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WAVELET BASED MOBILE LOCATION ESTIMATION USING RSS MEASUREMENTS

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ABSTRACT

This paper studies the location of the position method is developed by applying factual analysis on GSM base station (RSS) down link signal strength by using wavelet transform. The GSM received signal strength is converted in terms of wavelet bases and this method estimates the positioning of the mobile and personal tracking the position based systems are used to find a person or an object related to known position or a coordinate system. NLos propagation is the major source of errors. Hence In this paper we propose a new method to solve the problem. The proposed method integrates the location estimation and Localization as a technique to solve the complex and challenging problems. Besetting line-of-sight (LOS) and non-line-of-sight (NLOS) transmissions has recently attracted considerable attention in the wireless sensor network field an approach utilizing the factual analysis with the help of Haar wavelet transform to increase the GSM –position accuracy.

Keywords: location based service (LS), GPS tracking, navigation, NLOS (Non line of sight).

1 INTRODUCTION

Nowadays Women security is at the stake worldwide. It is threatened of smartphones, mobiles, iPhones, and the entire gadget emerging today it's very important for the mobile user to have the location based services [1]. Location based service can be elaborate as the services which uses the users geographical location which consists of X and Y coordinates, which can be generated by GPS(Global positioning system) The wavelet based mobile communication is superlative for other positioning system. The mobile location estimation using RSS measurements are investigated by several methods LS, WLS positioning algorithms are implemented for mobile positioning [2]. All the wavelet transforms [8] may be considered form of time frequency representation for continuous time (Analog) signals. The Wavelet analysis is used as a robust technique to Fourier analysis and it is a time –frequency domain operation. The Wavelet transform results obtained show that the performance of mobile location measurements.

The rest of this paper is organised as follows we describe the location-based services, and the need of location based service and types of location based services in Section 2 and Section 3 describes mobile positioning methods and section 4 demonstrates wavelet transform and different types of wavelet form. Finally results and conclusions along with future work are presented in Section 5.

2. LOCATION BASED SERVICE

2.1 The need of Location based service

The Location Based services [9] group of telecommunication services, accurate positioning with location related content of telecommunication. An LBS requires five basic components: the service provider's software application, a mobile network to transmit data and requests for service, a content provider to supply the end user with geo-specific information, a positioning component (Ex: GPS) and the end user's mobile device. By law, location-based services must be permission-based. That means the end user must opt-in to the service in order to use it. In most cases, this means installing the LBS application and accepting a request to allow the service to know the device's location. The release of Apple's 3G iPhone and Google's LBSenabled Android operating system, however, has allowed developers to introduce millions of consumers to LBS.

2.1 Types of location based service

A wide variety of location based techniques have been proposed so far, each one presenting certain advantages, as well as drawbacks, to deal with the issue of required investment on.

3. MOBILE POSITIONING METHODS

To find the position of the mobile [7] from celluler system and to develop a new method and signalling to make necessery measurements [6] and transfer results. The Table-1 shows various positioning methods used in major cellular systems. The telecommunication industry Association/Electronics industry alliance is abbreviated as TIE/EIA shown in the below Table-1. In this, Category 1 denotes basic service to all handsets while category 2 is enhanced service for new handsets with reasonable cost. Both are cellular system specific. Category 3 is common to all systems and provides enhanced service to new handsets with higher cost.

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Table-1. (Tia/Eia-136) Curtecy by Bsnl.

System	Category	Location technology
GSM	1	Cell identity + time advance Uplink time of arrival
	2	Enhanced observed time difference
	3	(Assisted) Global Positioning System
TIA/EIA – 136	1	Cell identity
	2	-
	3	(Assisted) Global Positioning System
IS-95	1	Cell identity
	2	Advanced Forward Link Trilateration
	3	(Assisted) Global Positioning System
UMTS	1	Cell identity + round trip time
	2	Enhanced observed time difference Observed time difference of arival
	3	(Assisted) Global Positioning System

The mobile device exchanges RF signals with the reference points to estimate the distance or angle. The accuracy of the location information is affected by three factors one is the accuracy of the reference point's position, the accuracy of range /angle estimates and the geometrical configuration. The non-survey geolocation techniques compute location estimation through two steps Range/angle estimation and tri-lateration/angulation. The localization using received signal strength (RSS) for GSM is very similar to TOA-based technique. The distance to base stations are used in a tri-lateration approach to estimate the position. In LOS (line of sight) transmission exists between transmitter and a receiver, the signal arrival time or angle may be correctly obtained if the SNR is high and the multipath from the propagation channel is resolved properly. In situations where NLOS propagation exists and suitable NLOS mitigation techniques are needed for improving the accuracy of ranging and localization. To apply the TOA and TDOA Parameters for locating mobile stations or targets the exact range between transmitter and receiver in the wireless environment is correctly calculated only. When the direct path between transmitter and receiver, which is not always possible in all cases but in most of the cases errors caused by the NLOS effect. This cannot be ignored in wireless communication systems where high accuracy is demanded.

Consider an area divided into hexagons comprising of main or serving cells of uniform size. The base station is the circum center of Hexagon. The main or serving cell is denoted as BS1. The five neighbouring cells are denoted as BS2, BS3, BS4, BS5, BS6 respectively. The transmitted power is 0dB and the base station height is 30mt and the frequencies are 940,945,942,948,944, MHz and 946 MHz respectively. The results for algorithms are obtained either by changing the hexagon side (HS) or number of base stations. The actual location in each hexagon is estimated by using Haar wave analysis and error is calculated. Each time the hexagon side is increased by 0.5 Km and the process is repeated .Here the results for the case of 6 BSs are presented when the mobile moves in GSM network. It constantly receives the signal from different base stations and at a certain threshold values of signal strength, it decides to change serving BS, and initiates a handoff. To measure the signal strength Mobile station stores information about serving and six neighbouring BSs which it is receiving strongest signal called NMR (available only in MS) . MS has information about base station identity code and RSS.MS positioning is done using time, angle and RSS measurements. The time and angle based methods involve expensive upgrades at both MS and BS. The time based methods need synchronization between the BSs and MS while in angle-based methods even though they do not meet the requirement. Among all these methods, RSS based methods are feasible because RSS value is present at the MS every 0.48 s. Also, these methods do not need expensive improvement.

GSM mobile environment impact: The total impact of a system is normally stranger correlated to number of users of the system as more users mean more infrastructures, more consumer equipment, etc. There are many aspects of environmental impact that may be considered in the case of mobile communication. The overall life cycle of mobile environmental impact consists of the usage of raw material, energy consumption of usage, Land usage of base stations and switching stations and visual impact of base stations

4. WAVELET TRANSFORMS

There are different types of wavelet families whose qualities are varying according to several criteria

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and Wavelet are classified into two types one is continuous wavelets and the other is discretewavelets.

4.1 Continuous wave transform (CWT)

The continuous wave transform is a linear wave transform. It is the sum of two signals wavelet transform and each individual signal also the wavelet transform whose elements are the wavelet transform of the vector components

4.2 Discreet wavelets transform

A discreet wave let transform [12] is any wavelet transform for which the wavelet are discreetly sampled. It has high is temporal resolution and it captures both frequency and location information (location in time). This is the key advantages of wavelet transform over Fourier transform. DWT is the representation of signals as series summation of certain wavelets. Some popular DWT are Haar wave lets, Daubenchies wavelets, 5/3 orthogonal wavelets and 9/7 orthogonal wavelets and DWT is also called multi-resolution transform. The signal pass through two filters- a high pass filters that extracts the high frequency components(Detailed coefficients) and low pass filter that pass the low frequency components (Approximate components). The Haar wavelet is a certain sequence of functions and it is recognised as the first known wavelet. This sequence was proposed in 1909. Alfred Haar. Haar used these functions to give an example of a countable orthonormal system for the Space of square intergrable functions on the real line.

The integral wavelet transform is the integral transform defined as

$$[W_\psi f](a,b) = \frac{1}{\sqrt{|a|}} \int_{-\infty}^{\infty} \overline{\psi\left(\frac{x-b}{a}\right)} f(x)dx \quad (1)$$

The wavelet coefficients c_{jk} are then given by

$$c_{jk} = [W_\psi f]\left(2^{-j}, k2^{-j}\right) \quad (2)$$

Here, $a = 2^{-j}$ is called the binary dilation or dyadic dilation, and $b = k2^{-j}$ is the binary or dyadic position.

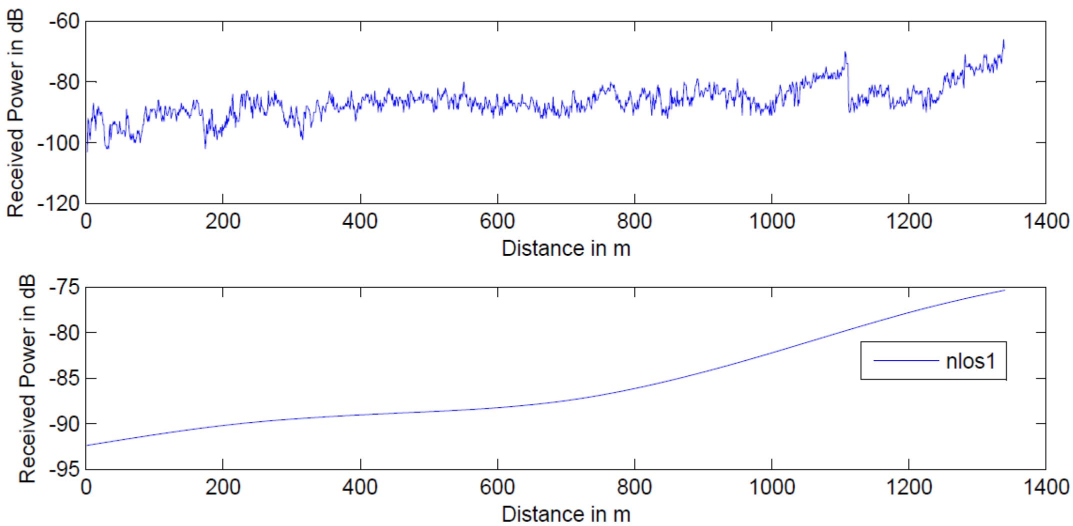

Figure-1(a). (Nlos1).

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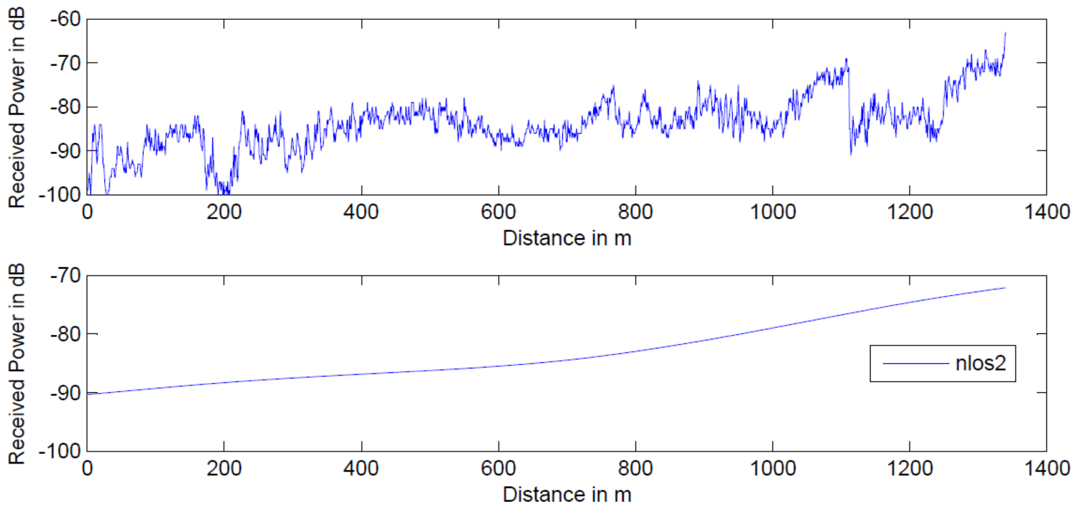

Figure-1(b). (NLOS2).

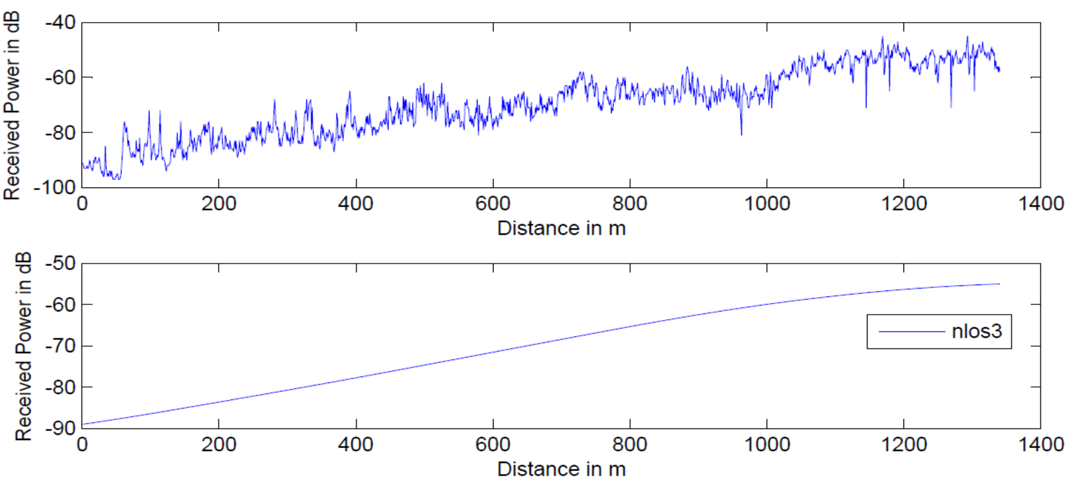

Figure-1(c). (NLOS3).

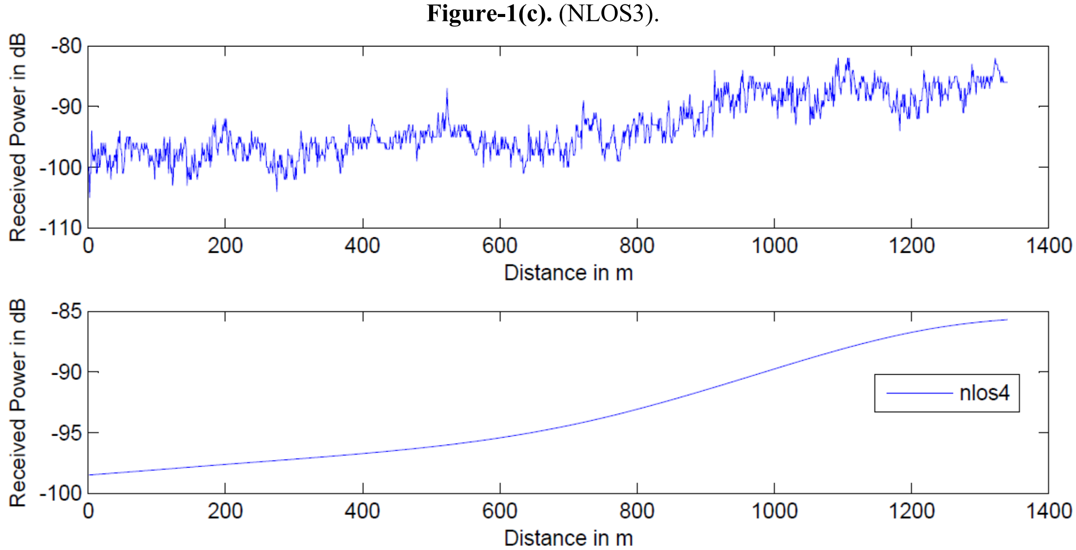

Figure-1(d). (NLOS4).

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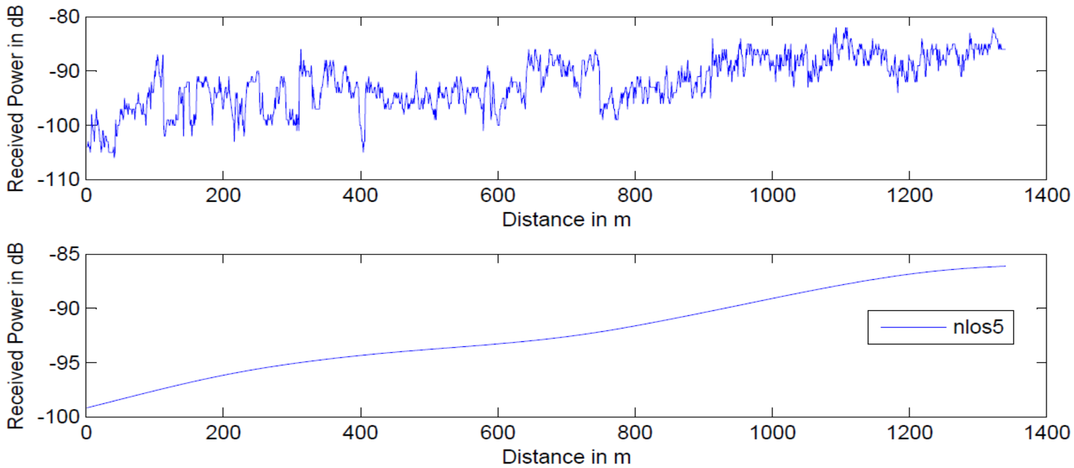

Figure-1(e). (NLOS5)N.

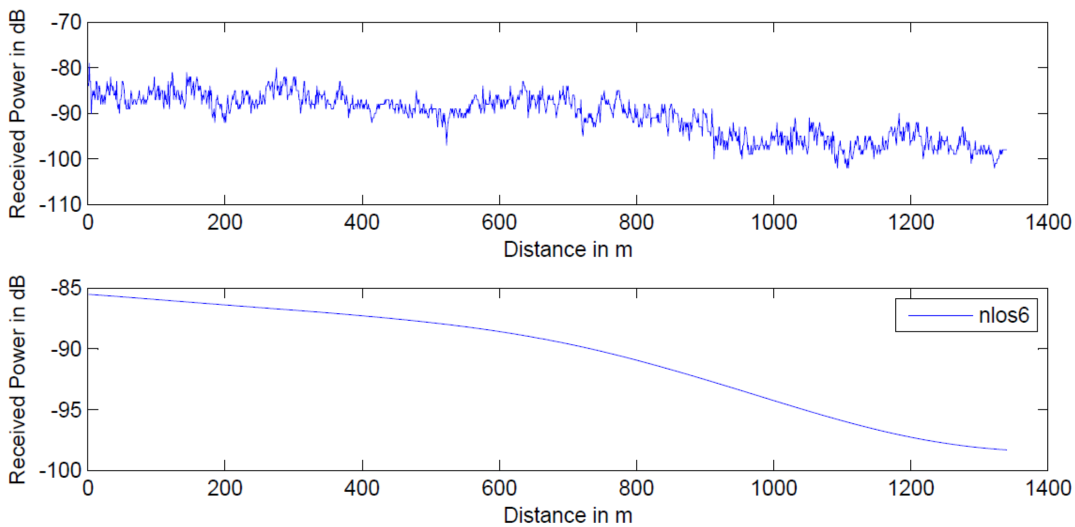

Figure-1(f). (NLOS6).

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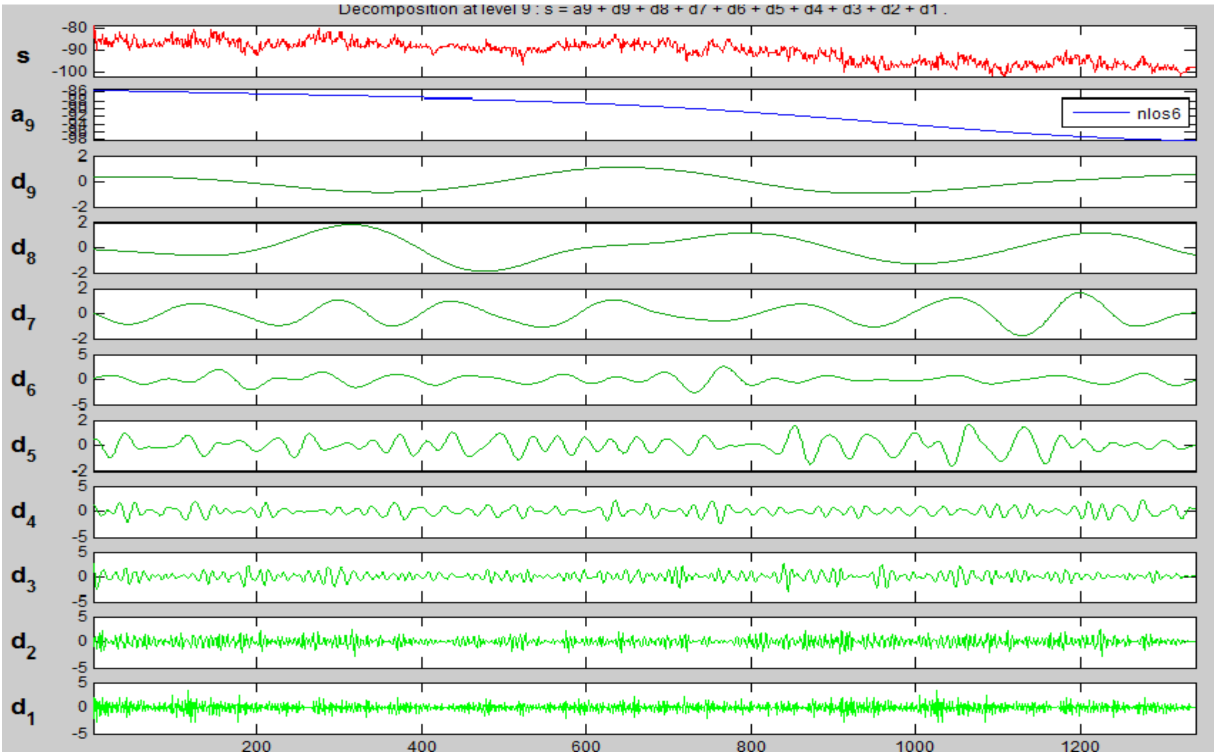

Figure-2. Wavelength decomposition for Nlos6 base stations.

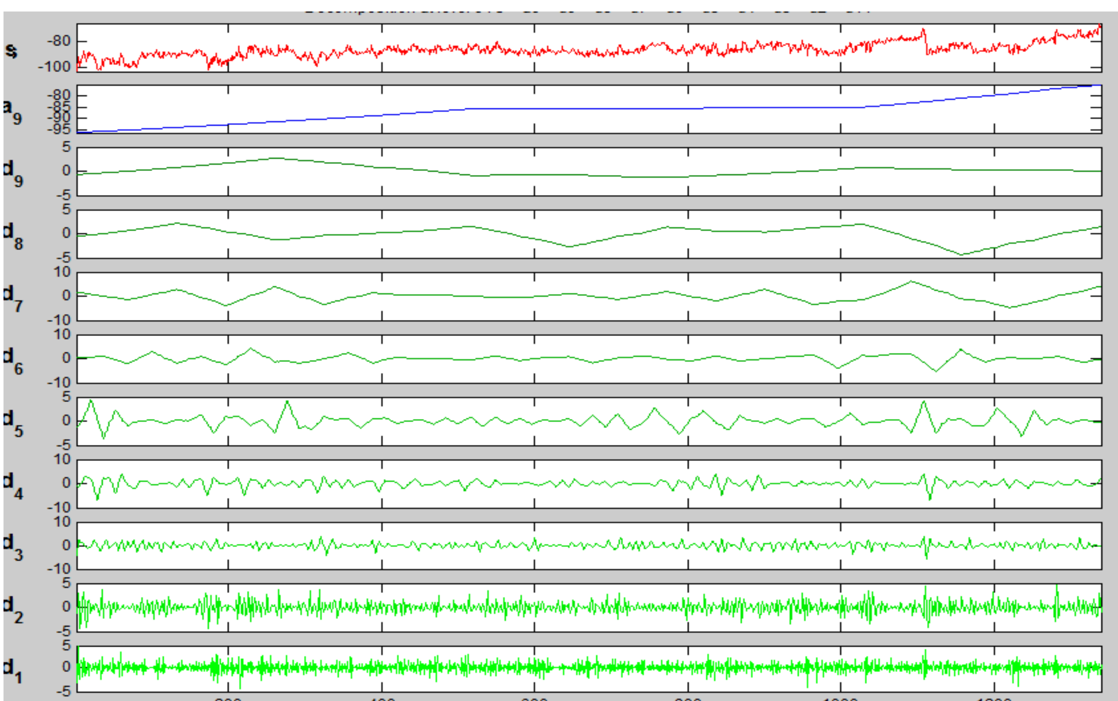

Figure-2(a). (NLOS1).

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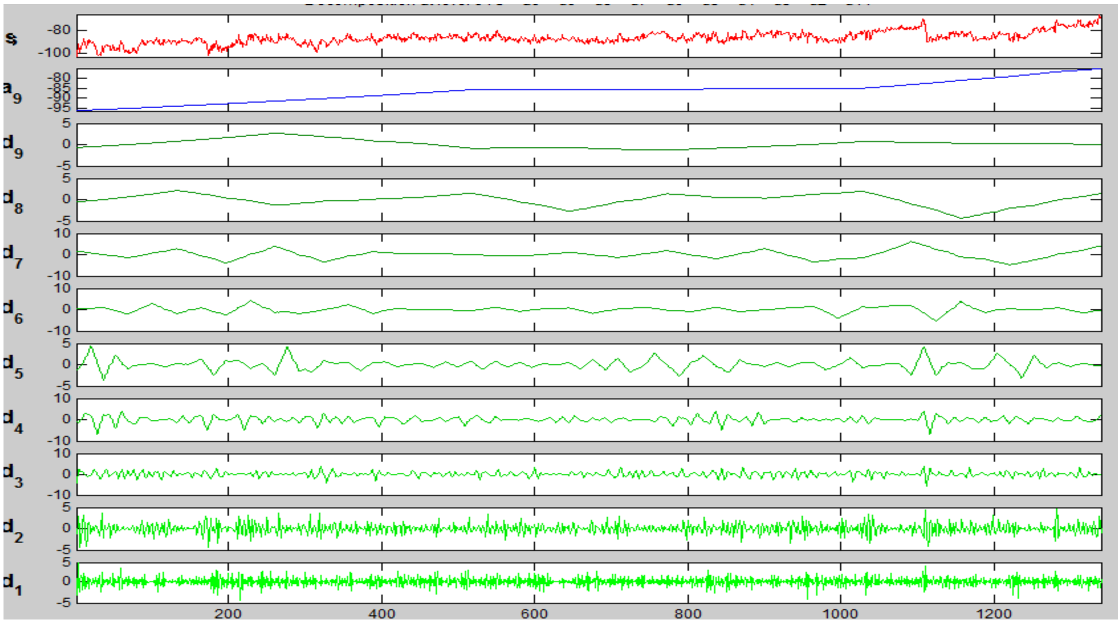

Figure-2(b). (NLOS2).

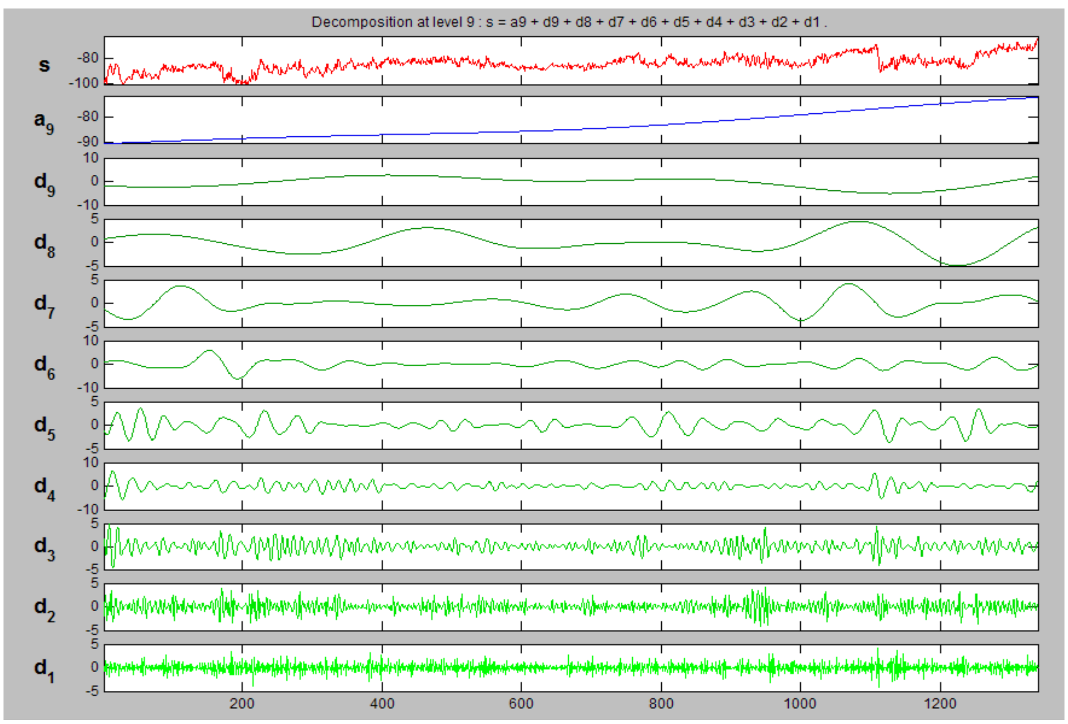

Figure-2(c). (NLOS3).

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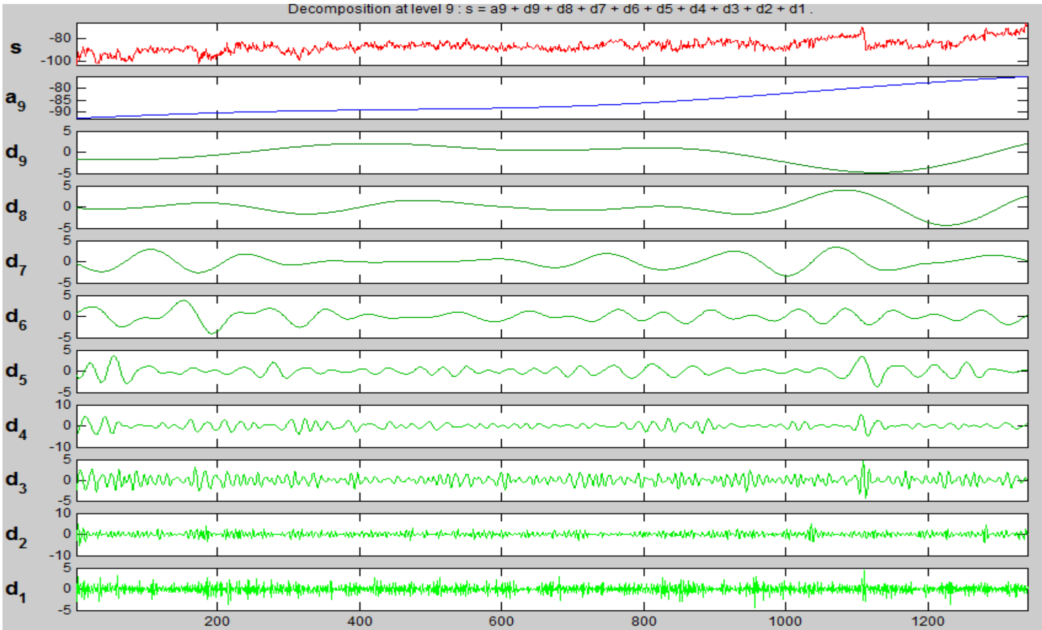

Figure-2(d). (NLOS4)

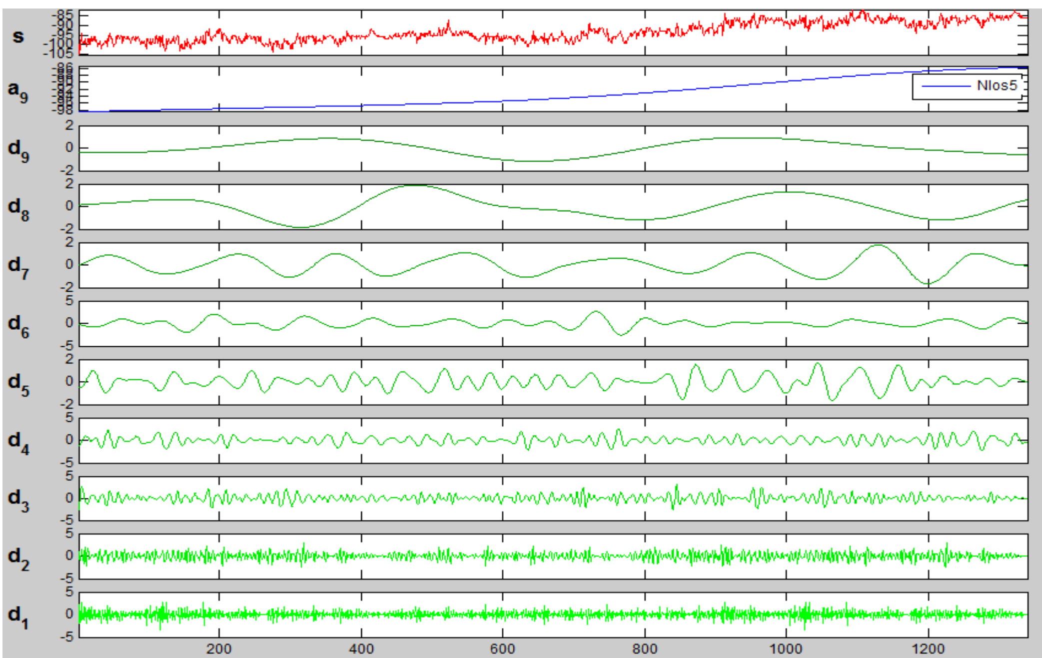

Figure-2(e). (NLOS5).

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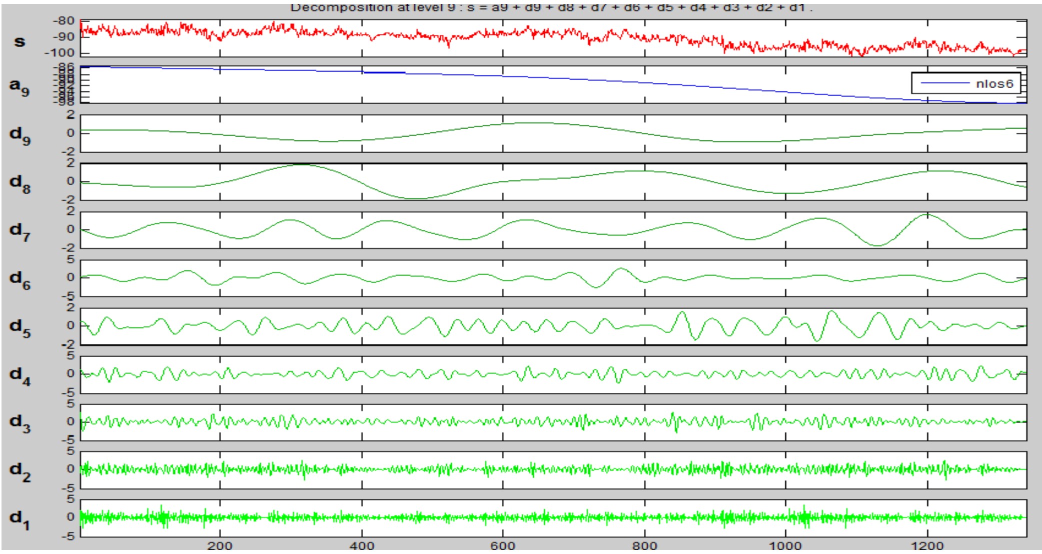

Figure-2(f). (NLOS6). Wavelet decomposition for different Nlos base stations.

TRACKING POSITION OF MOBILE USING WAVELET TRANSFORM

Table-2. Real time data from different base stations.

Distance	NborRxlev6	NborRxLev_1	NborRxLev_2	NborRxLev_3	NborRxLev_4	NborRxLev_5
1	**-67**	**-71**	**-77**	**-87**	**-92**	**-96**
1	-73	-72	-73	-91	-91	-95
3	-66	-66	-76	-91	-93	- 97
4	-75	-67	-75	-90	-91	-96
7	-92	-70	-75	-90	-91	-96
10	-68	-72	-77	-89	-90	-92
14	-76	-71	-72	-88	-92	-92
18	-83	-73	-73	-81	-92	-93
21	-78	-70	-73	-81	-92	-95
25	-80	-67	-70	-84	-89	-96
31	-79	-66	-66	-85	-93	-96
38	-92	-61	-64	-87	-94	-97
46	-84	-65	-66	-88	-89	-91
54	-82	-69	-69	-87	-93	-92
61	-82	-72	-74	-87	-93	-90
69	-78	-73	-76	-85	-91	-87
78	-74	-73	-76	-82	-91	-86

Table-3. Base stattions loctions.

S. No.	Site uniq ID	DHqtrs/ E-city/Rural	DHqtrs/E-city/Rural Name	Longitude	Latitude	GBT/RTT/RTP/Pole/Marr	TOWER Ht	Bldg Ht
1	KR2073	E-City	GVA_2-MICROWAVE	81.01221	16.43436	GBT	100 M	GBT
2	KR2152	DHQ	BHARATHINAGAR	80.66651	16.50624	RTT	12 M	10m (G+2)
3	KR2205	DHQ	NIRMALACONVENT	80.65686	16.49739	RTP	6 M	18m (G+5)
4	KR2158	DHQ	PATAMATA	80.66240	16.49809	RTP	6 M	20m (G+5+P.H.)
5	KR5017	DHQ	SONYVISION_PATAMATA	80.66266	16.49559	RTT	15 M	10m (G+2)
6	KR2200	DHQ	DONKAROAD	80.66338	16.48842	RTP	6 M	21m (G+5+PH)
7	KR2201	DHQ	SRINIVASNGRBANKCLY_GTL	80.67066	16.5114	RTP	9 M	21m (G+5+PH)
8	KR2083	DHQ	AUTONAGAR	80.67400	16.50437	GBT	40 M	GBT
9	KR2202	DHQ	YNAMALAKUDURU_ATC	80.66817	16.36888	GBT	40 M	GBT
10	KR2160	DHQ	ASHOKNAGAR_VJ	80.67889	16.48616	RTT	12 M	10m (G+2)
11	KR2062	DHQ	KAMAYYATOPU	80.68668	16.48789	RTP	6 M	20m (G+5+P.H.)
12	KR2188	DHQ	KAMAYYATOPU-2_VIOM	80.68664	16.48292	RTP	9 M	18m (G+5)
13	KR2187	DHQ	TADIGADAPA_VIOM	80.69732	16.47991	RTT	21 M	15m (G+4)
14	KR2041	DHQ	PORANKI	80.71217	16.47640	GBT	40 M	GBT
15	KR5105	DHQ	PENAMALURU2	80.71858	16.46990	RTT	18 M	13m (G+3)
16	KR2052	DHQ	ROYYURU_ATC	80.73518	16.39771	GBT	40 M	GBT
17	KR5014	DHQ	GANGURU_VIOM	80.72814	16.46570	GBT	40 M	GBT
18	KR2037	Rural	GOSALA_VIOM	80.75654	16.44353	GBT	50 M	GBT
19	KR2037	Rural	EDUPUGALLU	80.74136	16.45536	RTT	21 M	7m (G+1)
20	KR50221	Rural	KANKIPADU_RLU	80.76768	16.43217	GBT	40 M	GBT
21	KR5116	Rural	KANKIPADU_RLU2	80.76768	16.43217	GBT	40 M	GBT
22	KR5043	Rural	CHINAOGIRALA	80.82452	16.37827	GBT	40 M	GBT
23	KR2010	Rural	TELAPROLU	80.88840	16.58875	GBT	100 M	GBT
24	KR5075	E-City	VUYYURU_TE2	80.84197	16.36371	GBT	40 M	GBT
25	KR5091	E-City	VUYYURU2-IBS	80.85437	16.36120	RTP	6 M	21m (G+6)
26	KR2161	E-City	VUYYURU-2	80.85437	16.36120	RTT	18 M	RTT

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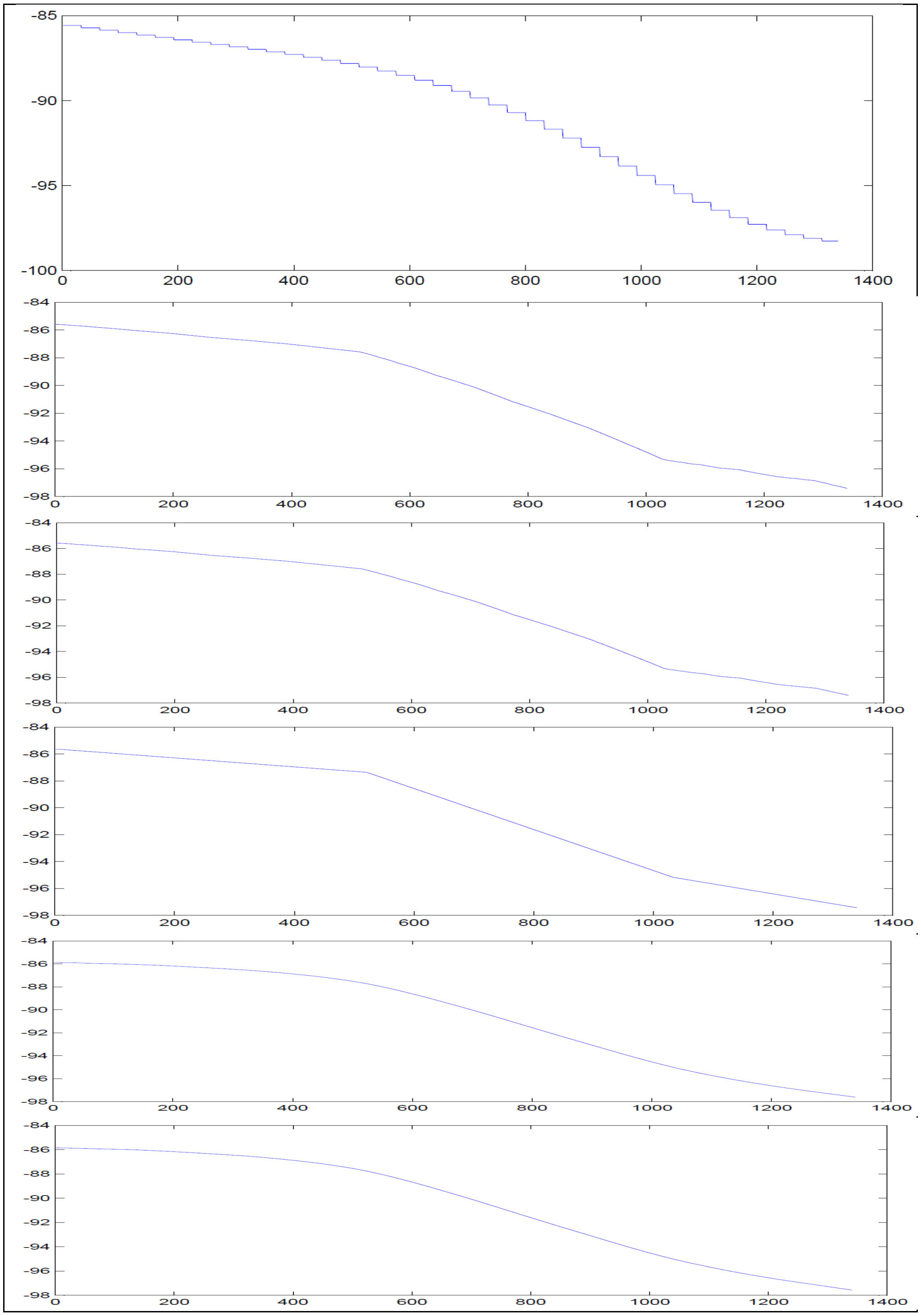

Figure-3. Wavelet decomposition by using different wavelets.

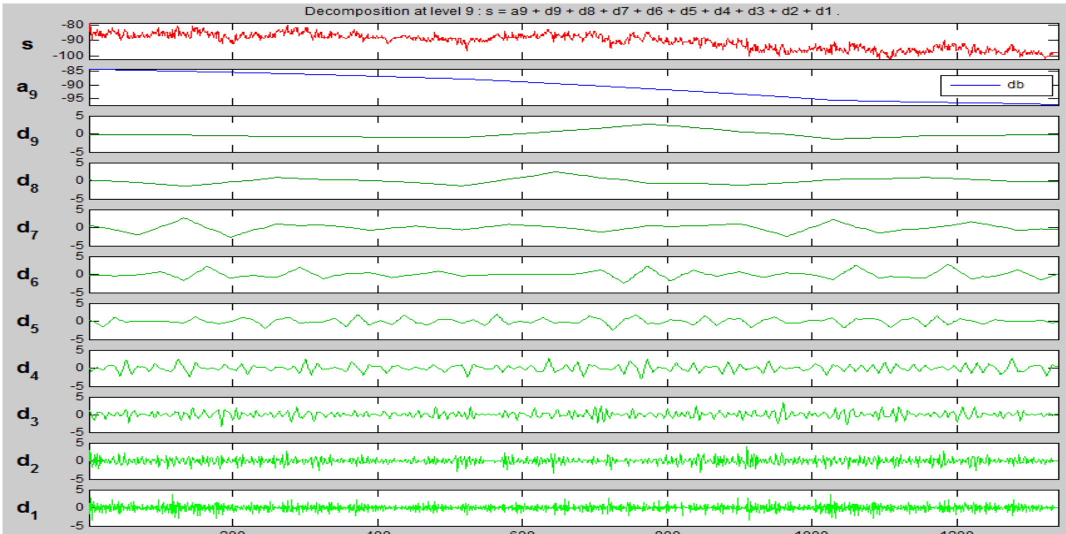

Figure-3(a). (dB) Distance.

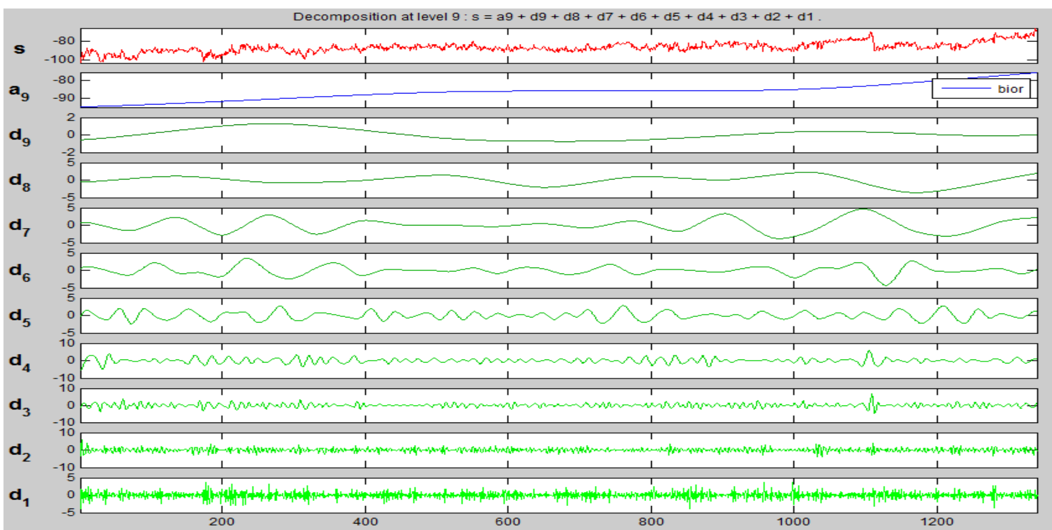

Figure-3(b). (blur).

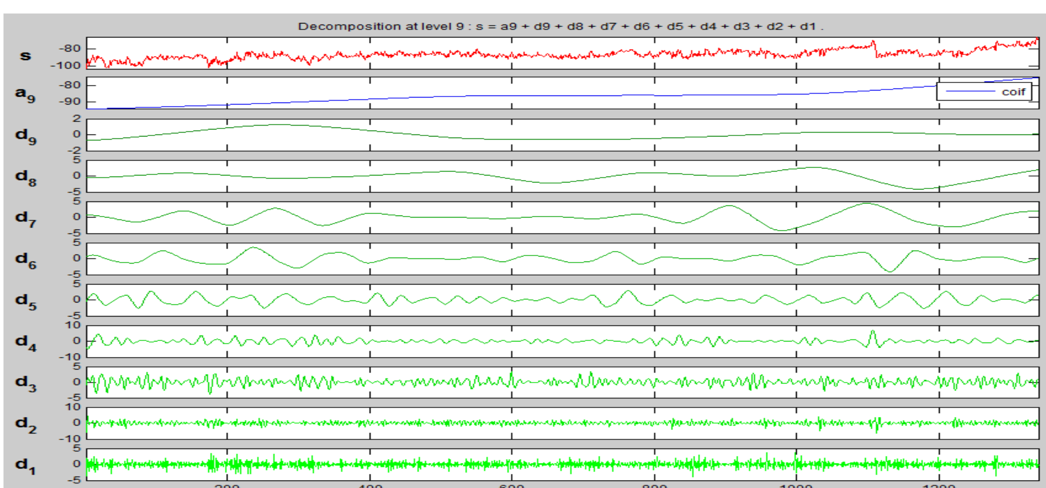

Figure-3(c). (Coif).

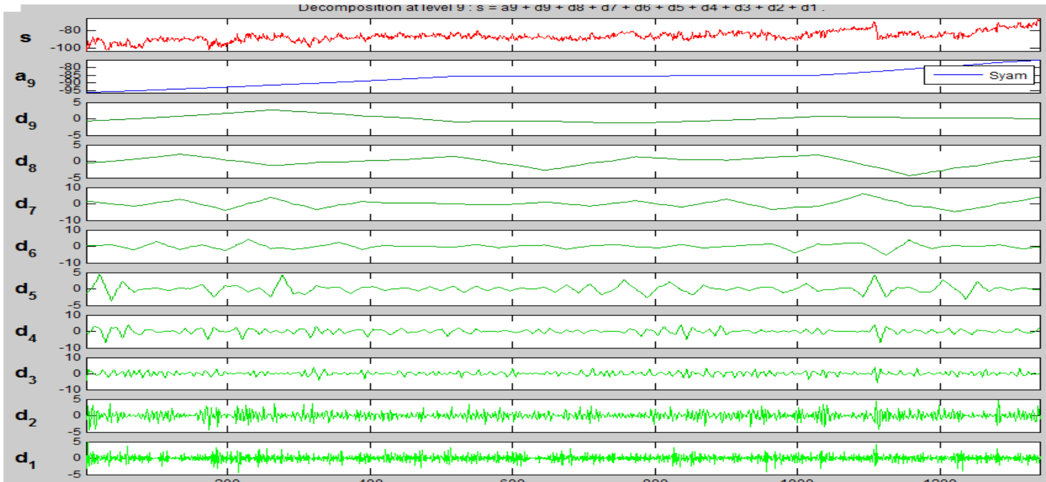

Figure-3(d). (Syam).

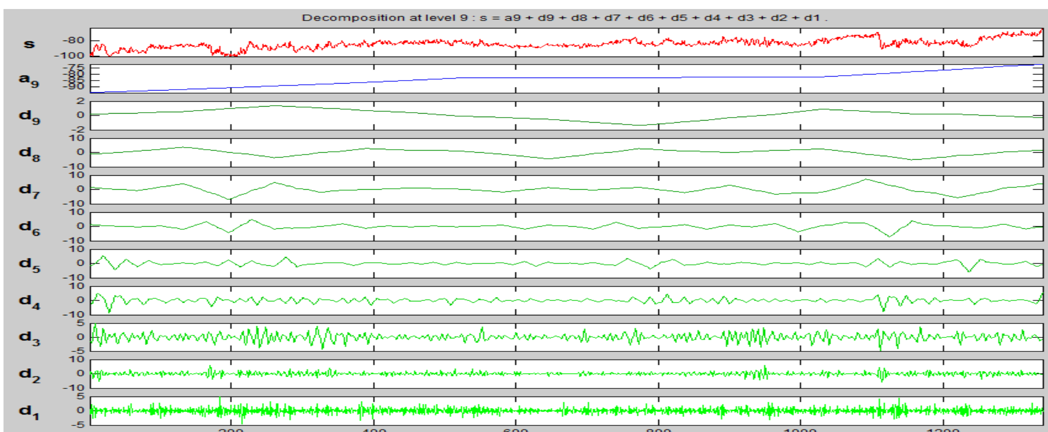

Figure-3(e). (Haar).

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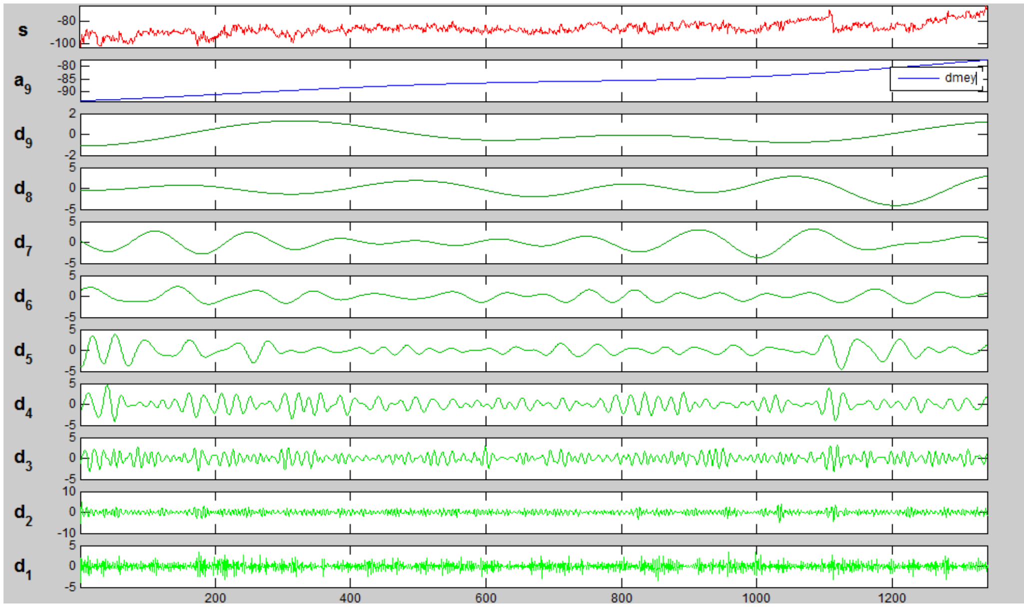

Figure-3(f). (dmey).

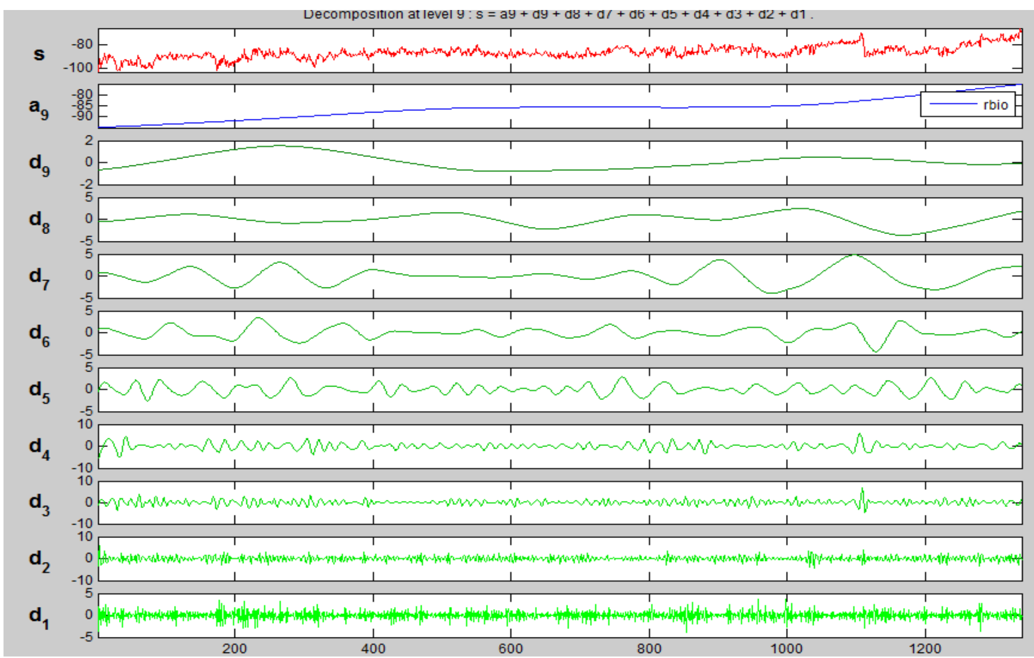

Figure-3(g). (brio).

Comparison wavelet decomposition for different wavelets

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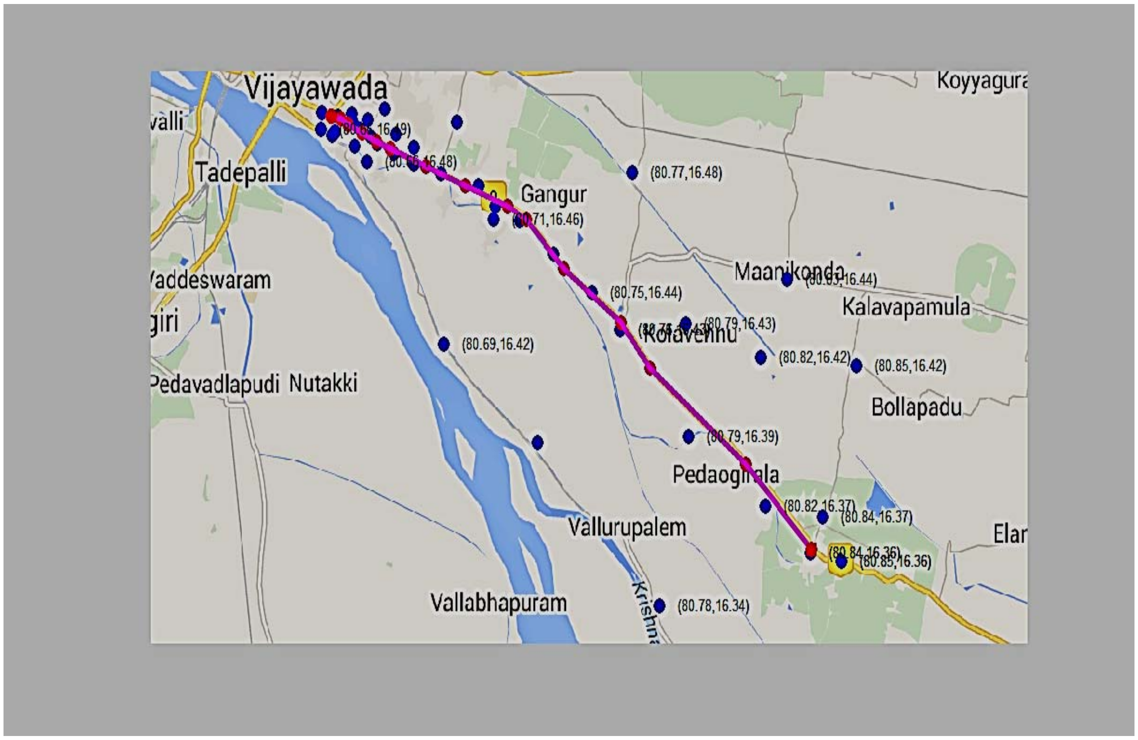

Figure-4. District map with radial areas (Courtesy:mapsofindia.com).

5. PERFORMANCE OF NLOS6 ANALYSIS FOR LOCATING THE POSITION OF THE MOBILE BY USING DIFFERENT WAVELET TRANSFORM

In the present study, the position of the mobile presented at real time measurements is monitored in different locations and map of Vijayawada urban to rural environment up to Vuyyuru via Benz circle is as shown in fig2 and the transmitter cell towers and neighbouring cell towers are located in a thickly populated zone surrounded by heavy traffic roads and national high way, congested multi-stored buildings ,newly constructed multiplex theaters and the characteristics of transmitter is as shown in Table-2. The receiver in the outer region of the base stations consider Nlos6 base station. The measurements were taken in the month of May. Total path area can be divided into three sectors. In sector 1 there is thickly populated zone and coverage area is more so that the maximum number of cell towers is located nearer to each other. When the mobile is starting at Microwave tower, is located at M.G. Road Vijayawada is as shown in Table-2. The neighbouring IDKR2073 whose longitude is (81.0221) and latitude (16.4336) and tower height is 200m. After the wavelet analysis, it is clear that the received power is -85db for all the wavelet transform with a distance of 200mts decreases linearly as the distance increases. These results in the mobile moving away from the base station IDKR2073 which is located inner region and the remaining five base stations are IDKR2152, IDKR2158, IDKR5017 and IDKR2199 which are outer regions. We found that by applying different wavelet families like Haar, Bi orthogonal, Daubenchies, Reverse bio orthogonal, Symlet wavelets etc at NLOS6 and get the similar graphs as the mobile is moving away from the Nlos6. Now we consider one more location to identify the position of the mobile. Here a big circle is located in the midle of the junction and we observed that there is slight deviation in the arrangement of the nlos6 from the main road. The neighbouring cellKR2152 is located at Bharathinagar, kR2158 at patamata and KR5017 at sonovision-patamata, KR2205 at Nirmala convent etc. We observed that KR2152 tower and its longitude (80.66651) and latitude (16.50624) the received signal strength of wavelet layer a_9 power decreases which gives the position of the mobile which is nearer to the cell tower KR2152 and the remaining neighbouring cell towers will give increased received power. If the KR2205 tower received signal strength of wavelet layer a_9 power shows in the graph as exponentially decreased and the position of the mobile is located in the direaction towards Loyola college which is moving in another direction. In sector2 consider gangur section the neighouring cell is KR2037 tower received signal strength of wavelet layer a_9 power shows the wavelet graph has exponentially decreased this results in the position of the mobile moving towads Edupugallu.In sector 3 consider Kankipadu the neighbouring cell IDs are KR50221 and KR5116, its longitude(80.76768) and latitude is (16.43217) IF the KR50221 shows tower received signal strength of wavelet layer a_9 power graph has exponentially decreased the position of the mobile is locating at Kankipadu is moving towards Vuyyuru otherwise if the KR5116 which is located at Kankipadu_Rural show graph exponentially decreases then the mobile is moving in other direction i.e. towards kolavennu. The same results is observed around at any point on the path from vijayawada to vuyyuru.

Table-4. Base station antenna specifications.

Parameters	vijayawada	Vuyyuru
Transiting frequency	2.1GHz	2.1GHz
Transmitting power(W)	20	20
Transmitting antenna gain(dB)	17	17
Transmitting antenna height(m)	30	30

(Courtecy by BSNL-INDIA)

6. RESULT AND ANALYSIS

In this paper [14] we presented the location of the position method are investigated with real time cellular at BSNL Vijayawada and Table-1 and Table-2 shows the real time data is obtained from test drive by using TEMS software (The instrument used in the measurements used in the measurement and the way of doing experiment by using test drive to cover 30 KM from Vijayawada.

A GSM communication module as the receiver to measure the power of the base stations down signals. The power data signals from six base stations obtained in six channels and the measurement curves can be seen as the upper curves from Figure-1(a-f) To analyse the signal by using wavelet packet 1D and DB3 wavelet to apply level 9 processing then the signal power attenuation with respect to long distance range is obtained. One dimensional analysis is based on one scaling function and wave letthe wavelet transform constitutes a tool for the manipulation of scale –invariant signals and wavelet based approach to obtain the distance and movement direction or give information from the receiving power. After the wavelet transforming the power attenuation function can be obtained as lower curves from Figure-2 (a-f). Then the distance from the base stations can be obtained. The receiver is in the outer region of the six base stations. For example from Figure-2(c) it can be seen that the receiver is moving towards the base stations which transmit NborRxLev_2frequency signal and distance can be calculated based on power relative attenuation and the position of the receiver can be obtained based on the distance to the six base stations.

A cell decomposition environment is achieved through an appropriate selection by the use of scaling function and wavelet. We use wavelet transform to decompose the attenuated signal measured usually provide information about time and frequency of the signal. [15]

The Haar wavelet, continuous wavelet andsymlet, coiflet wavelet, db. Wavelet and biot and dmey wavelet are examples of compactly supported wave lets whose decomposed level is 9The Haar wavelet is selected for the following reasons the physical appperanence of experimental data, Haar has a coefficient equal to the experimental data. This wave let is applied to all the six neighboring cells and wavelet decomposition of the detailed and approximate signals is as shown from Figure-2(a-f). We concluded that except NLOS6 cell and remaining five NLOS have got similar levels of graph as shown but the NLOS6 cell has got graph which is opposite to the NLOS1 –NLOS5 cells. This result the received signal drops quickly from Nlos6 cell form a nonlinear curve and the received signal from the five base stations drop slowly to form a linear curves and we observed similar graph for five neighboring cells.

7. COMPARISON BETWEEN DIFFERENT WAVELET TRANSFORMS

A comparative performance analysis of the result is obtained from different wavelet families have also been carried out and the Wavelet transform comprise an infinite set. The different wavelet family's shows different tradeoff between how compactly the basic function localized in space and how smooth they are as shown in Figure-3 (a-f).

To locate the position of the mobile by applying different wavelets and the performance of different order of wavelets like db, coif, ior, haar, rbio is as shown from Figure-3 (a-f). The details of d1 and d2 shows the kind of variation similar shapes and mean value and it contain short irregularities caused by noise the inspection d3 detect local minimum. This family includes Haar wavelet and the analysis is orthogonal and db. are symmetrical and factual structure and bioorthognal wavelet pair and it is well known in sub band filtering community which will shows similar received power for all the wavelets like db, haar, Sym, bior. The first and second level (d1 and d2) shows the discontinuity because the rapture contains high frequency part. The discontinuity part is localized very precisely only small domain around time is 600sec.The advantage of wavelet analysis over Fourier analysis is that We would not able to detect the instant of the frequency change in signals, where as it is clearly observable here. There is much noise in the original signals that over all approximation up on visual inspection. There is slight deviation that can be observed from d3 --d4. We observed that trend becomes more and more clear approximation from d4 to d9 and this shows that as the slowest part of the

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signal and shows the greatest scale value in wave let analysis as the scale increases the resolution decreases. This results estimate the position of the mobile. After comparing the signal strength with different wavelet families we can estimate the position of the mobile with the same place and the signal strength is also same.

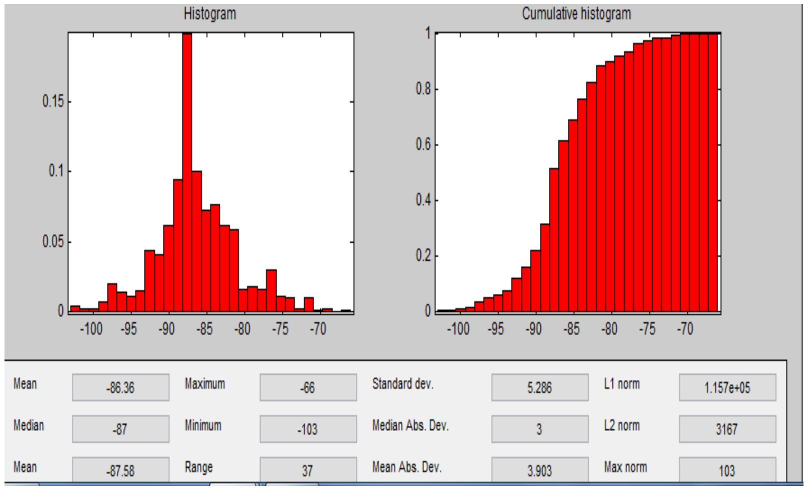

Figure-5. Statistical graph.

8. STATISTICAL ANALYSIS

The displayed statistics include the measure of tendency (mean, mode, median) and dispersion (range and standard deviation) is as shown in Figure-5. To examine the signal strength of the mobile and compare the statistics of the signal from wavelet analysis and signal strength from practical data is as shown in Table-2. We conclude that the mean value of Rxlevel is -81.32285714 and mean value from wavelet analysis is -86.36 which is close to the practical value-81.322. similarly we observe that the median value is -82 and wavelet analysis value is -87 and the wavelet analysis of maximum mean value is-66 and minimum mean is-103 and observed maximum value is -50 and the minimum value of mean is -108.The practical standard deviation value is 7. 694945863 and the S.D from wavelet analysis is 5.266 is also close to the practical value. The Table-3 shows the received signal from six NLos base stations.

Table-5.

Statistic	**Nlos RxLevSub** (BSNL provided)	**NlosRxLevSub** (Wavelet provided)
Mean	-81.32285714	-86.
Mode	-83	
Median	-82	-87
Maximum	-50	-66
Minimum	-108	-103
Count	14000	
Standard Deviation	7.694945863	5.266
Variance	59.21219184	

9. CONCLUSIONS

In this Paper, we proposed a new method in Location based services using Haar wavelet transform combined with fractal analysis. The location of the user position is identified by applying factual analysis on Received Signal Strength (RSS) of GSM base station with Haar wavelet transform. The data is converted into the representations of location in terms of wavelet bases. Later, by observing the relationship between RSS signal power and distance from the base station, the position of the receiver and its direction was estimated. The proposed method does not need to modify the GSM hand set receiver and apply automotive and personal tracking and navigation.

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REFERENCES

[1] Abhijeet Tekawade, Ahead Tutake, Ravindra Shinde, Pranay Dhole, Mr Sumit Hirve. Mobile Tracking Application for Locating Friends using LBS International Journal of Innovative Research in Computer and Communication Engineering. 1(2).

[2] Cu S. Zhang, K. Zhang. School of Mathematical and Geospatial Sciences, RMIT UniversityB012.010.21 RMIT University Fractal analysis with wavelet

transform enhancing gsm-based positioning accuracy for automotive navigation.,

[3] Li Cong and Weihua Zhuang. 2004. Non-Line-of-Sight Error Mitigation in Mobile Location. Department of Electrical and Computer Engineering, University of Waterloo, Waterloo, Ontario, Canada N2L 3G10-7803-8356-7/04/$20.00 (C) 2004 IEEE,

[4] Mingmei LiNaoki ImaiKDDI R and D Labs. An Integration Method for Wireless Location Using Mobile Phone Built-in Sensors and TDOAL and marks. Inc.2-1-15 Ohara Fujimino-shiSaitama, JAPAN 356-8502.

[5] 2015. Performance Analysis of Different Wavelet Families Over Fading Environments for Mobile WiMAX System International Journal of Future Generation Communication and Networking. 8(1): 87-98.

[6] Al Hallak M.; FMEE, Damascus Univ.; Safadi, M.S.; Kouatly, R. 2006. Mobile Positioning Technique using Signal Strength Measurement method with the aid of Passive Mobile Listener Grid information and Communication Technologies. ICTTA '06.

[7] Fischer S.; Ericsson Eurolab, Nuremberg, Germany; Koorapaty H.; Larsson E.; Kanga A. 1999. System performance evaluation of mobile positioning methods. ISSN NO1090-3038 Page(s):1962 -1966 vol. 3.

[8] Koll V.K, Mishara. 2013. A. Discreate wavelet transform based OFDM-IDMA system with AWGN channel engineering systems (SCES), 2013 student conference on 12-14-April, page(s)1-4ISBN: 978-1-4673-5628-2.

[9] Mohapatra D.; Jataayu Software (P) Ltd., Bangalore, India; Suma, S.B. 2005. Survey of location based wireless services Date of Conference:23-25 January. Print ISBN:0-7803-8964-6 pp. 358-362.

[10] Abbas R. 2010. Sch. of Inf. Syst. and Technol., Univ. of Wollongong, Wollongong, QLD, Australia An approach to studying location-based services regulation in Australia Date of Conference:7-9 June, IEEE pp. 77-86, Print ISBN:978-1-4244-7777-7.

[11] Can Komarand CemErsoy, Istanbul, Turkey Location Tracking and Location Based Service Using IEEE 802.11 WLAN Infrastructure.

[12] Souvik Banerjee, Prof. Amutha Jeyakumar, Vivek Nar. 2013. International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com. 3(2): 1016-1022 1016 |Wavelet Packet Modulation for Mobile Communication.

[13] Measuring the Environmental Impact of Power Generation at GSM Base Station Sites [14] Analysis of Pathloss Models for 3g Mobile Signals Inurban, Suburban and Rural Environment.

[14] N.V.K.Ramesh, K.Sarat Kumar, D.Venkat Ratnam, P. Sarathchaitanya, P.A. Rajeswari, P.V.S.L.Meghana. 2015. International Journal of Applied Engineering Research. ISSN 0973-4562, Volume 10, Number 10, pp. 25789-258006.

[15] Vlada N. Y. 2014. Department of Information and Technology, National Metallurgical Academy, Ukraine Wavelet Based Path Loss Modelling for Global System for Mobile Communication in an Urban Environment. 3(7), (IJSR) ISSN (Online): 2319-7064.