Journal of Electronic and Optical Communication

Volume No. 8

Issue No. 1

January - April 2024

ENRICHED PUBLICATIONS

ENRICHED PUBLICATIONS PVT. LTD

S-9, IInd FLOOR, MLU POCKET,
MANISH ABHINAV PLAZA-II, ABOVE FEDERAL BANK,
PLOT NO-5, SECTOR-5, DWARKA, NEW DELHI, INDIA-110075,
PHONE: - + (91)-(11)-47026006

Journal of Electronic and Optical Communication

Aims and Scope

Journal of Electronic and Optical Communication is a journal that publishes original research papers in the fields of Electrical and Electronic Engineering and in related disciplines. Areas included (but not limited to) are electronics and communications engineering, electric energy, automation, control and instrumentation, computer and Advanced technology, and the electrical engineering aspects of building services and aerospace engineering, Journal publishes research articles and reviews within the whole field of electrical and electronic engineering, new teaching methods, curriculum design, assessment, validation and the impact of new technologies and it will continue to provide information on the latest trends and developments in this ever expanding subject.

Journal of Electronic and Optical Communication

Journal of Electronic and Optical Communication

(Volume No. 8, Issue No. 1, January - April 2024)

Contents

Review on Prediction of Epileptic Seizure from EEG Signal By DWT and Ann Technique

[1]Deepali Khandekar, [2]Prof. Patil S. P

[1,2] Department of Electronics and Telecommunication Engineering

BMIT, Solapur (M. S.) India.

A B S T R A C T

Epilepsy is the most common neurological disorder which is characterized by sudden and recurrent neuronal firing in the brain. It can be detected by analyzing EEG of the subject. Electroencephalograms (EEG) are signal records of electrical activity of brain neurons. It can easily display wave patterns like alpha, beta, delta, etc according to human behavior. Prediction of EEG signals has core issues on EEG based brain mapping analysis. EEG, which is a compulsive tool, used for diagnosing neurological diseases such as epilepsy, besides of techniques such as magnetic resonance and brain tomography (BT) that are used for diagnosing structural brain disorders. EG input signals are in stationary and non-stationary form. It is very difficult to predict it. Various comparison and classification techniques are used to measure irregularities present in the EEG signals. This paper describes a novel approach for forecasting epileptic seizure activity, by classifying these EEG signals. The decision making consists of two stages; initially the signal features are extracted by applying wavelet transform (WT) and then an artificial neural network (ANN) model, which is a supervised learning-based algorithm classifier, used for signal classification.[3]

Wavelet transform is the effective method for time frequency representation signal analysis. The classification of EEG signals has been performed using features extracted from EEG signals. The performance of the Artificial neural network is used for signal classification and tests carried out by hidden layer.

Keywords—Electroencephalography, EEG signal, Dwt , ANN Feature Analysis, Prediction of EEG

1. Introduction

EEG is the most useful and cost effective and successful tool in neuroscience to diagnose diseases and neurological disorders which is caused due to the electrical activity within brain. Epilepsy is one of the most serious neurological disorders. About 50 million people world-wide are suffering from epilepsy and each year, 2.4million new cases are estimated to occur globally. In most of the adult patients, it occurs in the mesial temporal structures such as hippocampus, amygdale, and parahippocampal gyrus. It is characterized by recurrent seizures, transient impairments of sensation, thinking, and motor control, caused by sudden excessive electrical discharges in a group of brain cells.

The electrical activity of active nerve cells in the brain produces currents spreading. These currents reach the scalp surface, and resulting voltage differences on the scalp can be recorded as the electroencephalogram. Thus it is the recording of electrical activity along the scalp produced by the firing of neurons within the brain. The EEG records can easily display these electrical discharges as a rapid change in potential differences. Thus, neurologists invariably use EEG records to investigate suspected seizure phenomena.[7]

Epileptic seizures are sudden abnormal function of the body, with loss of consciousness, an increase in muscular activity or an abnormal sensation. There is use of wavelet based features for the classification between normal and seizure EEG signals.

Thus neurologists invariably use EEG records to investigate suspected seizure phenomena ejection of a seizure attack. EEG input signals are in stationary and non stationary form. There are various comparison and classification techniques are used to measure irregularities present to predict EEG signals. The detection of epilepsy is possible by analyzing EEG signals. [4]

II. Data Description

Data collection is a process of gathering information from a variety of sources. In this paper data from EEG signal of approximately 40 to 50 patients is collected and used to train Ann network model. Each EEG signal consists of 309000 data points. This data points are further divided with set of 154 each contains 2000 data points. The energy is extracted from these data packets for further analysis.

Methodology

Signals originated due to muscle movements are another artifact. The first step is to preprocess the data to remove artifact slow and high frequency components. The next step is to process the filtered signal and extract features that represent or describe the status and conditions of the system. Such features are expected to distinguish between normal and seizure.

Preprocessing:

Data preprocessing transforms the data into a format that will be more easily and effectively processed for the purpose of the user. There are a number of different tools and methods used for preprocessing such as sampling, de-noising, filtration, normalization etc. In this stage detailed frequency content is obtained by NFFT (Nyquist Fast Fourier Transform) which is considered in EEG Signal. The high frequency components are removed from the EEG signal and low frequency signals are allowed to pass. The Low Pass Filter is designed according to the Specification and Parameters. At the end of preprocessing stage we obtained new filtered signals.

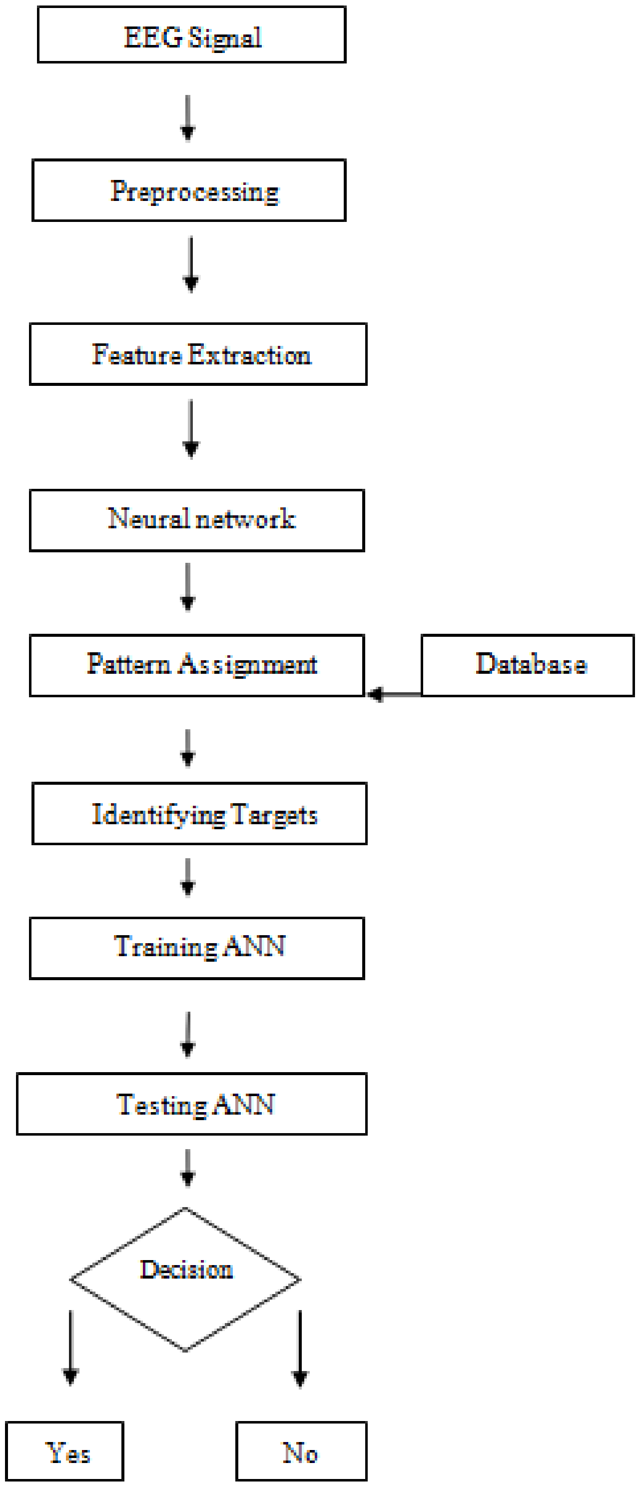


Fig 1 : Functional Modulus of EEG Preprocessing System

III. Design and Implementation Wavelet Transform (WT)

The wavelet transform (WT) is designed to address the problem of non-stationary signals. The main advantage of the WT is that it has a varying window size, being broad at low frequencies and narrow at high frequencies.

Spike parameters extracted from the EEG signal, such as slope and sharpness, are presented to the ANNs for training and testing. The selection of the parameters is very important task for success of such types of system. The EEG signals, consisting of many data points, can be compressed into a few features by performing spectral analysis of the signals with the WT. These features characterize the behavior of the EEG signals. Using a smaller number of features to represent the EEG signals is particularly important for recognition and diagnostic purposes. The window size of 20 points (100 ms) produced successful results [8- 10]. Later, this window was extended to 30 points (150 ms) for further improving detection accuracy.[4]

Feature Extraction

Feature extraction is the process of defining a set of features, or image characteristics, which will most efficiently or represent the information that is important for analysis and classification. The last step is the classification and diagnostics. In this step, all the extracted features are submitted to a classifier that distinguishes among different classes of samples, for example, normal and abnormal. In the seizure detection problem this step is the classification between normal and seizure EEG signals. Selection of appropriate wavelet and the number of decomposition levels is very important in analysis of signals using the WT. The number of decomposition levels is chosen based on the dominant frequency components of the signal. Thus, the EEG signals were decomposed into details D1–D4 and one final approximation, A4. The smoothing feature of the Daubechies wavelet of order 6 made it more suitable to detect changes of the EEG signals [2].Therefore, the wavelet coefficients were computed using DB 6.

The computed detail and approximation wavelet Coefficients of the EEG signals were used as the feature vectors representing the signals. The EEG signals were decomposed into time–frequency representations using discrete wavelet transform and statistical features were calculated[4].

In this stage filtered signal is Selected for feature extraction and DB6 level, applied to extract the feature on selected signal. Wavelet Energy is recorded after summing of detail coefficients. Then we can plot three subplots for detail, approximate and moving window number.

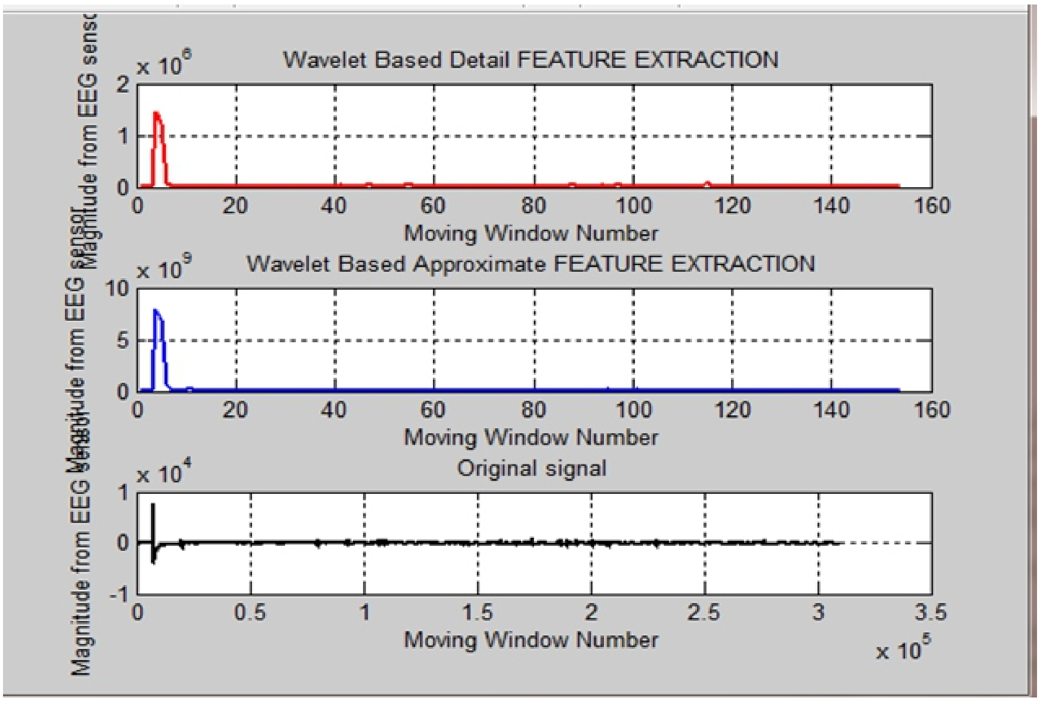


Fig 2: Detail and approximate feature extraction.

Artificial Neural Network:

A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. Neural networks are used for modeling complex relationships between inputs and outputs or to find patterns in data.

In this ANN approach the neural network is prepared Artificially by training it through giving various Inputs of EEG pattern such as Normal patients, Brain death, slow wave and Epilepsy etc. Neural Network gets trained for these various types of Inputs according to feature extraction, wave pattern and energy values. The trained model is checked tested for its efficiency up to acceptable level and then the completed Model is now can be used for actual testing and reorganization of unknown patients EEG pattern for different types o diseases as mentioned above.[4]

IV. Result

Target Pattern to the ANN model			Answer given by the ANN model at trained stage			Answer as per algorithmic absolute value			Error			Display Remark
1.00	0	0	0.9593	-0.0189	0.0616	1	0	0	0	0	0	Normal
0	1.00	0	-0.0210	0.9763	0.0452	0	1	0	0	0	0	Brain Death
0	0	1.00	0.0415	0.0187	0.9371	0	0	1	0	0	0	General Epilepsy

Table 1: Result of ANN trained data pattern (Classification and Training stage)

Accuracy of Algorithm for Brain death Disease (a)	Accuracy of Algorithm for Normal(b)	Accuracy of Algorithm for General Epilepsy(c)	Accuracy of Algorithm for Slow wave (d)	Accuracy of Algorithm for Focal Epilepsy(e)	Calculated Avg. Accuracy (= a+b+c+d+e) / 5
100%	**100%**	**90%**	**100%**	**100%**	**98.00%**

Table 2 : Summery of Result / Accuracy of ANN Algorithm

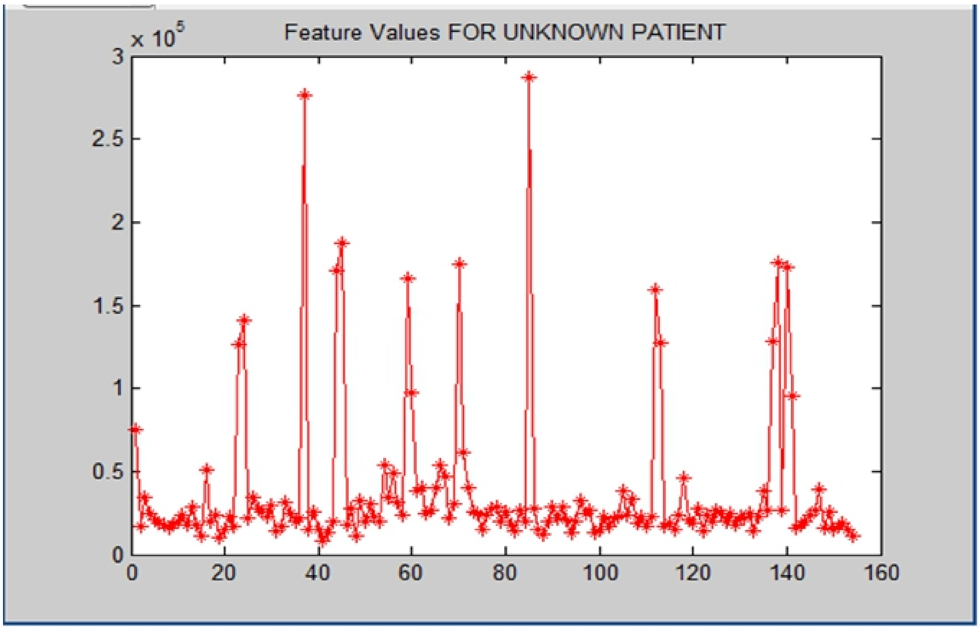


Fig 3: Energy Values for Patient under test (Disease detection stage)

V. Conclusion

This work presents a new method to calculate the features in the wavelet packet space, called as wavelet packet features. The aim is to demonstrate the application of wavelet method to analysis of the segment of spontaneous EEG. This application may turn especially useful for studying EEG synchronization in conditions with certain limitation for long duration records. Thus Wavelet coefficients were used as feature vectors identifying characteristics of the signal. Selection of appropriate wavelet and the number of decomposition levels is very important in analysis of signals using the WT to remove dominant frequency.

Selection of the ANN inputs is the most important component of designing the neural network based on pattern classification since even the best classifier will perform poorly if the inputs are not selected well.

Input selection has two meanings: (1) which components of a pattern, or (2) which set of inputs best represent a given pattern [8]. The first-level networks were implemented for the EEG signals classification using the statistical features as inputs. To improve diagnostic accuracy, the second-level networks were trained using the outputs of the first-level networks as input data. Three types of EEG signals recorded from healthy volunteers, epileptic patients, patients with brain death disease were classified. ANNs do not need any specific rules but only examples for training. Thus, ANNs offer an attractive solution to recognition and classification tasks where complete rules cannot written.

VI. Future Scope

Developing algorithms by combining ANN models and Fuzzy logic is another approach in classifying extracted features of EEG signals. Neuro-fuzzy systems are fuzzy systems, which uses the ANNs theory in order to determine their properties (Fuzzy sets and fuzzy rules) by processing data samples. By replacing the extreme values of wavelet coefficients with suitable percentiles, the classifiers gave better classification accuracy. The high overall classification accuracy obtained verified the promising potential of the proposed classifier that could assist clinicians in their decision making process. The task of epileptic seizure prediction [8] is another interesting task where it requires the classifier to differentiate between pre-ictal and inter-ictal data. A major drawback of the existing wavelet neural networks is that their application domain is limited to static problems due to their inherent feed forward network structure. In the future, a recurrent wavelet neural network will be proposed for solving identification and control problems.

References

[1]S. M. Shafiul Alam and M. I. H. Bhuiyan, ―Detection of Seizure and Epilepsy Using Higher Order Statistics in the EMD Domain‖, IEEE Journal Of Biomedical And Health Informatics, Vol. 17, NO. 2, March 2013.

[2] Daubechies, I. (1992). Ten lectures on wavelets. CBMS-NSF regional series in applied mathematics. Philadelphia, PA: SIAM.

[3] Dr. R Harikumar, M. Balasubramani, Saravanan S. ― FPGA Implementation of Wavelet Neural Network for Epilepsy Detection ‖, Volume 2, Issue 9, March 2013.

[4] Nandish.M , Stafford Michahial, Hemanth Kumar P, Faizan Ahmed ―Feature Extraction and Classification of EEG Signal Using Neural Network Based Techniques‖, Volume 2, Issue 4, October 2012.

[5] Alexandros T. Tzallas, Markos G. Tsipouras, and Dimitrios I. Fotiadis, ―Epileptic Seizure Detection in EEGs Using Time–Frequency Analysis‖, IEEE Transcations On Information Technology , VOL. 13, NO. 5, September 2009.

[6] Y. U. Khan and O. Farooq, ―Autoregressive features based on classification for seizure detection using neural network in scalp electroencephalogram‖, International Journal of Biomedical Engineering and Technology, vol. 2, no. 4, pp.370-381, 2009.

[7]F.H.Lopesda Silva,―EEG analysis:Theory and practice,‖in Electroencephalography, Basic Principles, Clinical Applications and RelatedFields, E. Niedermeyer and F. H. Lopes da Silva, Eds. Baltimore,MD: Williams and Wilkins, 1993, pp. 1097–1123.[10-28electrodes]

[8] Schelter B, Winterhalder M, Drentrup H, Wohlmuth J, Nawrath J, Brandt A, Schulze- Bonhage A, Timmer J. Seizure prediction: The impact of long prediction horizons. Epilepsy Res 2007; 23:213-7.

Distinguishability-To-Noise Ratio (Dnr), A Parameter To Determine The Discriminating Capability of An Eit Instrument

S. Talha Ahsan[1,2] and H. McCann[1,3]

[1] *School* of Electrical and Electronic Engineering, University of Manchester, UK
[2] Dept. of Electrical Engineering, Usman Institute of Technology (UIT), Karachi, Pakistan.
[3] School of Engineering, University of Edinburgh, UK.

A B S T R A C T

An important aspect of an EIT (Electrical Impedance Tomography) instrument's performance is its Distinguishability, i.e. effectiveness in discriminating the conductivity contrasts present in the object being probed, in the presence of measurement noise. A comparison of the value of distinguishability with that of measurement noise is critical, as good detection capability due to high distinguishability can be masked by the large noise present in the EIT instrument. This paper suggests a newly-coined term distinguishability-to-noise ratio (DNR), which is the value of distinguishability divided by that of measurement noise. It is proposed that DNR which quantifies the comparison of distinguishability with the measurement noise, would be useful in determining the capability of an EIT system to detect conductivity contrasts. For the EIT instrument FEITER (functional EIT of Evoked Responses), measured values of distinguishability and DNR have been presented, and the reconstructed images have been analyzed in this context, showing that the lower is DNR, the higher is the error in the size of an inserted inhomogeneity as shown in the reconstructed image.

***Key Words**: Distinguishability, Noise, Detection, Image, SNR, DNR*

1. INTRODUCTION TO DISTINGUISHABILITY

Definitions

The distinguishability of an EIT instrument has many possible definitions. [1] talks about an inhomogeneous conductivity distribution being *distinguishable* from a homogeneous conductivity distribution and suggests the term distinguishability, pointing out its similarity to another term, visibility, used by [2]. [3] defines distinguishability as the "ability of a pattern of currents to distinguish between two conductivities". Distinguishability is thus synonymous with discrimination – an important characteristic of any measurement system [4]. Distinguishability is generally defined in literature as the change in the boundary voltage levels, caused by the change in the conductivity distribution of the subject [5, 6]. Conductivity changes must themselves be defined in terms of both conductivity contrast and spatial extent (figure 2 in [7]).

Mathematically, distinguishability has been defined as the norm of the voltage differences (resulting from the conditions of pre- and post-change in conductivity distribution within the subject) divided by the norm of the applied current [1, 8]. In this definition, the numerator is a number which represents the change in voltages, pre- and post- perturbation, measured on all of the electrode-pairs for all of the current patterns. There can be many ways to calculate this number [3, 9]. One possible way to calculate a number representing the change in voltages can be to use either the mean or median of the voltage measurements normalised by the value of the injected current. Equations 1 and 2 enable calculation of distinguishability (d), as the mean of ΔV_i, which are the absolute differences of the normalised voltages.

$$\Delta V_i = |V_{i,pre} - V_{i,post}| \quad (1)$$

$$\delta = \frac{1}{N}\sum_{i=1}^{N}\Delta V_i \quad (2)$$

Where:

$V_{i,pre}$ and $V_{i,post}$ are the pre- and post-perturbation values, respectively, of the ith voltage measurement, normalised by the current, and

i is called the measurement index having values from 1 to N, where N is the total number of voltage measurements for all combinations of measurement-electrode-pairs and current injection patterns, comprising one frame of data.

The unit of distinguishability (δ) is either ohm, or volts normalised for the value of the injected current. The latter unit has been followed in this paper. Equations 1 and 2 have been used for the analysis of results.

Factors controlling Distinguishability

Distinguishability of an EIT system depends upon the cumulative effect of following several factors:

a) number of current sources [10, 11, 12]

b) type of current drives [13] and current patterns [14, 9, 15, 16]

c) number, size and configuration of the electrodes [17, 18, 19, 20, 21]

d) measurement precision of the system [6, 7]

The above factors can be collectively called „measurement configuration‟. These have been discussed in detail in the above-cited sources and need not be repeated here.

2. DISTINGUISHABILITY-TO-NOISE RATIO (DNR)

In the context of EIT systems‟ performance, the comparative relationship between distinguishability and measurement noise is critical, as good detection capability of the EIT instrument due to high distinguishability can be masked by the measurement noise. One approach incorporates noise into the definition of distinguishability, proposing that distinguishability is a product of the impedance change amplitude, the measurement strategy and the inverse of the noise amplitude [22]. This approach has been used to explore different current stimulation patterns. [23] have suggested various parameters to evaluate and compare EIT systems‟ performance. These parameters characterize noise and accuracy in measured data and reconstructed image, as well as detectability and distinguishability of single and multiple contrasts. [24] have proposed a new noise performance metric for EIT algorithms which is based on distinguishability.

In order to quantify the comparative link between distinguishability and measurement noise considered separately, in case of a given set of current injection and voltage measurement strategies, a scheme is hereby proposed. The value of distinguishability calculated as per equation 2, is divided by the measurement noise (calculated as standard deviation in the voltage measurements), resulting in a non-dimensional quantity normalised for a certain value of current. This quantity is hereby called distinguishability-to-noise ratio (DNR). It is proposed that DNR which quantifies the comparison of distinguishability with the measurement noise, would be useful in determining the capability of an EIT system to detect conductivity contrasts, as supported by the results discussed later.

The impact of the measurement signal-to-noise ratio (SNR) on the quality of the reconstructed image is well- established [19, 25]. In order to have good spatial resolution in images, it is necessary to have both high distinguish- ability and low measurement noise; this would mean high value of the proposed parameter DNR in the EIT instrument. This is a necessary but not sufficient condition, as the other factor controlling image quality is the image reconstruction process itself. The overall link among SNR, distinguishability, DNR and spatial resolution in images can be depicted schematically as in figure 1.

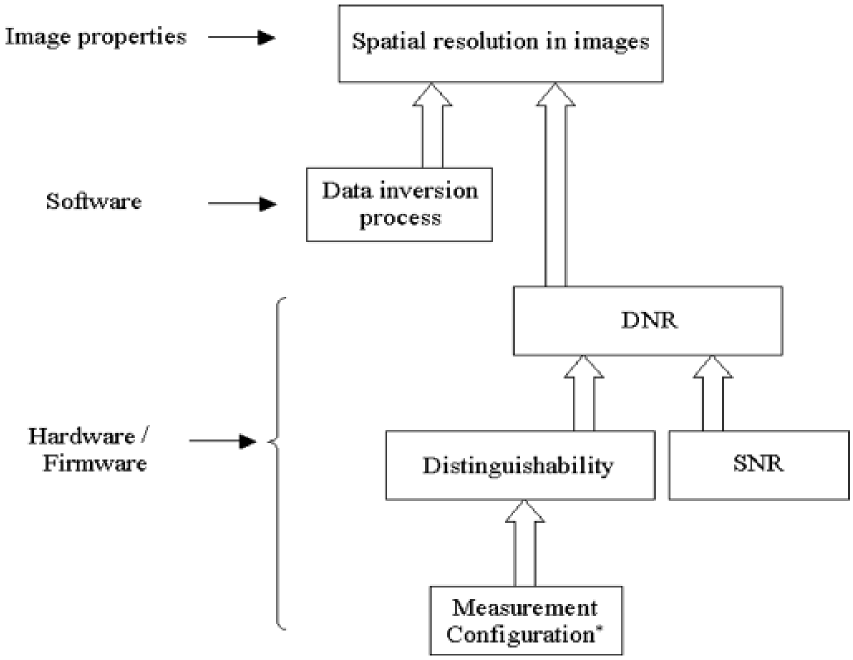


Fig. 1 Inter-dependence among SNR, DNR and Image quality in an EIT system

* *Number of current sources; type of current drives; number, size & configuration of electrodes; and system precision*

Distinguishability is not uniform throughout the subject, due to the nature of the electric field resulting from the injected current in an EIT system. It is always poorer in the centre of the subject, compared with peripheral regions where the electrodes are placed [26]. Therefore, having high DNR near the centre of the subject is a major challenge for EIT instruments.

Next section presents the distinghuishability and DNR results measured for the 35-channel bio-medical EIT instrument fEITER (functional Electrical Impedance Tomography of Evoked Responses) built at the University of Manchester [27]. The aim of the fEITER system is to achieve brain function imaging at sub-second time-scales, with the measurement sensitivity of around 80 dB at the high data-capturing rate of 100 frames/sec. Firmware loaded on a Xilinx Virtex-4 SX35 FPGA performs the EIT operation, with injection current of 10 kHz frequency and 1 mA peak-to-peak amplitude. Images are reconstructed with the method employed in [28], using the EIDORS 3D software.

3. RESULTS OF MEASURED DISTINGUISHABILITY AND DNR

In order to assess the noise- and distinguishability-related performance of the bio-medical EIT instrument fEITER, tank tests were performed. Measured voltage results of these tank tests were reported in [29]. In these tests, the typical measured value of SNR was around 80 dB. Test results using precision resistor wheel were reported in [27].

Following is a presentation of the tank test results in terms of the measured values of distinguishability and DNR, and an analysis of the reconstructed images. Similar work has been reported in literature for other EIT instruments, e.g. [8, 5, 30].

Test Methodology

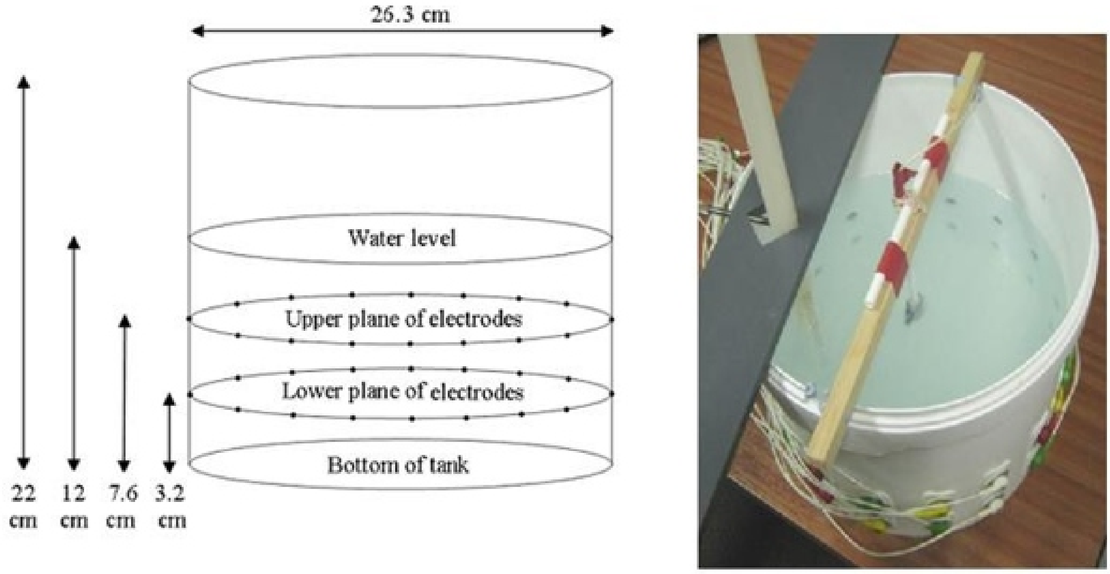


Fig. 2 (a) 3D view of cylindrical tank (b) Nylon rod inserted in tank

The cylindrical tank (figure 2) had the diameter and height of, respectively, 26.3 and 22 cm, and the water depth during tank tests was 12 cm. On the inner surface of the tank, 32 electrodes were arranged in two planes of 16. Electrodes 1 to 16 made up the lower plane, at a height of 3.2 cm from the bottom of the tank. Electrodes 17 to 32 made up the upper plane, at a height of 7.6 cm from the bottom of the tank. The reference electrode was dipped into the water at the centre position of the tank, from a wooden bar fixed at the top of the tank. For the tests, the tank was pre-filled with homogeneous medium (almost 7 litres of saline solution of typical conductivity 500 µS/cm), through which planar, polar current injection patterns were passed, and inhomogeneities were introduced during EIT data capture. There were 8 current injection patterns per plane, *viz.* 1-9, 2-10, 3-11, 4-12, 5-13, 6-14, 7-15, 8-16 in the lower plane and 17-25, 18-26, 19-27, 20-28, 21-29, 22-30, 23-31, 24-32 in the upper plane (figure 3).

For the test, initially a nylon rod having length more than the water depth and diameter of 2.1 cm was used as the single solid inhomogeneity. EIT data capture using fEITER system was started. After approximately 30 seconds, the nylon rod was slowly inserted into the tank at a position in front of electrodes 10 and 26 and kept there till the end of the one minute data capture. The rod was fully inside the water and it barely touched the bottom. Because of the clamp,

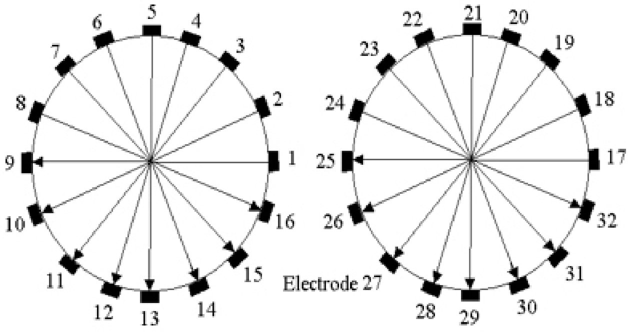


Fig. 3 Top view of current injection patterns for the electrodes in lower (left figure) and upper planes

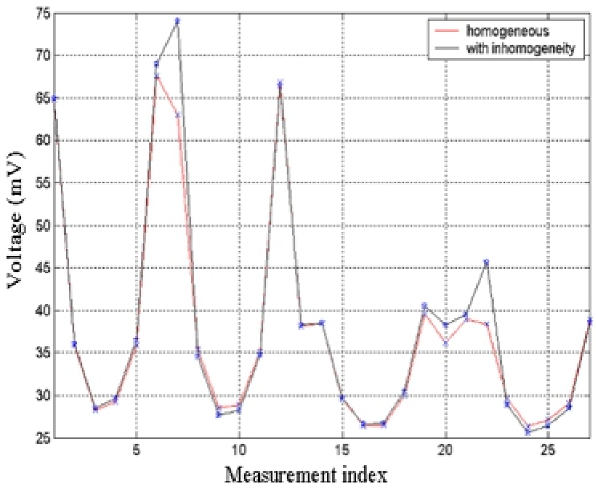


Fig. 4 Pre- and post-perturbation peak-to-peak normalised magnitudes, averaged over 500 frames for the current (figure2(b)).

For the analysis of the measured voltage data, in both pre- and post-perturbation cases, the average of ith voltage measurement was calculated over 500 frames, where i is the measurement index i.e. combination of current- injection- and voltage measurement-pairs, ranging from 1 to 420.

Distinguishability and DNR of the EIT instrument for solid inhomogeneity

Figure 4 shows the plots of measured voltages for pre-perturbation i.e. homogeneous (red colour) and post- perturbation (grey colour) cases, for a sub-set of the measurement indices (numbers 1 to 27, involving all the voltage measurements for the current injection at electrode-pair 1-9). DV_i (as per equation 1) is the absolute difference in the two normalised voltage magnitudes of pre- and post-perturbation cases and, for the first 27 measurement indices, is visible as the difference between the two plots in figure 4.

Figure 5(a) shows the plot of DV_i for all 420 measurement indices. Figure 5(b) shows two example time-based plots over one minute, of the normalised voltage magnitudes, for two of the measurement indices from figure 5(a). These plots are for measurement index number 7 (red in both (a) and (b)) and 218 (black in both (a) and (b)). These measurement indices correspond to, respectively, „1-9 (current injection-pair) 10-11 (measurement-pair)‟ and „17-25, 8-9‟. Table 1 shows the five largest values of absolute changes in normalised voltage magnitudes along with their corresponding current-injection and measurement electrode-pairs.

Distinguishability can be calculated (as per equation 2) as the average of DV_i calculated over all 420 values of measurement index i. The Distinguishability of the fEITER system for this inhomogeneity, i.e. nylon rod of cross- sectional area 0.64 % of the tank, at this position, comes out to be 963.2 mV as normalised for 1 mA injected current. The pre- and post-perturbation mean standard deviations (calculated over 500 frames in each case) are, respectively, 10.26 mV and 12.38 mV. Using the higher value of 12.38 mV as denominator, with the distinguishability of 963.2 mV as numerator, gives the worst case DNR value as 77.8. (Figure 9 in section 3.4 shows the image reconstructed for this case.)

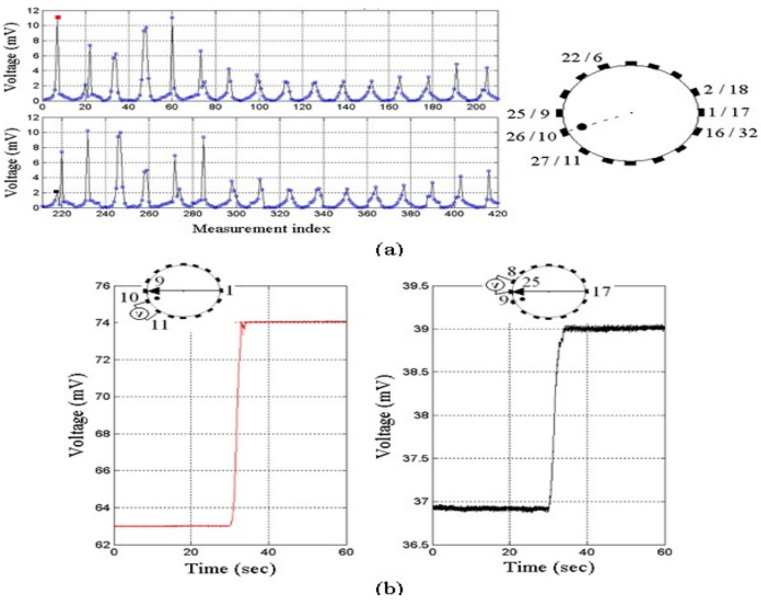


Fig. 5 (a) Absolute change in normalised magnitudes, pre- and post-insertion of nylon rod in tank (b) Time-based plots of normalised magnitudes for two measurement indices of (a) i.e. numbers 7 („1-9, 10-11"; red plot) and 218 ("17-25, 8-9"; black plot)

S. No.	Measur-ement index	'current injection-pair, voltage-measurement-pair'	ΔV_i (mV)
1	60	„3-11, 9-10"	11.07
2	7	„1-9, 10-11"	11.05
3	232	„17-25, 26-27"	10.23
4	247	"18-26, 10-11"	10.02
	48	„2-10, 26-27"	9.75

Table 1. Five largest absolute changes in inserted normalised voltage magnitudes, pre- and post- insertion of nylon rod in tank

S. No.	In-homogeneity	Cross-sectional area (% of tank)	Distingu-ishability (µV)	DNR
1	Wooden rod	0.036	42.4	3.78
2	Nylon rod	0.64	963.2	77.8
3	PEEK rod	1.39	1678.4	94.3
4	No in-homogeneity (reference solution)	-	6.7	0.62

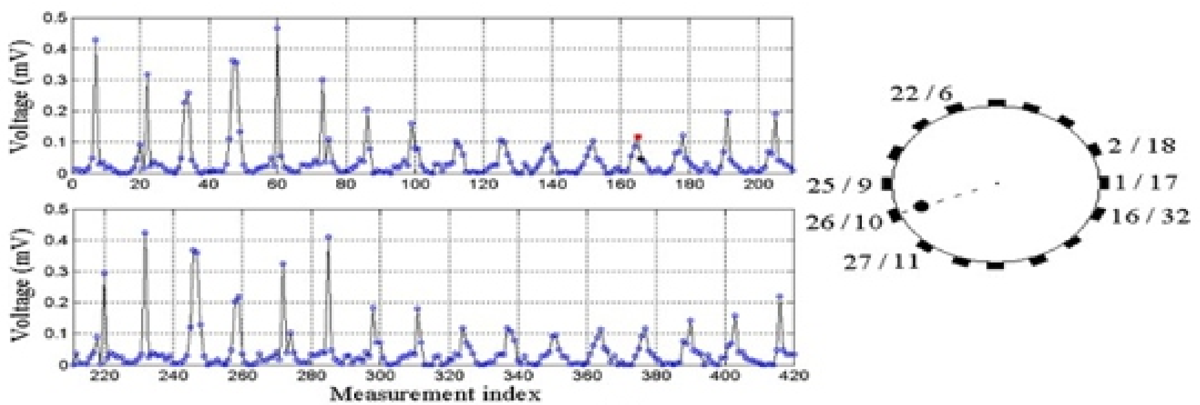
Table 2. Distinguishability measured for different objects in tank at the same position

Tank tests, with the same methodology were conducted with two other solid inhomogeneities, *viz.* wooden and PEEK rods, each inserted (one at a time) at the same position as shown in figure 5(a). The results are presented in table 2. These results convey a comparative picture of the distinguishability of fEITER for the inhomogeneities of different material as well as spatial size, introduced in the subject at the same location. An important aspect of these results is the almost linear relationship between spatial size of the introduced inhomogeneity and the resulting distinguishability. The last result in table 2 shows the instrument‟s distinguishability measured for a homogeneous solution. It gives a very low value, though the value being non-zero suggests that the solution was not ideally homogeneous. Section 3.4 presents conductivity images reconstructed using these results, for wooden, PEEK and nylon rods.

Detectable' and 'Undetectable' Distinguishability, for a solid inhomogeneity of small spatial size

The results of measured distinguishability for wooden rod in table 2 present a special case of the inhomogeneity of very small spatial extent (occupying only 0.036 % of the area of the subject), though of high conductivity contrast. Figure 6(a) shows the plot of DV_i (calculated using equation 1) for all 420 measurement indices, in this case. Figure 6(b) shows time-based plots over one minute, of the normalised voltage magnitudes, for two of the measurement indices from figure 6(a), having medium-to-low values of voltage change. These plots are for measurement index number 165 (red in both (a) and (b)) and 166 (black in both (a) and (b)). These measurement indices correspond to, respectively, "7-15 (current injection-pair) 10-11 (measurement-pair)" and "7-15, 11-12". The red and black plots show a voltage magnitude change of, respectively, 116 mV and 44.9 mV. The black plot shows that it is nearing the noise limit, with the measured change in voltage magnitude (44.9 µV) slightly higher than the noise level. The black plot still shows a well-resolved change of 0.162 %. This is the typical case of having voltage change bordering on "detectability" limit. Smaller voltage changes would be merged into noise voltage and would not be detectable.

The overall situation is depicted by the low distinguishability value of 42.4 mV, which is expected to be bordering



(a)

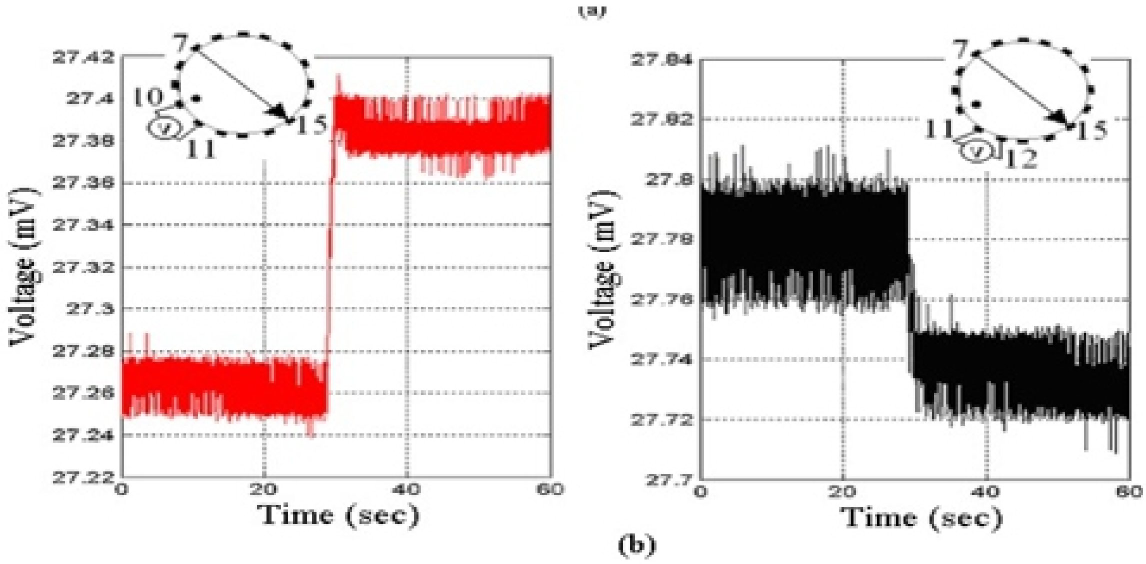


Fig. 6 (a) Absolute change in normalised magnitudes, pre- and post-insertion of wooden rod in tank
(b) Time-based plots of normalised magnitudes, for two measurement indices of (a)
i.e. numbers 165 („7-15, 10-11"; red plot) and 166 ("7-15, 11-12"; black plot)

on "detectability limit". The pre- and post-perturbation mean standard deviations (calculated over 500 frames in each case) are, respectively, 11.22 mV and 10.55 mV. Using the higher of the two as denominator and the distinguishability of 42.4 mV as numerator gives DNR value as 3.78. Comparing with the case of nylon rod at the same position (when DNR was 77.8), this DNR value is almost 20 times less, which is due to the much smaller- sized inhomogeneity. (Figure 8 presents the image reconstructed for this case.)

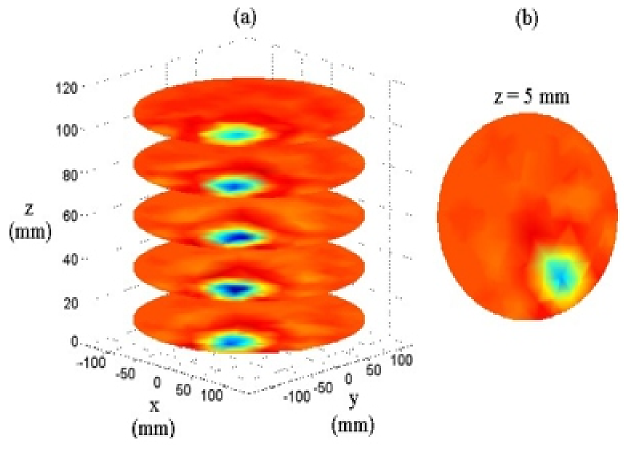


Fig. 7 Difference image of conductivity when a PEEK rod was inserted near the tank periphery in front of electrode 10, showing (a) slices at multiple planes (b) top view of the plane at z=5 mm planes

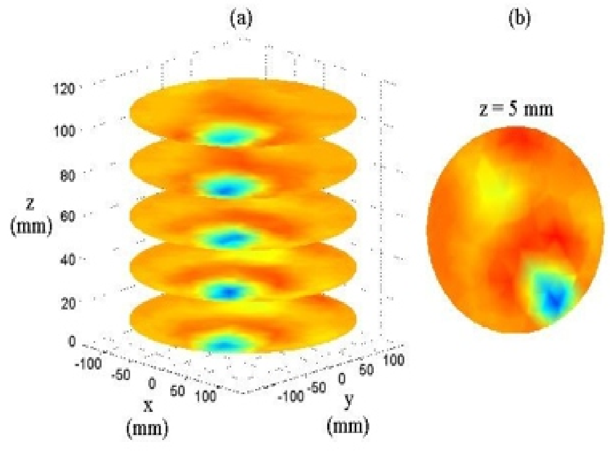


Fig. 8 Difference image of conductivity when a Wooden rod was inserted near the tank periphery in front of electrode 10, showing (a) slices at multiple planes (b) top view of the plane at z=5 mm

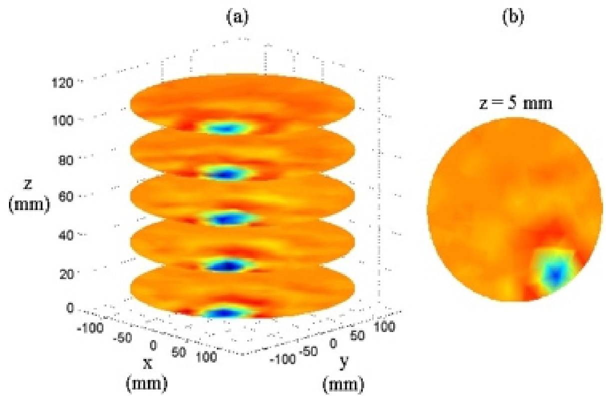


Fig. 9 Difference image of conductivity when a Nylon rod was inserted near the tank periphery in front of the electrode 10, showing (a) slices at multiple planes (b) top view of the plane at z=5 mm planes

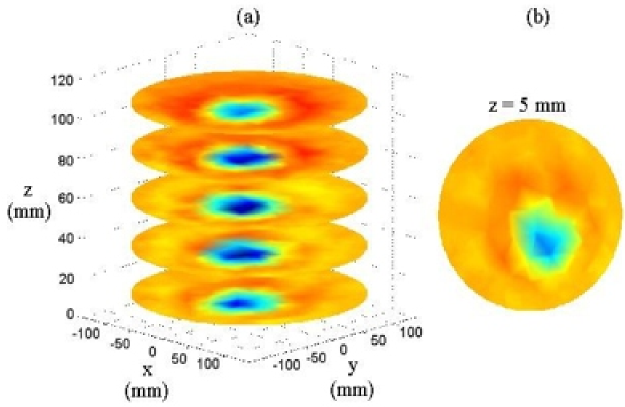


Fig. 10 Difference image of conductivity when a Nylon rod was inserted near the tank Centre, on line joining tank centre with electrode 10, showing (a) slices at multiple planes (b) top view of the plane at z=5 mm

Reconstructed images and link with DNR values

For the tank test data presented in table 2 for the inhomogeneities of wooden, nylon and PEEK rods, images were reconstructed. Another image for one more data set was reconstructed, when the same nylon rod was inserted near the tank centre, on the line joining electrode 10 and the centre of the tank.

Image reconstruction was performed using the method employed in [28]. It is based on General Tikhonov Regularization, with a model of 4413 tetrahedral elements and uses EIDORS 3D software. Reconstruction uses the real component of the captured data (normalized to 1 mA current). 100 data frames in the homogeneous part of data capture are averaged to give a 'reference frame'. The images are reconstructed from the differences in voltage measurements between the 'reference frame' and the 'target frame' at t=50 s (based on a 5 frame average).

Figures 7, 8, 9 and 10 show the solutions for the four cases mentioned above, plotted in ranges corresponding to their own local maxima and minima. Part (b) of these figures show a scalar cut plane plot for each solution at the tank height of z =5 mm. All reconstructed images are consistent with the inhomogeneity being almost in line of electrode 10 (x=100, y=-100).

Figure 7 is the image reconstructed for the PEEK rod, having the distinguishability of 1678.4 µV and DNR of 94.3. The ratio of actual diameters of tank to PEEK rod („actual dia.-ratio") is 8.5:1, whereas the image shows a dia.-ratio of 6.33:1 (for blurred green portion). Thus in the image, this inhomogeneity is shown with a size slightly larger than the actual, with an error of 25.5 % (s. no. 1 in table 3).

Figure 8 is the image reconstructed for the wooden rod, having the distinguishability of 42.4 µV and DNR of 3.78. The two „actual dia.-ratio" and „image dia.-ratio" (for green portion) in this case are, respectively, 52.6:1 and 4.22:1. The huge difference in the two ratios, reflecting 92 % error (s. no. 2 in table 3), can be related to two factors: i) Very low value of DNR and ii) larger size of the tetrahedral element (viz-a-viz the size of inhomogeneity) used in data inversion. Thus, as shown in figure 1, both of DNR and data inversion process are affecting the image quality in this case.

Figure 9 is the image reconstructed for the nylon rod, having the distinguishability of 963.2 µV and DNR of 77.8. The two „actual dia.-ratio" and „image dia.-ratio" (for green portion) in this case are, respectively, 12.5:1 and 4.75:1. The difference in the two ratios, reflecting 62 % error (s. no. 3 in table 3), is worse than the case of PEEK rod which had the largest values of distinguishability and DNR. However, it is better than the case of wooden rod which had the smallest values of distinguishability and DNR.

S. No.	In-homogeneity	Distinguishability (µV)	DNR	Tank-to-rod Diameter-ratio		
				Actual	In the reconstructed image	Error (%)
1	PEEK rod	1678.4	94.3	8.5	6.33	25.5
2	Wooden rod	42.4	3.78	52.6	4.22	92
3	Nylon rod	963.2	77.8	12.5	4.75	62
4	Nylon rod (inserted in tank-centre)	380.6	32.45	12.5	3.2	74.4

Table 3. DNR and the "tank-to-rod diameter-ratios" measured as actual vs in the reconstructed images

Thus, the comparative data of these images viz-a-viz DNR values, given in table 3, show that as DNR decreases (s. no. 1, 3, 4 and 2 in this order), the size of the portion of the image showing inhomogeneity increases erroneously. These images are showing the *location* of the inserted inhomogeneity correctly, even in the case of the smallest size of wooden rod. However, the *size* of the shown inhomogeneity is in error (i.e. the difference between the tank-to-rod diameter-ratio as in actual vs that in the reconstructed image), with the error being smallest and largest in the case of, respectively, largest and smallest distinguishability and DNR.

It is further interesting to compare figures 9 and 10, which are showing the same object (nylon rod) inserted near, respectively, periphery and centre of the tank. The distinguishability and DNR values for the latter case were, respectively, 380.6 mV and 32.45. The „actual dia.-ratio" in this case was the same as that for the case of figure 9 i.e. 12.5:1. However, figure 10 has „image dia.-ratio" (green portion) of 3.2:1, having an error of 74.4 % (s. no. 4 in table 3). Thus, as distinguishability and DNR decrease towards the tank centre, size of the green portion showing inhomogeneity has more error in figure 10, as compared with figure 9.

4. CONCLUSION

The comparison of distinguishability of an EIT instrument with the measurement noise determines its capability to discriminate the conductivity contrasts. In order to characterize this comparative link, a new term distinguishability- to-noise ratio (DNR) has been proposed in this paper, which is the distinguishability value divided by the noise in the voltage measurements. The result is a non-dimensional quantity, normalised for the value of the injected current. Usefulness of DNR in determining the capability of an EIT system to detect conductivity contrasts has been demonstrated through the examples of the inserted solid inhomogeneities. Results show that the lower is DNR, the higher is the error in the size of the inserted inhomogeneity as shown in the reconstructed image.

ACKNOWLEDGEMENTS

Author S. Talha Ahsan gratefully acknowledges Dr. J. L. Davidson (University of Manchester) for performing the reconstruction of images and Dr. P. Wright (University of Manchester) for providing the fEITER hardware system he had designed.

ABBREVIATIONS USED

DNR: Distinguishability-to-noise ratio; EIT: Electrical impedance tomography; fEITER: Functional Electrical Impedance Tomography of Evoked Responses; FPGA: Field Programmable Gate Array; PEEK: Polyether Ether Ketone; SNR: Signal-to-noise ratio.

REFERENCES

*1. Isaacson D 1986 Distinguishability of conductivities by electric current computed tomography IEEE Tr. Med. Imaging **5** 91-5*

*2. Seagar A D, T S Yeo and R H T Bates 1984 Full-wave computed tomography Part 2: Resolution limits IEE Proc. Science **131** Pt. A 616-22*

3. *Gisser D G, D Isaacson and J C Newell 1987 Current topics in impedance imaging Clin. Phys. Physiol. Meas.* ***8** suppl. A 39-46*
4. *Sydenham P H, N H Hancock and R Thorn 1989 Introduction to Measurement Science and Engineering John Wiley and Sons*
5. *Fuks L F, M Cheney, D Isaacson, D G Gisser and J C Newell 1991 Detection and imaging of electric conductivity and permittivity at low frequency IEEE Tr. Biomed. Eng.* ***38** 1106-10*
6. *Kao T-J, J C Newell, G J Saulnier and D Isaacson 2003 Distinguishability of inhomogeneities using planar electrode arrays and different patterns of applied excitation Physiol. Meas.* ***24** 403-11*
7. *Halter R J, A Hartov and K D Paulsen, 2008 Video rate electrical impedance tomography of vascular changes: preclinical development Physiol. Meas.* ***29** 349-64*
8. *Newell J C, D G Gisser and D Isaacson 1988 An electric current tomograph IEEE Tr. Biomed. Eng.* ***35** 828-33*
9. *Cheney M and D Isaacson 1992 Distinguishability in impedance imaging IEEE Tr. Biomed. Eng.* ***39** 852-60*
10. *Saulnier G J, R S Blue, J C Newell, D Isaacson and P M Edic 2001 Electrical impedance tomography IEEE Signal Processing Magazine Nov 2001 31-43*
11. *Saulnier G J, A S Ross and N Liu 2006 A high-precision voltage source for EIT Physiol. Meas.* ***27** S221-S236*
12. *Ashe J, D Shoudy, G Boverman, J Sabatini, T Kao and B Amm 2014 A high precision parallel current drive experimental EIT system, 15th Conf. Biomed. EIT Canada*
13. *Shi X, X Dong, W Shuai, F You, F Fu and R Liu 2006 Pseudo-polar drive patterns for brain electrical impedance tomography Physiol. Meas.* ***27** 1071-80*
14. *Gisser D G, D Isaacson and J C Newell 1988 Theory and performance of an adaptive current tomography system Clin. Phys. Physiol. Meas.* ***9** suppl. A 35-41*
15. *Demidenko E, A Hartov, N Soni and K D Paulsen 2005 On optimal current patterns for electrical impedance tomography IEEE Trans. Biomed. Eng.* ***52** 238-48*
16. *Silva O L, R G Lima, T C Martins, F S de Moura, R S Tavares and M S G Tsuzuki 2016 Influence of current injection pattern and electric potential measurement strategies in electrical impedance tomography* Control Engineering Practice (Elsevier online)
17. *Dickin F J and M Wang 1995 Impedance sensors – conducting systems, chapter 5 in Process Tomography: Principles, Techniques and Applications Williams R A and Beck M S ed. by (UK: Butterworth Heinemann)*
18. *Pinheiro P A T, W W Loh and F J Dickin 1998 Optimal sized electrodes for electrical resistance tomography Electronics Letters* ***34** 69-70*
19. *Polydorides N and H McCann 2002 Electrode configurations for improved spatial resolution in electrical impedance tomography Meas. Sci. Technol.* ***13** 1862-70*
20. *Mamatjan Y, B Grychtol and A Adler 2014 Effective electrode positions and stimulation patterns for head EIT Proc. 15th Conf. Biomed. EIT, Canada 85*
21. *Farooq A, J N Tehrani, A L McEwan 2014 Improvements and artifact analysis in conductivity images using multiple internal electrodes Physiol. Meas.* ***15** 2263-74*
22. *Adler A, P Gaggero and Y Maimaitijiang 2010 Distinguishability in EIT using a hypothesis-testing model, J. Phys.: Conf. Ser.* ***224** 012056*
23. *Yasin M, S Bohm, P O Gaggero and A Adler 2011 Evaluation of EIT system performance Physiol. Meas.* ***32,** 851*
24. *Adler A, F Braun and J Sola 2015 Distinguishability as a noise performance metric for EIT algorithms, 16th Conf. Biomed. EIT Switzerland*
25. *Stephenson D R, T A York and R Mann 2007 Performance and requirements of process ERT instruments Proc. 5th World Congress on IPT Bergen Norway 895-901*
26. *Seagar A D, D C Barber and B H Brown 1987 Theoretical limits to sensitivity and resolution in impedance imaging Clin. Phys. Physiol. Meas.* ***8** Suppl. A 13-31*
27. *McCann H, S T Ahsan, J L Davidson, R L Robinson, P Wright and C J D Pomfrett 2011 A portable instrument for high-speed brain function imaging: fEITER, Proc.33rd IEEE EMBS Conf. 7029-32*
28. *Davidson J L, L S Ruffino, D R Stephenson, R Mann, B D Grieve and T A York 2004 Three-dimensional electrical impedance tomography applied to a metal-walled filtration test platform Meas. Sci. Technol.* ***15** 2263-74*
29. *Davidson J L, P Wright, S T Ahsan, R Robinson, C J D Pomfrett and H McCann 2009 fEITER - a New biomedical EIT instrument for OR and ICU applications 10th Conf. Biomed. EIT, Univ. of Manchester UK*
30. *Lee K H, Y T Kim, T I Oh and E J Woo 2007 Complex conductivity spectra of seven materials and phantom design for EIT Proc. ICEBI'07 Graz Austria 344-7*

A Problems and Issues In Wireless Sensors Networks Existing In Efficiency Criteria

[1]Kamaljeet Singh & [2]Umesh Sehgal
[1]Assistant Professor
[2]Research Scholar

A B S T R A C T

Network security refers to the protection of information and resources from loss, corruption, and improper use. With WLANs, security vulnerabilities fall within the following areas .

- *Passive monitoring*
- *Unauthorized access*
- *Denial-of-service attacks*

The limited capabilities of a sensor node, such as restricted processing capabilities and a limited amount of energy, have an impact on all the parameters of a WSN. Taking into account the energy characteristics of transmitters in sensor nodes and their high susceptibility to interference, the quality of communication between sensor nodes can vary significantly with time. That is why the information loss and substantial delays often occur in WSNs. And their impact is closely associated with the size of a WSN.

Keywords: WSNs, Task Monitoring.

1. Introduction

Also, in order to save energy, sensor nodes in most WSNs are in the low power state (the sleep mode) most of the time, as mentioned in Section 2.2. At the low power state, all the components of a sensor node except the microcontroller are switched off and inside the microcontroller only a small portion of internal blocks are switched on. Moreover, in most applications, the amount of calculations, performed by the microcontroller at a sensor node, is reduced to minimum. This technique allows to extend the WSN lifetime up to several months or even several years.

For a typical monitoring applications information losses and shortage of the processing capabilities are not crucial, because dropping of one or several measurements does not have a strong influence on the result of the processing of the data from the whole WSN. Tolerance to partial loss of information due to the low communication quality is the main difference between common WSN applications and WSN applications for critical tasks. The critical tasks here and later will reference to such applications where the data received from the WSN is used as basis for responsible decision-making. The exact criteria for determining whether task is critical or not, are out of scope of this technical paper. This we describe only the main peculiarities and give a few examples of critical tasks. Applications of WSNs for critical tasks in comparison with applications for common tasks have stronger reliability, information security and quality of service (QoS) requirements. Clauses 7.2, 7.3 and 7.4 describe some relevant applications of WSNs for critical tasks.

2. Security and privacy

Wireless media is much more vulnerable than wired media for attackers. In critical tasks information security problems are particularly important since a security breach can result in a variety of negative effects. WSN applications for critical tasks are required to support integrity and confidentiality of the data exchanged during the application operations. These applications are required to provide security of exchanged data against malicious attacks. It is recommended to provide a secure channel to protect the data flows.

Data encryption and authentication are common information security techniques used in WSNs [50]. Restriction of access to the WSN settings and to the collected information is also a necessary measure of protection. These techniques in conjunction with the appropriate organization of interaction of sensor nodes in the WSN allow to achieve required level of security and privacy.

3. Fault tolerance

Errors in a WSN can occur for the following reasons: malfunction of one or more of sensor nodes, the change of environmental conditions, the actions of the attacker. According to most common practices, sensor node can be considered as failed if it sends measurements which significantly deviate from the results of the neighbor sensor nodes [51]. A faulty sensor node can be identified by the WSN as workable but provide bad measurement results.

A WSN intended for critical tasks has to operate well even if some nodes fail. In order to ensure a given level of fault tolerance, appropriate error correction mechanism must be provided. Besides, the WSN is required to ensure reliability and availability of the WSN infrastructure in order to handle a single sensor node failure. In case of such failures, the capabilities of the failed sensor nodes can be dynamically delegated to sensor nodes in order to provide consistent functioning and to prevent failure of the critical task.

Context Awareness

Context involves the information which can be used to describe the state of some physical object. This information has to be considered when making responsible decisions based on WSN measurements. For example, many of the processes are affected by temperature and time of day (especially in e-health applications). Without consideration of such dependencies, the data obtained from the WSN can be interpreted incorrectly. Data processing and decision- making systems of the WSN should also take into account the natural noise in sensor nodes, possible node failures and other sources of context information. For this purpose, context information is required to be collected, stored and used for decision making.

Quality of Service

The strict reliability requirements are often a key challenge for WSN utilization for critical tasks. Some applications require low latency in updating sensor readings, others may require high accuracy of measurements. Time response and accuracy characteristics of a WSN affect the accuracy and timeliness of the decision-making. Critical tasks ordinary need high levels of both of these parameters. Appropriate QoS mechanism must be implemented to make sure that QoS requirements are satisfied [52].

Emergency management

Emergency management is a good example of critical tasks where WSN can find its application [53]. Telecommunications during an emergency play crucial role in rescue coordination. And WSNs, and, in particular, sensor control networks (SCNs) which are considered in Section 6.4, are well applicable in this field because of easy deployment and self organization features. Besides monitoring the state of emergency and providing communication in emergency situations, WSNs have another potentially important application concerning emergency situations and saving people's lives. This application was described in [54].

An indoor emergency management system is based on SCNs. The main goal of the system is to provide everyone in the building with instructions concerning the appropriate way of evacuation. The system uses a personal mobile phones or tablet computers to deliver information to their owners. So every mobile device turns into a terminal of the rescue system in case of emergency. It is very reasonable due to the wide spread of mobile devices and because of the presence of additional communication channels in today's mobile devices.

At the entrance to the building a mobile user terminal automatically connects to the SCN infrastructure and obtains data from the SCN motes. While normal operation, system uses SCN motes to observe the physical conditions inside the building (temperature, smoke, etc.) as shown in Figure 1.1. When an emergency occurs, SCN motes automatically detect it. Then the information about the detection of signs of disaster spreads throughout the SCN and user terminals. Each user terminal automatically launches software for guidance in emergency cases. It gives instructions on the safest way of self-evacuation from the building. For example it can show one of the following: evacuation plans or maps; step-by-step sound commands and visual hints (e. g. interior photos with arrows towards the exit overlaid); videos showing how to use safety equipment. Especially important that the information displayed varies depending on the location of the user.

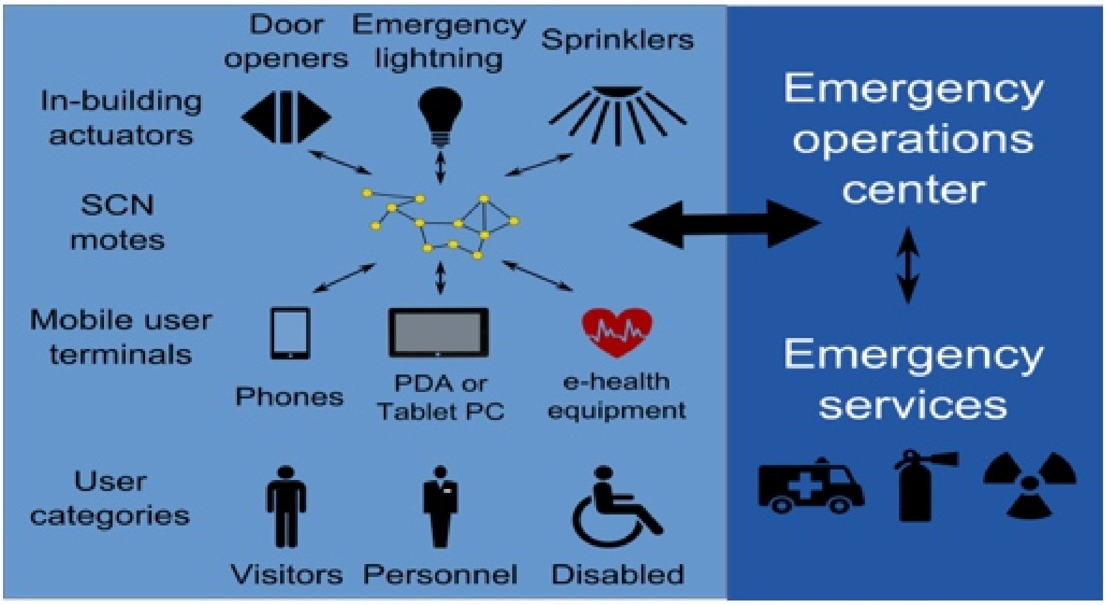


Figure 1.1: Emergency management system

The content of the instructions, which the system gives through the device to the owner, depends on various factors, for example:

- State of the building like accessibility and hazard level of rooms and escape routes. The state is determined by SCN motes;
- Position of the user determined by the nearest network node or using the GPS or GLONASS;
- User's health state determined by the e-health equipment.

User peculiarities awareness is a crucial feature of system. It means that while the personal mobile equipment is used the owner can chose appropriate customization options in software. These options will have impact on the instructions shown by the system. For example, a person with disabilities will receive special self-evacuation route, equipped with necessary facilities. Another example of customization is special instructions for building personnel. The system will remind them if they have specific duty responsibilities in case of emergencies. Also, the system will point to location of people with disabilities who need help.

In-building actuators (e. g. automotive door openers, emergency lightning and sprinklers) should also be equipped with SCN motes. Such actuators will also get commands from the system and start working if necessary.

4. Solution and Verification networks

Verification networks [55] are intended for the systems that operate automatically without human intervention. For a machine actuation unit in such automated system there exists a set of critical operations. Such operations can cause considerable negative consequences when carried out in improper system state. To avoid this for each critical operation a set of verification rules should be defined, which must be checked up before this operation and/or while the operation is in progress. Verification network can be designed to test these conditions. This type of critical task can be solved by using WSNs or SCNs. In this case the WSN should provide some kind of addition context awareness for automated systems.

To check verification rules the values of a number of parameters must be determined. Such parameters can be:

- Aggregate values, reference values, sensor readings presenting in SCN as part of normal flow of decision-making;
- Aggregate values, reference values, sensor readings presenting in SCN which are only intended to support verification;
- Sensor reading obtained from the machine actuation unit's own sensors;
- Values obtained by request from SCN server or other servers in NGN.

Verification network may have much more strict requirements concerning the reliability, security and performance. Data processing and transmission in a SCN for the purpose of verification may have higher priority in QoS in comparison with other activities in the SCN.

In Figure 1.2 a normal SCN decision-making flow is shown (see Section 6.4), but as soon as decision sets a machine actuation unit in motion, the verification process starts up by the verification network. If some of the check-ups of the verification process fail, some safe action (or no action) is performed instead of the action supposed in the decision.

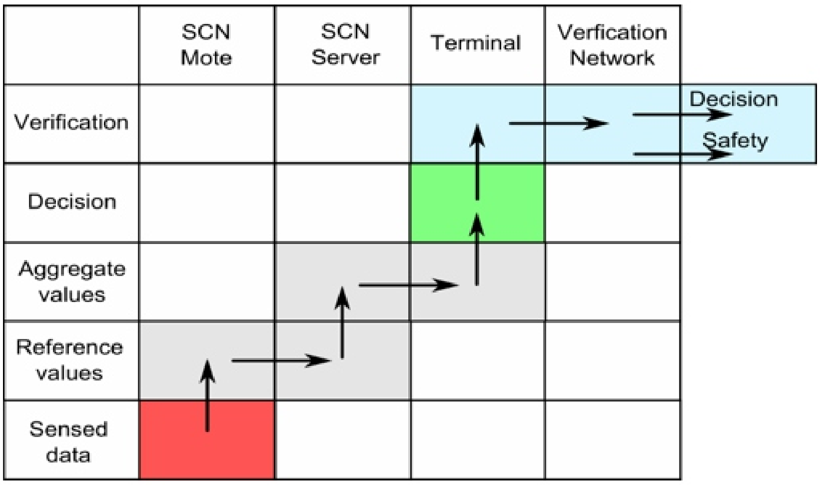


Figure 1.2: Verification network's decision-making flow

5. Conclusion:

A large private company in California implemented a WLAN to support enterprise mobility. The system was seemingly working great and providing significant benefits to its users. Over a year after the system went operational, the IT department noticed, through a routine network security audit, that several of its printers in the financial department had been configured to send all printed data to a file at a suspicious IP address. Unfortunately, the IT department had not locked down the administrative access ports on these printers. Even though all the details of what happened here are not known, it is likely that a hacker gained unauthorized access to the WLAN (which did not implement any form of authentication) and ran a port scan to find the open printer administration port. With the open port's IP address (resulting from the scan), the hacker could easily log in to the administrative port and set the printer to send all print jobs to a file located on the hacker's laptop. The printer would then continue to print on paper and also send the print data to the hacker's laptop. Of course this would send to the hacker everything that the printer would print, such as internal goals and objectives, company sales information, employee salaries, and so on. After discovering this issue, the company promptly implemented an authentication system to disallow all unauthorized people from accessing the WLAN.

6. References

[1] S. Glazyev, "The global economic crisis as a process of technological shifts," Problems of Economic Transition, vol. 52, no. 5, pp. 3–19, 2009.

[2] C.-Y. Chong and S. P. Kumar, "Sensor networks: evolution, opportunities, and challenges," Proceedings of the IEEE, vol. 91, no. 8, pp. 1247–1256, 2003.

[3] W. Dargie and C. Poellabauer, Fundamentals of wireless sensor networks: theory and practice. Wiley. com, 2010.

[4] R. T. Lacoss, "Distributed mixed sensor aircraft tracking," in American Control Conference, 1987, pp. 1827–1830, IEEE, 1987.

[5] G. J. Pottie, "Wireless integrated network sensors (WINS): the web gets physical," in Frontiers of Engineering: Reports on Leading-Edge Engineering from the 2001 NAE Symposium on Frontiers of Engineering, p. 78, National Academies Press, 2002.

[6] G. J. Pottie and W. J. Kaiser, "Wireless integrated network sensors," Communications of the ACM, vol. 43, no. 5, pp. 51–58, 2000.

[7] S. Vardhan, M. Wilczynski, G. Portie, and W. J. Kaiser, "Wireless integrated network sensors (WINS): distributed in situ sensing for mission and flight systems," in Aerospace Conference Proceedings, 2000 IEEE, vol. 7, pp. 459–463, IEEE, 2000.

[8] W. J. Kaiser, K. Bult, A. Burstein, D. Chang, et al., "Wireless integrated microsensors," in Technical Digest of the 1996 Solid State Sensor and Actuator Workshop, 06 1996.

[9] G. Asada, A. Burstein, D. Chang, M. Dong, M. Fielding, E. Kruglick, J. Ho, F. Lin, T. Lin, H. Marcy, et al., "Low power wireless communication and signal processing circuits for distributed microsensors," in Circuits and Systems, 1997. ISCAS'97., Proceedings of 1997 IEEE International Symposium on, vol. 4, pp. 2817–2820, IEEE, 1997.

[10] J. Rabaey, J. Ammer, J. da Silva Jr, and D. Patel, "PicoRadio: Ad-hoc wireless networking of ubiquitous low-energy sensor/monitor nodes," in VLSI, 2000. Proceedings. IEEE Computer Society Workshop on, pp. 9–12, IEEE, 2000.

[11] J. Da Silva Jr, M. JS, C. G. Ammer, S. Li, R. Shah, T. Tuan, M. Sheets, J. Ragaey, B. Nikolic, A. Sangiovanni-Vincentelli, et al., "Design methodology for Pico Radio networks," Berkeley Wireless Research Center, 2001.

[12] J. M. Kahn, R. H. Katz, and K. S. Pister, "Next century challenges: mobile networking for Smart Dust," in Proceedings of the 5th annual ACM/IEEE international conference on Mobile computing and networking, pp. 271–278, ACM, 1999.

[13] K. S. Pister, J. M. Kahn, B. E. Boser, et al., "Smart dust: Wireless networks of millimeter-scale sensor nodes," Highlight Article in, p. 2, 1999.

[14] "µAMPS research." URL:http://www- mtl.mit.edu/researchgroups /icsystems/uamps /research/overview.shtml, 2004. Accessed: 2013-11-08.

[15] B. H. Calhoun, D. C. Daly, N. Verma, D. F. Finchelstein, D. D. Wentzloff, A. Wang, S.-H. Cho, and A. P. Chandrakasan, "Design considerations for ultra-low energy wireless microsensor nodes," Computers, IEEE Transactions on, vol. 54, no. 6, pp. 727–740, 2005.

[16] J. A. Gutierrez, M. Naeve, E. Callaway, M. Bourgeois, V. Mitter, and B. Heile, "IEEE 802.15. 4: a developing standard for low-power low-cost wireless personal area networks," network, IEEE, vol. 15, no. 5, pp. 12–19, 2001.

[17] "The ZigBee alliance." URL: http://www.zigbee.org/About/AboutAlliance/TheAlliance.aspx, 2014. Accessed: 2014- 02-26.

[18] "HART communications foundation official website." URL: http://www.hartcomm.org/, 2014. Accessed: 2014-02-26.

[19] "6LoWPAN working group." URL: http://www.ietf.org/dyn/wg/charter/6lowpan-charter.html,2014. Accessed: 2014-02-26.

[20] "Requirements for support of ubiquitous sensor network (USN) applications and services in the NGN environment." ITU-T Recommendation Y.2221 (2010).
[21] J. Yick, B. Mukherjee, and D. Ghosal, "Wireless sensor network survey," Computer networks, vol. 52, no. 12, pp. 2292–2330, 2008.
[22] G. Simon, M. Mar´oti, ´ A. L´edeczi, G. Balogh, B. Kusy, A. N´adas, G. Pap, J. Sallai, and K. Frampton, "Sensor network-based countersniper system," in Proceedings of the 2nd international conference on Embedded networked sensor systems, pp. 1–12, ACM, 2004.
[23] J. Yick, B. Mukherjee, and D. Ghosal, "Analysis of a prediction-based mobility adaptive tracking algorithm," in Broadband Networks, 2005. BroadNets 2005. 2nd International Conference on, pp. 753–760, IEEE, 2005.
[24] T. Gao, D. Greenspan, M. Welsh, R. Juang, and A. Alm, "Vital signs monitoring and patient tracking over a wireless network," in Engineering in Medicine and Biology Society, 2005. IEEE-EMBS 2005. 27th Annual International Conference of the, pp. 102–105, IEEE, 2006.
[25] K. Lorincz, D. J. Malan, T. R. Fulford-Jones, A. Nawoj, A. Clavel, V. Shnayder, G. Mainland, M. Welsh, and S. Moulton, "Sensor networks for emergency response: challenges and opportunities," Pervasive Computing, IEEE, vol. 3, no. 4, pp. 16–23, 2004.
[26] M. Castillo-Effer, D. H. Quintela, W. Moreno, R. Jordan, and W. Westhoff, "Wireless sensor networks for flash-flood alerting," in Devices, Circuits and Systems, 2004. Proceedings of the Fifth IEEE International Caracas Conference on, vol. 1, pp. 142– 146, IEEE, 2004.
[27] G. Wener-Allen, K. Lorincz, M. Ruiz, O. Marcillo, J. Johnson, J. Lees, and M. Walsh, "Deploying a wireless sensor network on an active volcano. data-driven applications in sensor networks (special issue)," IEEE Internet Computing, vol. 2, pp. 18–25, 2006.
[28] C. Buratti, A. Conti, D. Dardari, and R. Verdone, "An overview on wireless sensor networks technology and evolution," Sensors, vol. 9, no. 9, pp. 6869–6896, 2009.
[29] R. Hartley, "Transmission of information," Bell System Technical Journal, 1928.
[30] P. Levis, S. Madden, J. Polastre, R. Szewczyk, K. Whitehouse, A. Woo, D. Gay, J. Hill, M. Welsh, E. Brewer, et al., "TinyOS: An operating system for sensor networks," in Ambient intelligence, pp. 115–148, Springer, 2005.
[31] "Wireless Medium Access Control (MAC) and physical layer (PHY) specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)." IEEE 802.15.4 Standard. Part 15.4 (2006).
[32] D. R. Green, "Geospatial tools and techniques for vineyard management in the twenty- first century," in The Geography of Wine (P. H. Dougherty, ed.), pp. 227–245, Springer Netherlands, 2012.
[33] A. Galloway, "An Internet of Cows (and Sheeps!)," Design Culture Lab, 07 2011. URL: http://www.designculturelab.org/2011/07/20/an-internet-of-cows-and-sheeps/.
[34] "Requirements for the support of machine-oriented communication applications in the next generation network environment." ITU-T Recommendation Y.2061.
[35] W. Huiyong, W. Jingyang, and H. Min, "Building a smart home system with WSN and service robot," in Measuring Technology and Mechatronics Automation (ICMTMA), 2013 Fifth International Conference on, pp. 353–356, IEEE, 2013.
[36] P. Waide, J. Ure, G. Smith, and B. Bordass, "The scope for energy and CO2 savings in the EU through the use of building automation technology," final report, Waide Strategic Efficiency, 08 2013.
[37] K. Jaafar and M. K. Watfa, "Sensor networks in future smart rotating buildings," in Consumer Communications and Networking Conference (CCNC), 2013 IEEE, pp. 962– 967, IEEE, 2013.
[38] S. Kim, S. Pakzad, D. Culler, J. Demmel, G. Fenves, S. Glaser, and M. Turon, "Health monitoring of civil infrastructures using wireless sensor networks," in Information Processing in Sensor Networks, 2007. IPSN 2007. 6th International Symposium on, pp. 254–263, 2007.
[39] W.-Z. Song, R. Huang, M. Xu, A. Ma, B. Shirazi, and R. LaHusen, "Air-dropped sensor network for real-time high-fidelity volcano monitoring," in Proceedings of the 7th international conference on Mobile systems, applications, and services, pp. 305–318, ACM, 2009.

[40] G. Liu, R. Tan, R. Zhou, G. Xing, W.-Z. Song, and J. M. Lees, "Volcanic earthquake timing using wireless sensor networks," in Proceedings of the 12th international conference on Information processing in sensor networks, pp. 91–102, ACM, 2013.
[41] I. Dietrich and F. Dressler, "On the lifetime of wireless sensor networks," ACM Transactions on Sensor Networks (TOSN), vol. 5, no. 1, p. 5, 2009.
[42] T. Saaty, Decision Making with Dependence and Feedback: The Analytic Network Process: the Organization and Prioritization of Complexity. Analytic hierarchy process series, Rws Publications, 2001.
[43] L. Yu and Z. Heng, "Measuring agility of enterprise using analytic hierarchy process and bayesian belief networks," in Management Science and Engineering, 2006. ICMSE'06. 2006 International Conference on, pp. 551–556, IEEE, 2006.
[44] C.-x. Chen, Z.-w. He, J.-g. Jia, J.-m. Kuang, and Z.-y. Zhang, "Fuzzy evaluation algorithm for system effectiveness of wireless sensor networks," in Global High Tech Congress on Electronics (GHTCE), 2012 IEEE, pp. 43–48, IEEE, 2012.
[45] N. Kamiyama and D. Satoh, "Network topology design using analytic hierarchy process," in Communications, 2008. ICC'08. IEEE International Conference on, pp. 2048–2054, IEEE, 2008.
[46] N. Ruan, Y. Ren, Y. Hori, and K. Sakurai, "Performance analysis of key management schemes in wireless sensor network using analytic hierarchy process," in Trust, Security and Privacy in Computing and Communications (TrustCom), 2011 IEEE 10th International Conference on, pp. 1739–1744, IEEE, 2011.
[47] M. R. Ahmad, E. Dutkiewicz, et al., "Performance analysis of MAC protocol for cooperative MIMO transmissions in WSN," in Personal, Indoor and Mobile Radio Communications, 2008. PIMRC 2008. IEEE 19th International Symposium on, pp. 1–6, IEEE, 2008.
[48] Y. Yin, J. Shi, Y. Li, and P. Zhang, "Cluster head selection using analytical hierarchy process for wireless sensor networks," in Personal, Indoor and Mobile Radio Communications, 2006 IEEE 17th International Symposium on, pp. 1–5, IEEE, 2006.
[49] N. Yang, T. Liqin, S. Xueli, and G. Shukai, "Behavior trust evaluation for node in WSNswith fuzzy-ANP method," in Computer Engineering and Technology (ICCET), 2010 2nd International Conference on, vol. 1, pp. V1–299, IEEE, 2010.
[50] I. M. Khan, N. Jabeur, M. Z. Khan, and H. Mokhtar, "An overview of the impact of wireless sensor networks in medical health care," in The 1st International Conference on Computing and Information Technology (ICCT), pp. 576–580, 2012.
[51] W. Dargie and C. Poellabauer, Fundamentals of wireless sensor networks: theory and practice. Wiley. com, 2010.
[52] M. Souil and A. Bouabdallah, "On QoS provisioning in context-aware wireless sensor networks for healthcare," in Computer Communications and Networks (ICCCN), 2011 Proceedings of 20th International Conference on, pp. 1–6, IEEE, 2011.
[53] A. Meissner, T. Luckenbach, T. Risse, T. Kirste, and H. Kirchner, "Design challenges for an integrated disaster management communication and information system," in The First IEEE Workshop on Disaster Recovery Networks (DIREN 2002), vol. 24, 2002.
[54] "Personal safety in emergencies." ITU News, 3 2012.
[55] "Sensor Control Networks and related applications in Next Generation Network environment." ITU-T Recommendation Y.2222 (2013).
[56] T. Gao, C. Pesto, L. Selavo, Y. Chen, J. G. Ko, J. H. Lim, A. Terzis, A. Watt, J. Jeng, B.-r. Chen, et al., "Wireless medical sensor networks in emergency response: Implementation and pilot results," in Technologies for Homeland Security, 2008 IEEE Conference on, pp. 187–192, IEEE, 2008.
[57] D. of Engineering and H. U. Applied Sciences, "Sensor networks for medical care," in Technical Report TR-08-05, 2005.

[58] K. Lorincz, B.-r. Chen, G. W. Challen, A. R. Chowdhury, S. Patel, P. Bonato, M. Welsh, et al., "Mercury: a wearable sensor network platform for high-fidelity motion analysis.," in SenSys, vol. 9, pp. 183–196, 2009.
[59] J. A. Weaver, A wearable health monitor to aid parkinson disease treatment. PhD thesis, Massachusetts Institute of Technology, 2003.
[60] B. Lo, S. Thiemjarus, R. King, and G.-Z. Yang, "Body sensor network-a wireless sensor platform for pervasive healthcare monitoring," in The 3rd International Conference on Pervasive Computing, vol. 13, pp. 77–80, 2005.
[61] "Open service environment functional architecture for next generation networks." ITU-T Recommendation Y.2020.
[62] "Open service environment capabilities for NGN." ITU-T Recommendation Y.2234.
[63] "Requirements and capabilities for ITU-T NGN." ITU-T Recommendation Y.2201.
[64] "Requirements and framework allowing accounting and charging capabilities in NGN." ITU-T Recommendation Y.2233.
[65] Y. B. Kim, "u-healthcare service based on a USN middleware platform," Networked Computing and Advanced Information Management, International Conference on, vol. 0, pp. 673–678, 2009.
[66] M. Kim, Y. Lee, and J. Park, "Trend of USN middleware technology," ETRI: Trend Analysis of Electronic & Telecommunication, vol. 22, pp. 67–79, 06 2007.
[67] Y. Kim, M. Kim, and Y. Lee, "COSMOS: A middleware platform for sensor networks and a u-healthcare service," in ACM SAC'08, (Brazil), pp. 512–513, 03 2008.
[68] "Service description and requirements for ubiquitous sensor network middleware." ITU- T Recommendation F.744.
[69] W. Lee, A. Datta, and R. Cardell-Oliver, "Network management in wireless sensor networks," Handbook of Mobile Ad Hoc and Pervasive Communications: American Scientific Publishers, 2006.
[70] A. Smailagic, "Location sensing and privacy in a context-aware computing environment," Wireless Communications, IEEE, vol. 9, pp. 10–17, 10 2002.

High Bandwidth Microstrip Antenna of Elliptical Patch With Square Slot And A Pin Shot

Mahendra Singh Meena
Assistant Professor, Department of Electronics and Communication Engineering,
Amity School of Engineering and Technology, Amity University, Haryana.

A B S T R A C T

FR4 is an inexpensive and easily available substrate material, which can be used to design efficient and cost effective microstrip patch antenna. This paper focuses on increasing the bandwidth of the microstrip patch antenna. Paper discusses about design of a elliptical patch antenna, having coaxial probe as a feed. To get the improved bandwidth, a rectangular slot has been digged along with a pin short, which changes the interaction of radiation. A huge increase in bandwidth is observed using the proposed design; almost 9 fold. All the simulation work is done using IE3D simulating software from Zeland has been used.

Key words: FR4, elliptical, slot, pin short

Introduction

A Microstrip or Patch Antenna is a low profile Antenna that has a number of advantages over other antennas. It is lightweight, inexpensive, and easy to integrate with accompanying electronics. While the antenna can be 3D in structure (wrapped around an object, for example), the elements are usually flat, hence their other name, Planar Antennas. A Planar Antenna is not always a patch antenna. But use of conventional elliptical microstrip patch antenna alone is very difficult because of its low gain and narrow bandwidth. So to overcome these problems various methods have been tried, some of them are listed in next section. This paper proposes a method in which slots are digged in patch antenna using pin short. Configuration of paper is as follows:Next section is literature review, which is followed by proposed design and in the last some conclusions are drown based on simulation done.

Literature Review

The *Gordon et.al* described that the band width of microstrip antennas can be increased by using thick substrate but with thick substrate coaxial probe feed introduces inductive component due to which unavoidable impedance mismatch occurs. So the solution to impedance mismatch was found in the form of capacitive feeding mechanism which can be used for annular ring MPA elements, consisted a small capacitor patch in the same layer as in the radiating element. [1]

Gordon et.al experimented on following three designs:

- Rectangular radiating elements,
- Circular radiating elements and
- Annular ring radiating elements

Feeding mechanism was common in all three designs. The position of the probe feed was decided to be in the center of the small patch. Design tool used was IE3D 12th version Zeland, substrate was FR4 with thickness 1.6 mm having dielectric constant 4.4. Height of patch from ground was taken as 15 mm, ground plane was taken as square of 150x150 mm and probe diameter 0.9 mm.

Experimental Results are shown below:

Resonant frequency- 1800MHz

10 dB return loss Band Width-

	Rectangular	Circular	Annular Ring
Simulated	25.9%	26.8%	25.9%
Measured	26.4%	27.9%	26.1%

Gain-

	Rectangular	Circular	Annular Ring
Simulated	8.5dBi	8.8 dBi	8.0 dBi
Measured	8.2 dBi	8.6 dBi	8.5 dBi

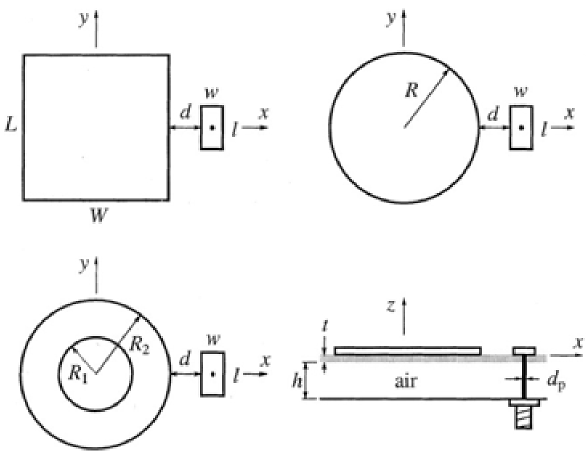


Figure 1 Structure of proposed antenna design for (a) rectangular, (b) circular and (c) annular ring radiating elements (d) side view of anteena.

Dheeraj et. al. proposed modified circular patch antenna to achieve 50.36% efficiency together with 4.10 dBi gain and 8.38% band width. Firstly they taken a circular patch and then an elliptical slot has been cut in it, after this, parallel to major axis of the inserted elliptical slot, splitting is applied and at last this elliptical hole is filled with an elliptical patch between two split halves of circular patch.

Fr4 of thickness 1.59 mm and dielectric constant 4.4 was taken as substrate which had loss tangent of 0.0148. Main circular patch radius was taken 12 mm. For inside elliptical patch semi major axis is of 9 mm, semi minor axis is of 4.8 mm and eccentricity is 0.846. Splitting width of circular patch in two halves is 0.25 mm. Ellipse filling the elliptical slot has a = 8 mm and b = 3 mm.

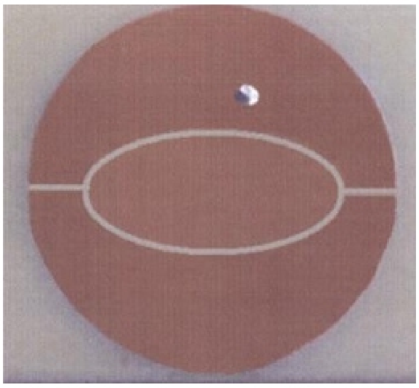
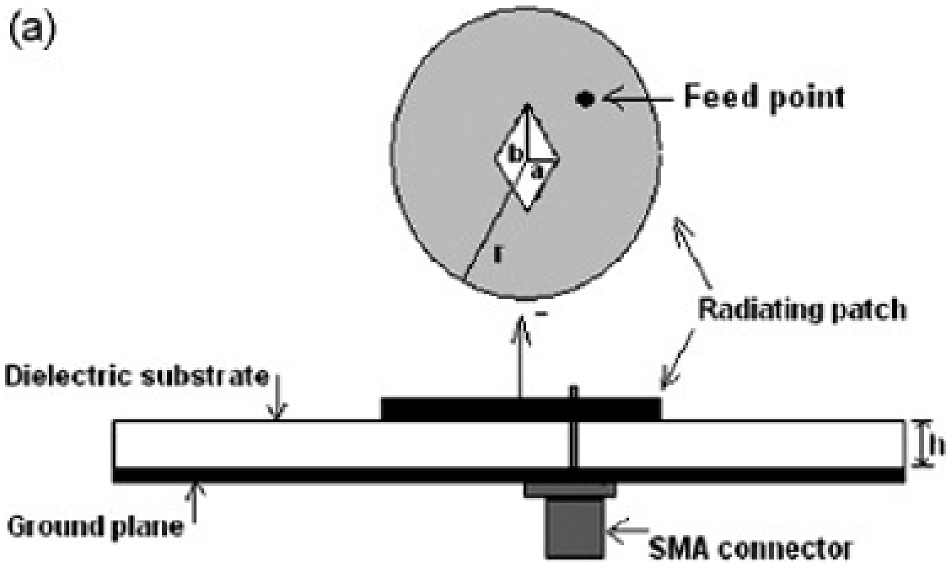


Figure 2 Split circular patch antenna with elliptical slot and filled with elliptical patch

Experimental Results are shown below:

Geometries	Resonance frequency, GHz	Radiation efficiency, %	Directivity , dBi	Gain, dBi	Bandwidth , %
Circular elliptical ring	4.96	22.48	6.30	1.11	6.02
Gap coupled split circular patch antenna with circular slot	5.16	53.35	7.61	4.87	6.64
Gap coupled split circular patch antenna with elliptical slot and filled with elliptical patch	5.01	50.36	7.08	4.10	8.38

Garima et. al. proposed concentric diamond shape slotted circular patch microstrip antenna which is useful for C band and space communication systems. Main disadvantage of microstrip antennas is efficiently at a single resonance frequency corresponding to their dominant mode, narrow bandwidth (1-2%) and low gain. They proposed antenna useful for satellite communication systems as it presents the desired performances, viz. improved bandwidth, gain and multiple operating frequencies needed for satellite communication systems. FR4 with having thickness of 1.59 mm, dielectric constant of 4.4 and loss tangent of 0.025 was used as substrate. Circular patch radius is 16.2 mm was fabricated. To improve bandwidth path of the patch current has been increased by digging a diamond shape slot having dimensions a= 6 mm and b= 10 mm as shown in figure



As a result resonating frequencies of 6.23GHz and 6.859GHz (simulating) and 6.66GHz and 7.42GHz (measured) were observed and bandwidth of 15.99% (simulated) and 13.58% (measured) along with Gain of 5.84 at 6.66GHz and 5.71 at 7.42GHz were observed, which is huge improvement over non-slotted design. [3]

To obtain improved bandwidth and circularly polarized radiation over conventional elliptical antenna, in this paper the elliptical shape patch antenna with truncated edges has been introduced. In [4] tow antennas were studied (1) a conventional elliptical antenna and (2) edges truncated elliptical antenna. FR4 with having thickness of 1.59 mm, dielectric constant of 4.4 and loss tangent of 0.025 was used as substrate. Ellipse patch with semi major axis a = 15 mm and semi minor axis b = 14.43 mm after truncation L1= L2=7.75 mm as shown in figure.

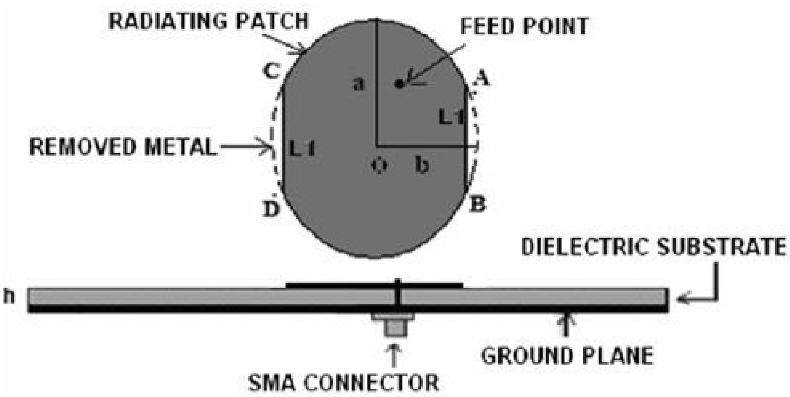


Figure 4 Edge truncated elliptical patch antenna

Results showed resonating frequency =2.71 GHz and 2.80 GHz (simulated) and 2.692 GHz and 2.802 GHz (measured) were measured. Input impedances = (62.30+ j11.71) ohm corresponding2.692 GHz and (48.49+ j5.34) ohm corresponding 2.802 GHz resonant frequency, Minimum Axial ratio = 0.68 dB at 2.751 GHz, Gain = 1.71 dB at 2.751 Ghz

Proposed Design and Results Design Specifications:

In this design elliptical shape microstrip patch has been designed for broadband purposes by cutting a square shape slot and using a pin short. Design specifications of the patch are-

- Resonant Frequency $f0$ = 7.25GHz
- Dielectric Constant ϵr = 4.4
- Substrate Thickness h = 1.59mm
- FR4 substrate is used

Dimension of the patch:

Wireless communication requires compact size antenna, which can be easily used in small hand held devices. We have proposed a compact size elliptical shape patch, which can be utilized for the purpose. Dimensions of the proposed antenna are:

- Semi major axis a = 15mm
- Semi minor axis b = 10mm
- Position of the square slot= (0, 5)
- Square slot area = 3mm×3mm

Use of pin short

To obtain the desired bandwidth a pin short at point (2, -2) has been used. The position of pin is in the fourth quadrant while the feed is used in third quadrant at same distance from origin. The pin changes the distribution of current so improves the bandwidth.

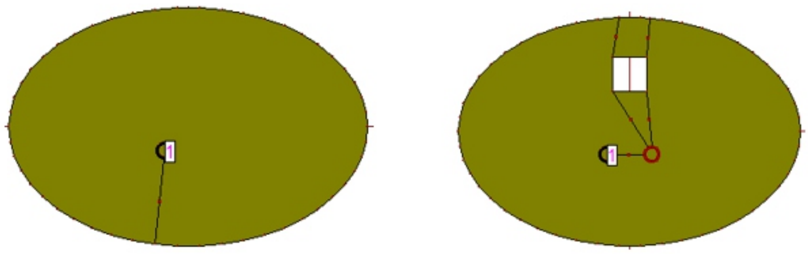


Figure 5 (a) and (b) Design of patch with feed only and with a slot and a pin

Return loss and bandwidth

The return loss with feed only was obtained -19.55dBi which have been improved to -38.84dBi and previously the bandwidth was 2.93% and after modification in geometry improved bandwidth is 21.048%.

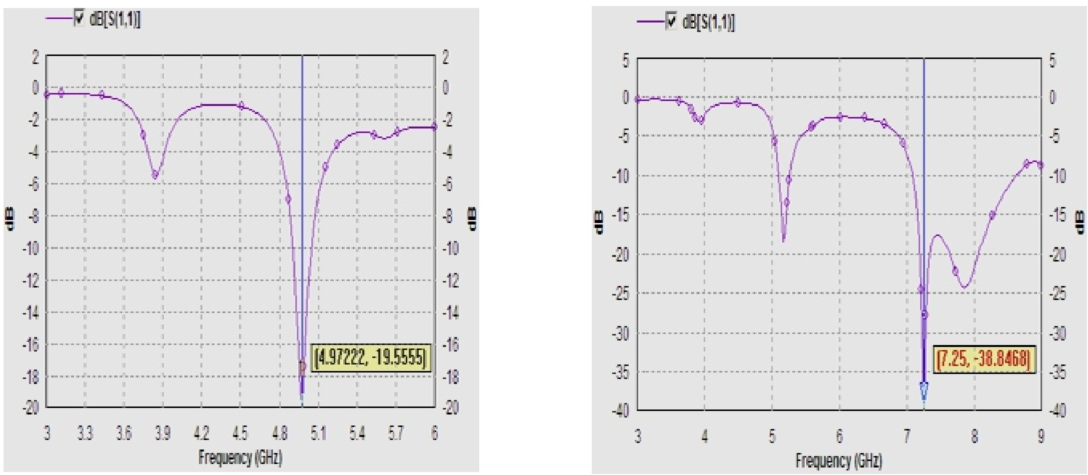


Figure 6 (a) and (b) simulated return loss verses frequency graph for conventional elliptical patch and proposed geometry

Smith chart

The corresponding smith chart of before modification and after modification in elliptical shape patch is shown in figure below. The figure shows that input impedance of is (55.12- j9.42) for simple feed geometry and (49.68- j1.10) for modified geometry.

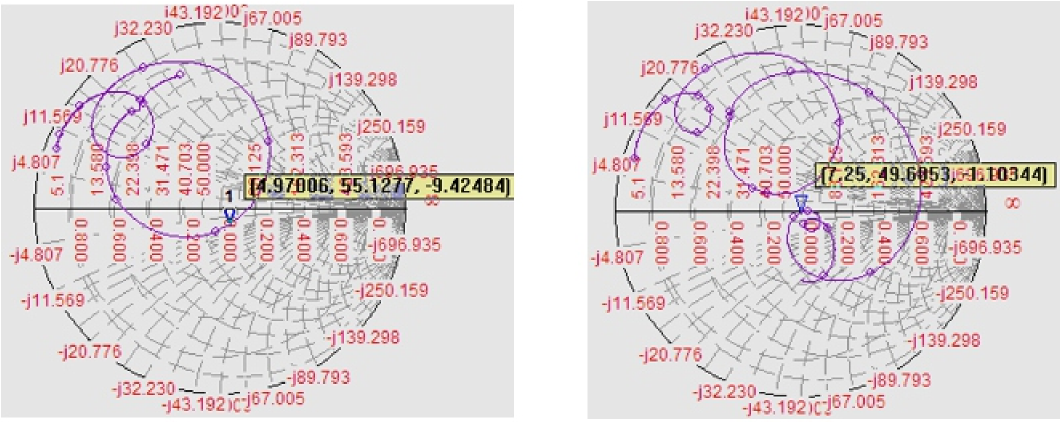


Figure 7 (a) and (b) smith chart of conventional elliptical patch and geometry

Radiation Pattern

Radiation pattern plot of these two patches are shown below.

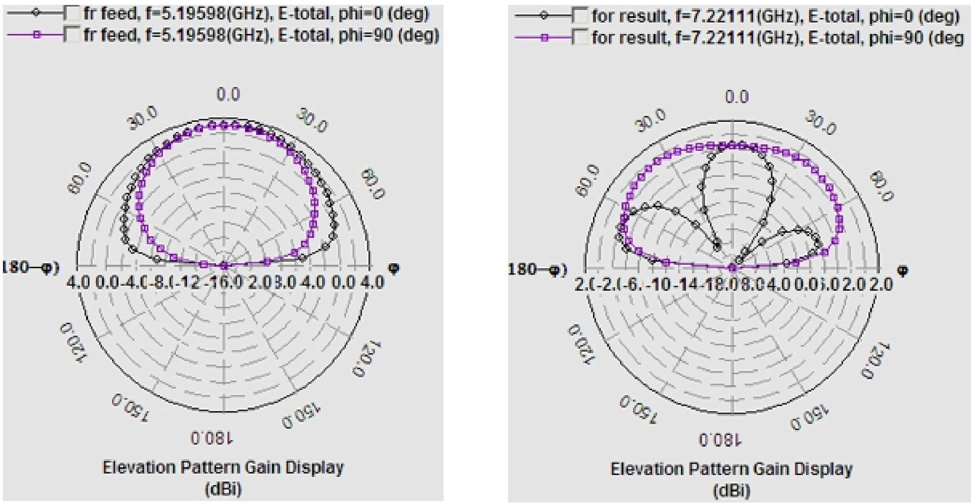


Figure 3.12 (a) and (b) 2D-Radiation pattern of elliptical patch without cut and with cut

Table 1 shows the comparison of results between modified and unmodified geometry

S. No.	Characteristic	Elliptical patch with only feed	Elliptical patch with a slot of square shape	Elliptical patch with square slot and a pin shot
1	Resonant frequency(GHz)	4.97	4.99	7.25
2	Return loss(dB)	-19.55	-19.47	-38.84
3	Gain (dBi)	1.56	1.63	0.25
4	Bandwidth	2.93	2.968	21.04
5	Antenna Efficiency (%)	21.52	22.27	16.43
6	Radiation Efficiency (%)	22.53	23.03	16.82

Conclusions

The FR4 substrate with aforesaid properties and dimension has been used. To optimized the output different location of the slot have been tried, maximum bandwidth was observed for square slot dimension 3mm×3mm at point (0, 5) has been digged and a pin short at (2, -2) is used. For the same dimensions conventional patch had bandwidth 2.93% and proposed design had bandwidth of 21.04%. The proposed antenna can be used a broadband antenna.

References

1. Gordon Mayhew-Ridgers, Johann W. Odendaal, and Johan Joubert, "Single-Layer Capacitive Feed for Wideband Probe-Fed Microstrip Antenna Elements" IEEE Transactions on Antennas and Propagation, Vol. 51, No. 6, June 2003

2. Dheeraj Bhardwaj, Komal Sharma, D. Bhatnagar, S Sancheti & B Soni, "Design and analysis of a gap coupled split circular patch with elliptical slot filled with elliptical patch" Indian Journal of Radio & Space Physics, Vol. 39, April 2010

3. Garima, D Bhatnagar, J S Saini, V K Saxena& L M Joshi, "Design of broadband circular patch microstrip antenna with diamond shape slot" Indian Journal of Radio & Space Physics, Vol. 40, October 2011.

4. Pratibha Sekra, Sumita Shekhawat, Manoj Dubey, D Bhatnagar, V K Saxena & J S Saini, "Design of circularly polarized edge truncated elliptical patch antenna with improved performance", Indian Journal of Radio & Space Physics, Vol. 40, August 2011.

5. Puneet Kumar, Mahendra Singh Meena, Ved Prakash , "Bandwidth Enhancement of a Patch Antenna by using Metamaterials for WLAN Application", Vol 01, Issue 04, June 2013, 105-109 (ISSN [2320-706X])

6. K. D. Prasad, "Antenna & Wave Propagation", Satya Prakashan, New Delhi, 2005

7. C. Balanis "Antenna Theory Analysis and Design", second edition, John Wiley, 1997.

8. Mahendra Singh Meena and Nisha Achra, "A text book of Antenna and Wave Propagation, College Book Center, 2013, Second Edition

9. R. Garg, P. Bhartia, I. Bahk, A. Ittipiboor, "Microstrip Antenna Design Handbook" Artech House, 2001.

10. R. A. Sainati, "CAD of Microstrip Antennas for Wireless Antennas for Wireless Applications", Artech House, 1996.

11. D. M. Pozar, "Microstrip Antennas", Proc. IEEE , Vol 80, pp 79-91

12. Kin-Lu-Wong, "Compact and Broadband Microstrip Antenna", John Wiley & Sons 2002.

13. Nasimuddin, Zhi Ning Chen, and Xianming Qing, "A Compact Circularly Polarized Cross-Shaped Slotted Microstrip Antenna", IEEE Transactions on Antennas and Propagation, Vol. 60, No. 3, March 2012

14. Mahmoud N. Mahmoud and Reyhan Baktur, "A Dual Band Microstrip-Fed Slot Antenna", IEEE Transactions on Antennas and Propagation, Vol. 59, No. 5, May 2011

15. Nasimuddin, Xianming Qing, and Zhi Ning Chen, "Compact Asymmetric-Slit Microstrip Antennas for Circular Polarization", IEEE Transactions on Antennas and Propagation, Vol. 59, No. 1, January 2011

16. Kunpeng Wei, Zhijun Zhang, and Zhenghe Feng, "Design of a Coplanar Integrated Microstrip Antenna for GPS/ITS Applications", IEEE Antennas and Wireless Propagation Letters, Vol. 10, 20

17. S N Mulgi, G M Pushpanjali, R B Konda, S K Satnoor & P V Hunagund, "Broadband aperture coupled equilateral triangular microstrip array antenna", Indian Journal of Radio & Space Physics, Vol. 38, June 2009.

18. G. Mayhew-Ridgers, J. W. Odendaal, and J. Joubert, "New feeding mechanism for annular-ring microstrip antenna," Electron. Lett., vol. 36, no. 7, pp. 605–606, Mar. 2000.

19. Yoon,W.S., Baik, J.-W., Lee, H.-S., Pyo, S., Han, S.-M., and Kim, Y.-S., "A reconfigurable circularly polarized microstrip antenna with a slotted ground plane", IEEE Antennas Wirel. Propag. Lett., 2010, 9, (1), pp. 1161–1164.

Traffic Management Using Wireless Sensor Networks

[1]Deep Mala & [2] Dr. Suhas H. Patil
[1]Research Scholar, JJTU, Rajasthan
[2] Professor, Bharti Vidyapeeth University, (College of Engineering), Pune.

ABSTRACT

The upcoming field of wireless sensor networks combines in a small device sensing, computation and communication. This network comprises spatially distributed autonomous sensors which monitor physical as well as environmental conditions like temperature, sound etc. though initially developed for military uses; this system is used for civilian applications like habitat monitoring, healthcare applications etc.This paper aims at analyzing different traffic patterns used in WSNs that supports some of the existing technologies of traffic control and therefore reduce the average waiting time.

Keywords : Data, monitoring, Sensors, Traffic management, Wireless.

1. INTRODUCTION

Wireless sensor networks (WSNs) are some of the fastest developing technologies and have many military and commercial applications. Sensor networks can be used not only for detection, reconnaissance, tracking, and targeting of enemy forces, but also for monitoring and effectively managing friendly forces. In addition, commercial applications such as traffic monitoring, environmental measurements and patient health monitoring can be easily implemented using wireless sensor networks. But different applications also demand different types of design architecture and technical requirements for sensor networks. During the last few years, the development of new micro mechanical and electronic devices has boosted sensor technologies by reducing the size and improving the power and communication abilities of sensors. A sensor network consists of a large number of micro sensors, each with limited power, communication and processing abilities, deployed around a geographical area to collect data for a special phenomenon or event. Sensors are sensitive to mechanical failures, environmental conditions, and battery limitations that demand dynamic topology configuration. Sensor networks have unique characteristics and requirements. Since a sensor network consists of small sensors, each with limited power, communication and memory capabilities. [3][4]

2. TRAFFIC PATTERNS IN WIRELESS SENSOR NETWORKS

In general, traffic patterns in WSNs can be based on a one- hop or multi- hops design architecture. In a one- hop scenario, data from the nodes are forwarded directly to the base station. As for the multi- hop scenario, traffic patterns can be further subdivided based on the number of transmissions and reception sensor nodes and whether any processing procedure (i.e., aggregation) is applied in the network. According to traffic patterns in WSNs can be categorized as local communication, point-to-point routing, aggregation, convergence or divergence.

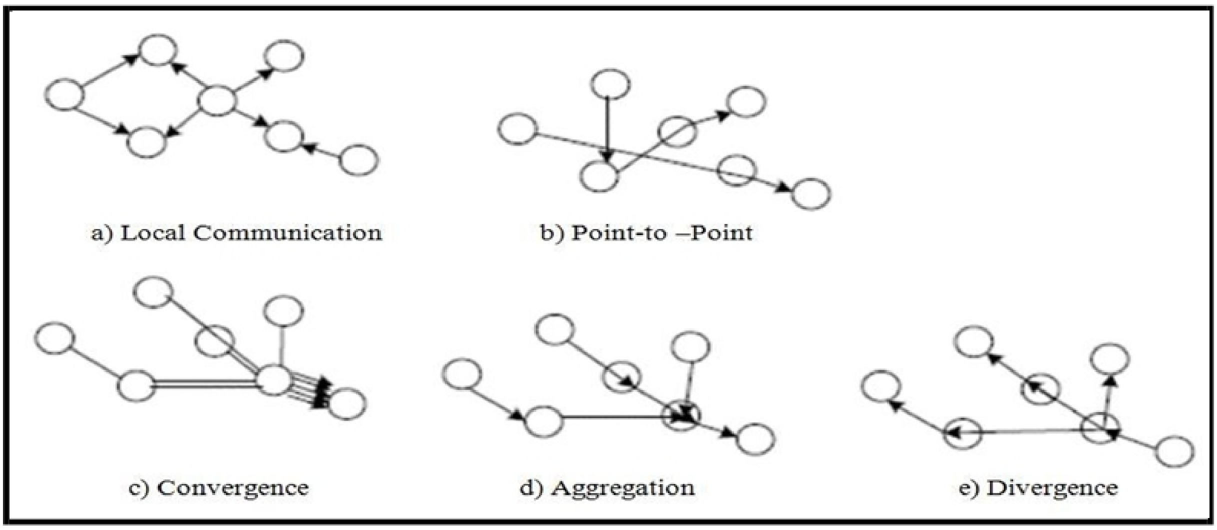


Figure1: Traffic patterns in WSNs

Traffic patterns describe different types of communication procedures between sensor nodes. For example, local communication is used when a node sends data to its neighbors. Point-to-point routing is used in wireless LAN (Local Area Network) so that a sensor node can send data to another sensor node. In an aggregate traffic pattern, some sensor nodes send data to a cluster- head or an intermediate sensor node after applying aggregation functions. In that case, only the aggregated values of data are forwarded, instead of all the data values. Similar to the aggregate traffic pattern, in a convergence traffic pattern, all the data from sensor nodes is send it to a relaying node and then forwarded to the next sensor level, or base station, without applying any aggregation function. Finally, a divergence traffic pattern is used when a sink node or base station sends control messages or queries to sensor nodes. [1]

3. CLUSTER-BASED HIERARCHICAL DESIGN IN WIRELESS SENSOR NETWORKS

The objective of each traffic model in WSNs is to minimize the delay for packets propagating through the network and to reduce the energy consumption and thus maximize the lifetime of the network. A cluster-based hierarchical design in combination with efficient data aggregation is a good consideration for WSNs. This design is appropriate for WSNs that consist of a great number of sensors. A simple one-hop design is inappropriate for WSNs. Given that a sensor node has limited power resources and the loss of energy in a transmission is proportional to the square of distance, d 2, from the base station, the sensor may not be able to communicate with the base station. A simple case is shown in Figure 2. For a multi-hop design, the data from each sensor node is forwarded to the base station following a path designated each time by the routing protocol in use. The drawbacks in this case are high latency in the network, since a packet needs much time to reach the destination, and, as some sensor nodes are closer to the base station, designation of nodes as relays for the rest of the network. The latter can drive the relaying nodes to an early death, causing degradation of network performance. A simple multi- hop architecture is shown in Figure3.

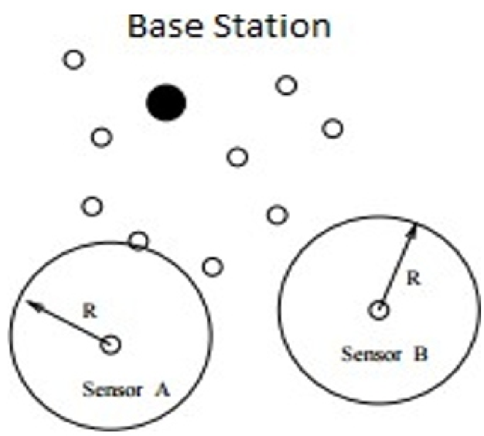


Figure2: One-hop Design

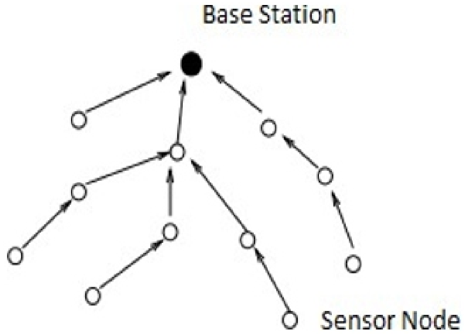


Figure3: Multi hop Design

In cluster-based design architecture, data is first collected at the cluster- head and then fused and forwarded to the next cluster layer toward the final destination. In this case, the data from each sensor travels shorter distances, reducing the total latency in the network. In addition, aggregation is taking place only at the cluster heads saving energy for all the non-cluster-head nodes, since additional processing is not required at sensors. [1][2]

4. CONCLUSION

The wireless sensor networks are an ideal platform for monitoring traffic which can offer competition to the current technology. The main challenges are congestion control, averagewaiting time reduction, prioritizing and many more. The processing of large amount of real time traffic data, run time of control system and reliability are the problems to be solved.

5. REFERENCES

1) http://www.dtic.mil/dtic/tr/fulltext/u2/a457004.pdf

2) www.google.com

3) https://www.researchgate.net/publication/292175972_A_Survey_on_Urba n_Traffic_Management_System_Using_Wireless_Sensor_Networks

4) http://www.wseas.org/multimedia/journals/communications/2014/a305704-343.pdf

Instructions for Authors

Essentials for Publishing in this Journal

1 Submitted articles should not have been previously published or be currently under consideration for publication elsewhere.

2 Conference papers may only be submitted if the paper has been completely re-written (taken to mean more than 50%) and the author has cleared any necessary permission with the copyright owner if it has been previously copyrighted.

3 All our articles are refereed through a double-blind process.

4 All authors must declare they have read and agreed to the content of the submitted article and must sign a declaration correspond to the originality of the article.

Submission Process

All articles for this journal must be submitted using our online submissions system. http://enrichedpub.com/ . Please use the Submit Your Article link in the Author Service area.

Manuscript Guidelines

The instructions to authors about the article preparation for publication in the Manuscripts are submitted online, through the e-Ur (Electronic editing) system, developed by **Enriched Publications Pvt. Ltd**. The article should contain the abstract with keywords, introduction, body, conclusion, references and the summary in English language (without heading and subheading enumeration). The article length should not exceed 16 pages of A4 paper format.

Title

The title should be informative. It is in both Journal's and author's best interest to use terms suitable. For indexing and word search. If there are no such terms in the title, the author is strongly advised to add a subtitle. The title should be given in English as well. The titles precede the abstract and the summary in an appropriate language.

Letterhead Title

The letterhead title is given at a top of each page for easier identification of article copies in an Electronic form in particular. It contains the author's surname and first name initial .article title, journal title and collation (year, volume, and issue, first and last page). The journal and article titles can be given in a shortened form.

Author's Name

Full name(s) of author(s) should be used. It is advisable to give the middle initial. Names are given in their original form.

Contact Details

The postal address or the e-mail address of the author (usually of the first one if there are more Authors) is given in the footnote at the bottom of the first page.

Type of Articles

Classification of articles is a duty of the editorial staff and is of special importance. Referees and the members of the editorial staff, or section editors, can propose a category, but the editor-in-chief has the sole responsibility for their classification. Journal articles are classified as follows:

Scientific articles:

1. Original scientific paper (giving the previously unpublished results of the author's own research based on management methods).
2. Survey paper (giving an original, detailed and critical view of a research problem or an area to which the author has made a contribution visible through his self-citation);
3. Short or preliminary communication (original management paper of full format but of a smaller extent or of a preliminary character);
4. Scientific critique or forum (discussion on a particular scientific topic, based exclusively on management argumentation) and commentaries. Exceptionally, in particular areas, a scientific paper in the Journal can be in a form of a monograph or a critical edition of scientific data (historical, archival, lexicographic, bibliographic, data survey, etc.) which were unknown or hardly accessible for scientific research.

Professional articles:

1. Professional paper (contribution offering experience useful for improvement of professional practice but not necessarily based on scientific methods);
2. Informative contribution (editorial, commentary, etc.);
3. Review (of a book, software, case study, scientific event, etc.)

Language

The article should be in English. The grammar and style of the article should be of good quality. The systematized text should be without abbreviations (except standard ones). All measurements must be in SI units. The sequence of formulae is denoted in Arabic numerals in parentheses on the right-hand side.

Abstract and Summary

An abstract is a concise informative presentation of the article content for fast and accurate Evaluation of its relevance. It is both in the Editorial Office's and the author's best interest for an abstract to contain terms often used for indexing and article search. The abstract describes the purpose of the study and the methods, outlines the findings and state the conclusions. A 100- to 250-Word abstract should be placed between the title and the keywords with the body text to follow. Besides an abstract are advised to have a summary in English, at the end of the article, after the Reference list. The summary should be structured and long up to 1/10 of the article length (it is more extensive than the abstract).

Keywords

Keywords are terms or phrases showing adequately the article content for indexing and search purposes. They should be allocated heaving in mind widely accepted international sources (index, dictionary or thesaurus), such as the Web of Science keyword list for science in general. The higher their usage frequency is the better. Up to 10 keywords immediately follow the abstract and the summary, in respective languages.

Acknowledgements

The name and the number of the project or programmed within which the article was realized is given in a separate note at the bottom of the first page together with the name of the institution which financially supported the project or programmed.

Tables and Illustrations

All the captions should be in the original language as well as in English, together with the texts in illustrations if possible. Tables are typed in the same style as the text and are denoted by numerals at the top. Photographs and drawings, placed appropriately in the text, should be clear, precise and suitable for reproduction. Drawings should be created in Word or Corel.

Citation in the Text

Citation in the text must be uniform. When citing references in the text, use the reference number set in square brackets from the Reference list at the end of the article.

Footnotes

Footnotes are given at the bottom of the page with the text they refer to. They can contain less relevant details, additional explanations or used sources (e.g. scientific material, manuals). They cannot replace the cited literature.
The article should be accompanied with a cover letter with the information about the author(s): surname, middle initial, first name, and citizen personal number, rank, title, e-mail address, and affiliation address, home address including municipality, phone number in the office and at home (or a mobile phone number). The cover letter should state the type of the article and tell which illustrations are original and which are not.

<u>**Address of the Editorial Office:**</u>

Enriched Publications Pvt. Ltd.
S-9,IInd FLOOR, MLU POCKET,
MANISH ABHINAV PLAZA-II, ABOVE FEDERAL BANK,
PLOT NO-5, SECTOR -5, DWARKA, NEW DELHI, INDIA-110075,
PHONE: - + (91)-(11)-45525005

Notes: