining algorithm to detect animals [10]. Rahayani et al. have performed a work on elephant detection system using radio signals [11]. Rangdal and Hanchate have performed a work on feature extraction system using Haar of Oriented gradients [12]. Artificial Neural Networks can be used effectively to detect the patterns which indicate the presence of Elephants near the railway tracks. ANN has already been used in many applications which is related to pattern recognition [13, 14].

This paper is divided into three sections. Section I-Discusses about the architecture of the prototype model. Section II-Discusses the overall methodology of the prototype model. Section III – Discusses the Result Analysis.

2. ARCHITECTURE OF THE PROTOTYPE MODEL

Figure 1 depicts the Elephant tracking system. The following hardware is used in this setup:

- Two Geophone Sensors
- Two Arduino Sensors
- Two Registers
- Two ICs
- Two Potentiometers
- Twenty LED lights
- Two 9 volts battery
- One Computer

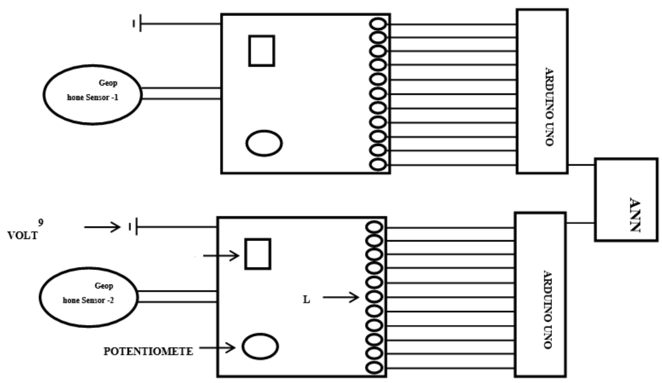

Figure 1. Elephant Tracking System using Geophone Sensors

In this prototype model two geophone sensors are used to detect the vibrations generated by any heavy weight put on the prototype board. The geophone sensors are actually seismic sensors used to measure vibrations on the ground produced by any movement. Here the geophone sensors are connected to the circuit boards. Each circuit board is connected to a 9 volt battery, a potentiometer, an IC and ten LED lights. The LEDs actually indicates various patterns generated by the heavy weights at different locations. The patterns generated by the vibrations are fed to the ANN developed here using Arduino sensors. The inputs of the ANN are the outputs generated by the LEDs which are connected to the Arduino UNO. The ANN developed here is trained to find out the exact location of the movements near the railway tracks. It is used for measuring electric potential generated by the seismic sensors. Figure 2 depicts the ANN developed for the Elephant tracking system. In this model there are three layers of neurons. Layer-1 denoted by **'x_i'** is used to accept inputs from the LEDs. Layer-2 denoted by **'y_out_j'** is the hidden layer sandwiched between Layer-1 and Layer-3. Layer-3 denoted by **'z_k'** is the output layer. There are two layers of weights denoted by **'w_{ij}'** and **'v_{jk}'**. The working method of the ANN developed here is explained in the next section.

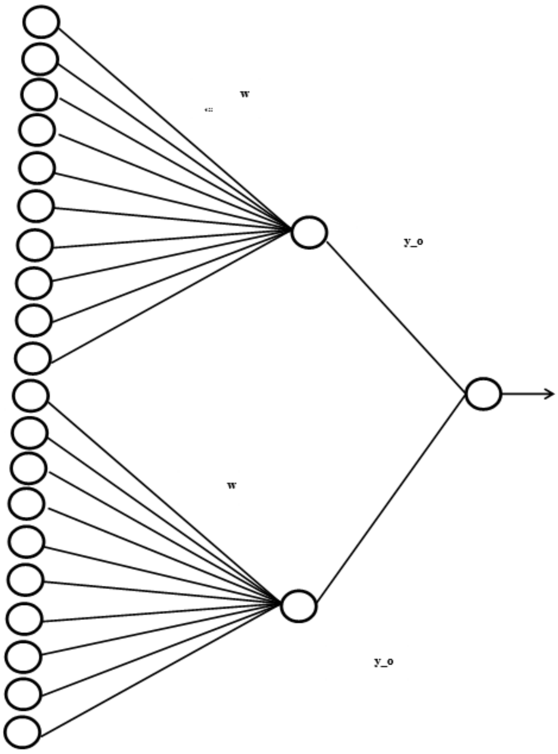

Figure 2. ANN developed for Elephant Tracking System

3. OVERALL METHODOLOGY OF THE PROTOTYPE MODEL

Here the Layer-2 neurons generate the output as given in Eq. (1) and Eq. (2). 'y_out^1', denotes the output by taking input from the first ten neurons. 'y_out^2' generates the output by taking input from the next ten neurons. The weight w^{1ij} is set to '1' to indicate the presence of Elephants in the proximity of the first geophone. The weight w^{2ij} is set to '0.1' to indicate the presence of Elephants in the proximity of the second geophone. The proximity of the two geophones is divided into ten concentric circles of radii 1 to 10 kms. The two weights are selected randomly and are kept fixed. The two weights are kept different in order to identify the presence of elephants in different seismic zones.

$$y\_out^1 = \sum_{i=1}^{10} x^{1i} w^{1ij} \quad (1)$$

$$y\_out^2 = \sum_{i=1}^{10} x^{2i} w^{2ij} \quad (2)$$

'z_out' as given in Eq. (3), denotes the output of the Layer-3 neuron. The output is fed to a function 'f'.

$$z\_out = y\_out^1 * w^{1jk} + y\_out^2 * w^{2jk} \quad (3)$$

$$z = f\,(k\_out) \quad (4)$$

$$f = \{(v^1, v^2) \text{ where } v^1 = z\_out \text{ div } 10 \;\&\&\; v^2 = z\_out \bmod 10\} \quad (5)$$

Function 'f' generates the values of 'v^1' and 'v^2' which indicates the exact location of the elephants near the railway tracks as given in Eq. (4) and Eq. (5). The net outputs y_out^1, y_out^2 and z_out are based on perceptron. Function 'f' has been developed here to find out the location of the elephant movement. The current location of the elephants near the railway tracks is indicated by the output 'z' which is a vector. For example, if the value of z is (0, 0) then it indicates that no elephant is present in the proximity of any of the geophones. Value (2, 1) depicts the presence of elephants in the proximity of geophone-1 as well as geophone-2. Here v^1 is 2 and v^2 is 1 which indicates the presence of elephant in the proximity of geophone-1 is 8 kms and presence of elephant in the proximity of geophone-2 is 9 kms.

4. RESULT ANALYSIS

Table 1 displays the percentage of accuracy of the system. Depending upon the architecture of the system 121 readings has been taken to detect the presence of elephants in different proximities of the geophones. There are 121 co-ordinates which indicate the presence of elephants in 121 locations. These co-ordinates are formed by taking the two outputs produced each related to particular geophone proximity. Out of which the system gives ambiguous results in 21 locations and accurate results in 100 locations. The accurate results produced by the system are considered as false negative and the ambiguous results are considered as the false positive. Eq. (6) denotes the accuracy of the system. Accuracy of the system is the total percentage of the false negative results out of the total number of possible locations. Here false negative results are denoted by 'F_N', false positive results are denoted by 'F_P', 'N' denotes the number of possible locations where elephants can be detected.

$$\textbf{Accuracy} = \frac{F_N \; X \; 100}{N} \quad (6)$$

Table 1. Location of the Elephants near the Railway Tracks

Number of Readings (N)	False Negative (F_N)	False Positive (F_P)	Accuracy (%)
121	100	21	82.64%

For example the following results show ambiguity/erroneous. First row indicates the presence of elephant in the proximity of first geophone but actually it is present in the proximity of the second geophone.

0000000000	1111111111	1	0.1	0	1	1.0	(1, 0)
0000000001	0000000000	1	0.1	1	0	1.0	(1, 0)

Similar types of errors are found in some more places.

5. DISCUSSION

It is a challenging task to implement such automated systems. In most of the places manual system to drive away elephants are used. For example in some places train drivers are responsible for detecting the movement of elephants on the railway tracks. If such movements are seen they inform the nearby railway crossings where loud speakers are installed to produce bee sound to drive away elephants. Such loud speakers are not able to cover the whole stretch of the forest. And it is very difficult for the train drivers to detect the movement of elephants from the moving trains. The prototype model detects the presence of Elephants throughout the stretch. The existing methods used to detect elephants now days are either partially or fully manual but the prototype model has been designed to implement fully automated elephant detection systems. The traditional system used to detect elephants emphasizes on the presence of Elephants near Elephant corridors and takes precautionary measures accordingly in those places only. The prototype model emphasizes on any possibility of the presence of single Elephant away from the corridors. Most of the traditional methods are manual but the prototype method is fully automated. In some traditional methods electric fencing is used to restrict elephants to certain areas. The Elephants are clever enough to cross those barricades also. They use dry branches to avoid electric fences and try to cross the railway tracks but in the prototype model no such possibility is there as electric fences are not used. In traditional methods manual follow up of the herds by forest officials is required which is not required in the prototype model. Now a days in some places authority use bee sound to drive away elephants from the railway tracks. But those systems are fully manual as continuously vigilance is required to observe the movement of elephants. In the prototype model bee sound can be used to drive away elephants but the system will be fully automated and no vigilance will be required to watch the movement of the elephants.

6. CONCLUSION

So it can be concluded by saying that in this paper the approach is to design a prototype model which will be fully automated to drive away elephants from the railway tracks to avoid the casualties of the wildlife. Because most of the existing systems used to drive away elephants are based on manual process. The prototype model developed here is fully automated. In most of the existing work Elephant corridors and level crossings are the main areas of execution to find the presence of the Elephants. Prototype model developed here can find out the presence of Elephants at any location. The prototype model is mainly based on one type of simulated vibrations produced by the Elephant foot. More work will be done on various other aspects like feature extraction from variant vibrations, wireless system and practical implementation of the system. This model if implemented near railway system on a large scale will be able to reduce the elephant casualties near the railway tracks.

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