

Elephant Localization Estimation within Acoustic Sensor Network Based On Real Time Data

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Abstract— The Acoustic Sensor Network has become the major impact in the field of wild life ecology and sensor network technology, according to the Naturalists. Under the ring topology, each sensor node can transmit and receive the information within circularly covered area of 3 kms in thick forests, situated in and around coimbatore. The primary goal of our proposed methodology is to determine the direction and location of the elephant within the vicinity of any village using hyperbolic circular array algorithm and results are implemented using MAT LAB Wave tool 8.1. The secondary goal is to identify the different external factors that affect the sensor network coverage area and also to estimate the error analysis report and error rectification methods. The simulation results shows that, there seems to be an error occurred in some of the specific cases and which is to be rectified using the Nearest Neighbouring algorithm for identifying the location of the elephant with respect to minimum distance between source and sensor. The necessity of doing this research is to avoid the collision between human beings and elephants and also to protect both communities.

Keywords— sensor network, ring topology, hyperbolic circular array, nodes.

Introduction

Elephants and mankind are bound together by a long social tradition of interdependence from ancient times. However, at present Human Elephant Conflict (HEC) has become one of the most emerging and significant socio-ecological problems in the world[14]. Human- Elephant collision has become an increasing concern nowadays and do not have safety on both sides. Innumerable elephants have lost their lives due to the greed of mankind for abducting tusks since 1980's[15].

Existing Methodology and Drawbacks

Estimation of Direction of Arrival(DOA) in array signal processing has been implemented for decades, and its super-resolution performance is acknowledged by many researchers. A series of classical algorithms, e.g. MUSIC, ESPRIT, are often used in estimation of DOA, however, the biggest drawback of these algorithms is that they cannot process the status of coherent signal

sources[5]-[9]. So it is necessary to remove coherency in advance. Though estimation of DOA has been applied in many fields about measurement, very few studies concern low-angle tracking in the surface and proposed a method of polarization diversity and blind central DOA estimation algorithm[12]-[15].

Before the arrival of Acoustic Sensor there are several traditional ways to monitor the elephant near the forest first, x-band radars are normally used to monitor elephants. One drawback is that the radar can't distinguish between elephants even though it can monitor animal several kilometres away[10][11]. Second, Human observer track animal with binoculars or cameras etc Third, Commercial trackers-GPS+satellite uploads : Unfortunately, for a large number of sensor nodes, adding GPS to all nodes in the network is not feasible, because in the presence of dense forests, mountains or other obstacles that block the LOS from GPS satellites, GPS cannot be implemented. Fourth , infrared cameras are used to monitor animals [1]-[4].

Implementation Of Research Data In Proposed Methodology

Research data transmission in proposed methodology is split up in to 4 stages. They are **Sensor deployment in forests** - In sensor recording, the sample rate of elephant sound is fixed as 500msec. If the sampling frequency > 500 msec then the corresponding signal is stored in the sensor database as acoustic wave file in the analog form and sampling frequency < 500 msec are considered as noise or unwanted sound.

Analog to Digital Conversion - As soon as the sensor senses the incoming signal, the signal pre-processing (Analog/Digital(A/D) conversion, Filtering and Compression) are done. The digitized signals are accumulated to transfer to PC after pre-processing.

Filtering of signal - In order to remove the unwanted signal occurring from external environment the system is designed with adaptive filter to extract the specified frequency ranges.

Splitting of filtering signal - Depending upon the frequency, the filtering signal is split up as S1(f) to S4(f) as shown in the figure(1). Split up signal is next transferred in to proposed methodology for direction of arrival estimation.

Direction of Arrival Computation - The retrieved digital signals were post-processed inside the PC to determine the DOA arrival. Using this minimum distance calculation the acoustic source Direction of Arrival (DOA) with respect to the microphone array.

The above process is repeated for all the microphones when the acoustic source is present within the region of sensor array. The trigonometry angles are considered in order to estimate the sound source location and distance estimation between source and sensor.

Hyperbolic Circular Array Algorithm

- STEP 1 : Start the process
- STEP 2 : Four sensors are deployed using set position = [x,y,z,x1]area .
- STEP 3 : if sampling frequency > 500 msec then stored *.acoustic wave file ,compressed and filtered Else goto step2.
- STEP 4: if (Packet type!= broadcast) then Add Neighbour table using SPIN Protocol and remove the redundancy of signal Else goto step 5.

Step 5: if digital signal(ds) > 500msec then estimate parabolic height $h1 = \sqrt{x^2 + (x1 + d / 4)^2}$,

distance between source and sensor $h12 = h1 - h2$, minimum distance with Angle of Arrival(AoA) = $s^2 = r1^2 + r2^2 - 2 r1 r2 \cos \theta$, minimum distance

between 4 sensors $D = \sqrt{(x1 - x2)^2 + (y1 - y2)^2 + (z1 - z2)^2}$ and Angle of Arrival (AoA) .

Step 6: if expected position (i, 1)(j, 2) (k,3)= estimated position (x, y, z) then goto step 7.

Else Check : if (d (S, D) < d (N, D) then Apply Error Rectification Methods and Nearest Neighbour algorithm for identifying the nearest sensor with respect to source.

Step 7: Stop the process.

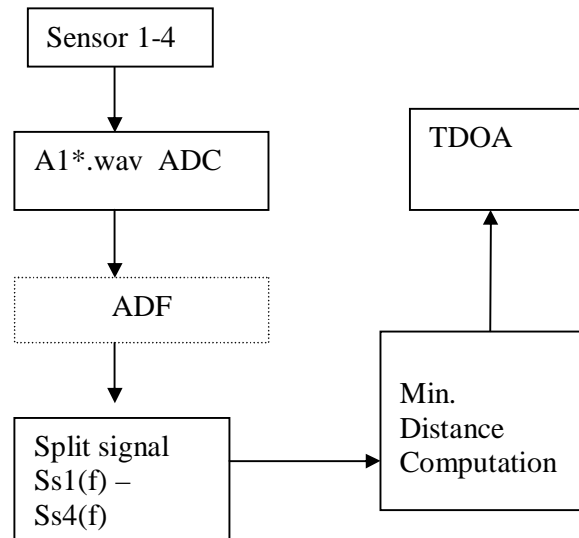


Figure 1: Research data transmission in Sensor Network Coverage
 • ADC - Analog to Digital Conversion, ADF - adaptive Filtering, TDOA - Time difference of arrival

Real Time Sensor Value Direction Of Signal Receiving In Base Station

In order to estimate signal arrival in our sensor network coverage area, the following parameters are estimated between signal reaching different microphones.

Table 1. Direction Of Signal Analysis in Base Station

By comparing the real time sensor network value table the real time sensor network coverage on forests encountered various external factors. Due to the external factors the accuracy of signal direction estimation is affected and also signal propagation is also affected by metrological parameters such as(thunder, echo,reflection etc). In order to reduce

Target Cases & Category	sensor ID	Distance Between sensor' (d)	Distance Between Source and sensor(mts) (D)	Expected Direction Of Arrival		Estimated Direction Of Arrival		Time Diff. Of Arrival (msec) TDOA
				Azimuth angle Θ (angle direction)	Elevation \square (hyperbolic Height)	Azimuth θ	Elevation \square	
1.Moving near object	1	0.5	10	40	20	40	20	5
2.Moving object signal	2	0.5	8.3	45	12	60	32	3
3.moving signal	3	0.5	6.5	75	25	70	24	6
4.signal stand alone	4	0.5	6.5	73	21	60	20	7
5.signal moving	2	0.5	5.8	80	-12	60	27	2

the above error rate in direction of arrival results, location difference and average difference between real time data and tool data are estimated in future.

Comparisons could then be made of the performance of real time and simulated tool data under hyperbolic circular array algorithm. Each circumstance can produce various results, and few of them are more sensitive to error factors than others. Each microphone was separated by a distance of 0.5m for all the experiments. The sensor distance was chosen for real time practical experimental purposes in forests as well as limitations suited for the sensor device.

In the above table, **yellow colour shade** indicates there is no change in expected and estimated values for direction of arrival estimation. **Red colour font** indicates due to some external factors there is a major change in expected and estimated direction of arrival results.

Conclusion And Future Work

The main aim for selecting this research problem at this juncture, is to focus and draw the attention of our government and society in order to protect both the Elephant and human beings and the resulting consequences in our society. Before estimating the Direction of Arrival, the acoustic signals are first pre-processed (Analog to Digital Conversion, Compression and Filtering).After pre-processing the signal, the digital signals are considered as input to data validation phases. After estimating the real time direction of signal analysis from base station, it is necessary to determine direction of signal arrival for simulated tool Matlab 8.1. After

estimating the direction of signal results, it clearly shows that there is an error rate occurred in specific cases. In order to reduce the errors occurred in elephant signal, various constraints are estimated using the proposed methodology in future. In Future I would like to extend and evaluate the work in the following areas. Identify the elephant network path, type of elephant and increase the distance of sensor coverage area.

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