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***Research Paper***



# Localization of mobile using RSS and Hilbert-Huang transform

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**Abstract**

Mobile navigation has drawn much attention in multitudinous application. However, operational capability of mobile degrades due to buildings and dense foliage. The proposed methods like 'RSS mobile estimation using wavelets' are designed for detecting the mobile location for different outdoor environments. This paper presents deciphers the subtleties involved in the application of EMD and Hilbert-Huang Transform approach applied for collected rural and urban data for mobile localization possible even in indoor scenario. By experimental results shown the variations in signal strength due to the distance travelled by the mobile.

***Keywords***: *Mobile Navigation; H-H Transform; EMD; RSS; Signal Strength Estimation.*

## 1. Introduction

The application of H-H Transform will play prominent role to get the prolific results. This phenomenally deploys two ways to solve the required problem, one is EMD (Empirical mode of decomposition) algorithm and other is Hilbert Spectral Analysis (HAS).Our paper solely utilizes the EMD methodology for the estimation of the mobile using signal strength received from the base stations. The present techniques to navigate and estimate the mobile in a considerable manner but there are certain drawbacks in each of the methods. For example the accuracy of the GSM mobile in localization technique is very less. Similarly the usage of GPS, but here one cannot estimate the mobile in indoors as a loophole in its revolution. Later by new techniques i.e. the usage of wavelets for the measurement of signal strengths can compensate the drawback of previous methods. At this juncture Empirical Mode Decomposition is applied to the signal strengths as it has efficacy. The application of the H-H Transform to the Real data collected from BSNL-Vijayawada urban area ending at Vuyyuru (rural) via Benz circle. The total path area can be divided into three sectors as shown in Figure 2. The Sector1 starts from BSNL Office (M.G.Road Vijayawada) and ends at beginning of Gangur Village. Sector2 is from ending of sector1 (beginning of Gangur Village) and ends at beginning of Kolavennu Village. Sector3 starts from ending of sector2 (beginning of Kolavennu Village) and ends at Vuyyuru Village. By using intended result of navigating the mobile to be obtained seen through the graphs. There are two extensive components of H-H Transform one is Decomposition Algorithm (EMD) and the other is Spectral Analysis tool out of which the Empirical Mode Decomposition method will be used.[1]Empirical Mode Decomposition is literally a method of amputation of signal for getting the required characteristics from the time domain. This process is used in the scrupulous of natural signals like stationary and non-stationary. The EMD become obsessed with this particularly in the analysis of pure natural signals and explore the versatile range of opportunities in Transforms to provide completeness. This is understood simply by manner in which the decomposition of signal is done.

The H-H Transforms are prolific enough and taking advantage to navigate the mobile, there by differentiating this technique from the wavelet analysis.

## 2. Channels of process

EMD is literally a method of internal amputation of signal, even getting the required characteristics from the time domain (time domain is not left). This process is used in the scrupulous analysis of natural signals which were said to be non-linear and non-stationary. On knowing the concept of Empirical Mode Decomposition, one can become obsessed with this as it particularly deals with the analysis of pure natural signals. And on becoming so, one can simply explore the versatile range of opportunities the Hilbert Huang Transform proffers using the Empirical Mode Decomposition. The one thing that is worthy about this technique is completeness .This is understood simply by the manner in which the decomposition of signal is done. One cannot get with the argument, if it is stated that the uses of the Hilbert Huang Transform are prolific enough and can even be astounded for its reliability. So ultimately taking advantage so such a technique to navigate the mobile, there by differentiating this technique from the wavelet analysis.

## 3. Methodology

In this method of navigating the mobile, the data is collected and Empirical Mode Decomposition is applied, by which Intrinsic Mode Functions (IMFs) are obtained. The data was collected from the different areas which are broadly divided in to Urban data, Semi Urban data and Rural data. On doing so it is understood that there lies a great disparity in the results obtained in each of the areas. Firstly, when implemented with the rural area, it is understood that, for the mere reason that most of the rural areas have comparably

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less traffic pertinent to less population and therefore the signal attenuation is less. So when applied on the rural data more accuracy can be estimated. The situation is completely different in the urban and semi urban areas, where, although the data of signal strengths is dependable for the process of EMD , the high traffic resulted through the high population and buildings or hills which ultimately gives great attenuation in the signal ,there by the accuracy is less when compared to those results in rural areas.

## 4. Contrast between wavelet analysis and HHT

Specifically saying, the contrast between wavelet analysis and HHT lies in its efficacy of finding out subtle changes in the frequency of signal. The signal strength efficiency in HHT is more than wavelet form as there-exists number of oscillations/iterations[3]. So the number of Intrinsic Mode Functions for the given data depends upon the number of iterations obtained. As in wavelet transform GSM technology is used i.e., Location Based Services to identify the mobile navigation but coming to HHT, Empirical Mode Decomposition Algorithm is preferred in which accurate data is obtained in form of Intrinsic Mode Functions. In HHT, the signal strength readings are used as data to obtain the frequency part of the signal.

## 5. Empirical mode decompostion

For any one dimensional discrete signal Sn=S[n], EMD can ultimately be written in the following way

$S_n=\sum_{k=1}^{k} imf_{k,n} + r_n$

Here the $imf_k$ is the $k^{th}$ mode or considered as the IMF of the signal and r is the residual trend.
From this it is understood as the sine-qua-non of all the EMD process or the so called Empirical Mode Decomposition algorithm is to locally estimate the utmost rapid oscillations in the signal. This can also be stated as the interpolation of waveform to inter woven local maxima and minima.
This process is used in the scrupulous analysis of natural signals which were said to be non-linear and non-stationary. From the so called initial signal (original), what Empirical Mode Decomposition does is the filtration of functions from which the approximately orthogonal base for the real time signal is formed. As said earlier the completeness largely depends on this process of Empirical Mode Decomposition.

## 6. EMD algorithm

The sifting process is essentially done like this-

1) Firstly the data of local extreme has to be identified i.e. the minima and maxima of the signal.
2) The maxima have to be connected with the interpolation, thereby creating the top envelope of the signal.
3) Minima is connected with the interpolation function, thereby creating the lower envelope of the signal.
4) Calculate mean value of the upper and lower envelopes.
5) The local mean has to be subtracted from the original signal.
6) The left out one is considered as the same data and therefore the same process is repeated [6].

The completion of the EMD process is noted with one of these characteristics:

1) Only when the residue is the function with one unique extremism.
2) Also when the so called residue becomes the monotonic function where it can be stated that IMF can never be extracted.

## 7. Results

To obtain the navigation of mobile using the received signal strengths and able to determine the interpolation of these signal strengths i.e., connecting the segregated parts of data into a single unit and transferring to the mobile station area which is automatically determines the location services to the user or required client. Here the interpolation involves the data from base station to mobile station i.e., the minima and maxima. These determined functions give the residue of different tracking locations and this helps the user to convey or to retrieving the location of that particular mobile. The major part here is as the base station is always hexagonal shape and the towers are been set-up at the outsourcing edges of it, which ensures the signal or the coverage area to avoid overlapping and also to prevent cross-talk 5, 7. This key feature helps us to ensure the distance of mobile connectivity to the connected base station to released base station through signal strength data. These data graphs can be listed and illustrated as below, by applying the core principle on rural data and urban data collected from BSNL base station are analyzed as shown in Figures 3, 5, 7 and Figure 9 respectively. The signal strength (dB) varies with distance (meters) travelled away from base station effects IMF of rural data and urban data are shown in Figures 4, 6, 8 and Figure 10 respectively.
Software used: Mat lab.

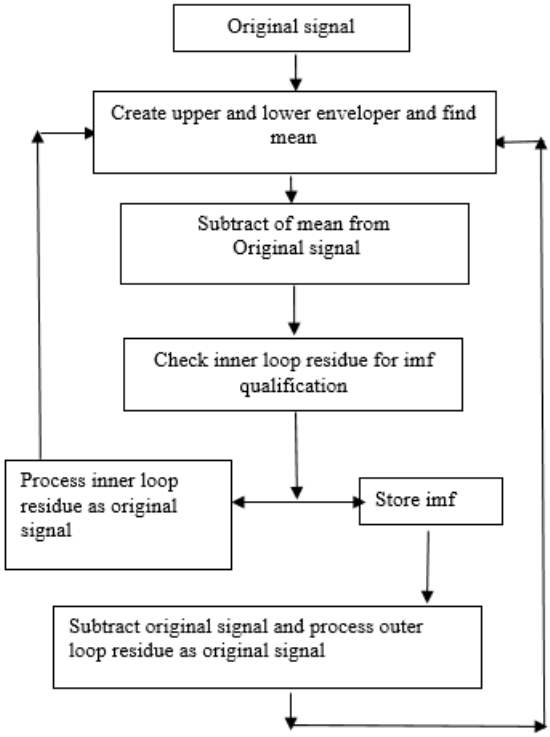



**Fig. 1:** EMD Algorithm.

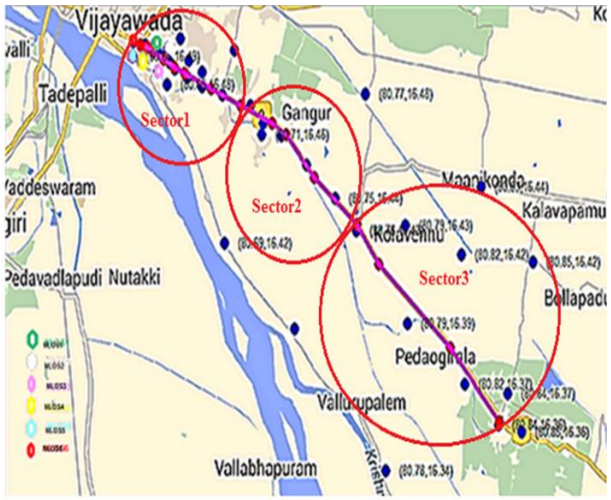



**Fig. 2:** Trajectory of Experimental Data.

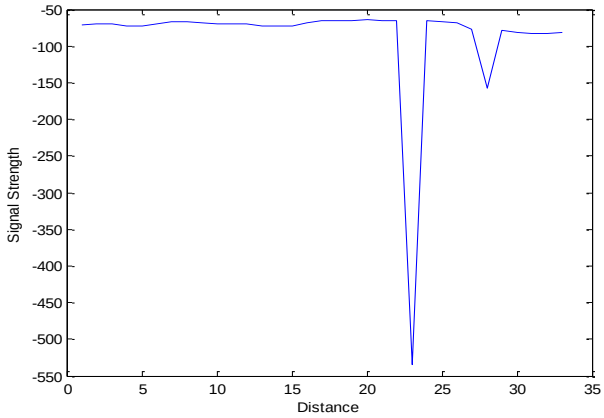



**Fig. 3:** Rural Data.

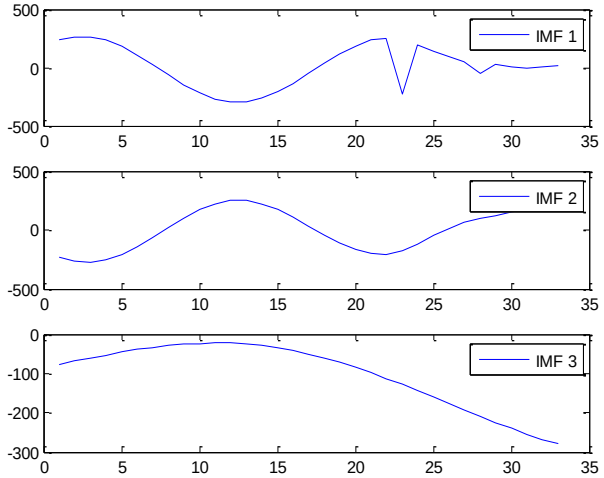



**Fig. 4:** IMF's of Rural Data.

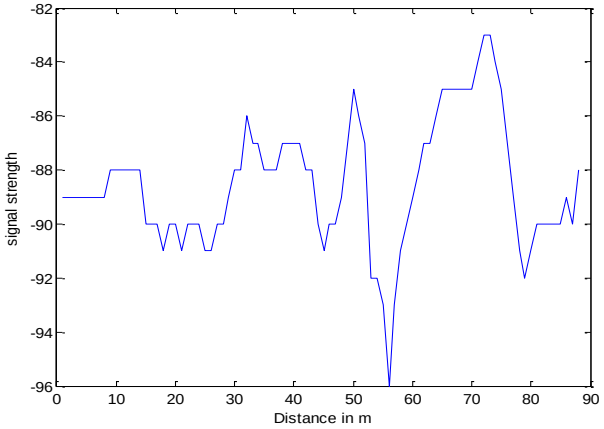



**Fig. 5:** Rural Data 2.

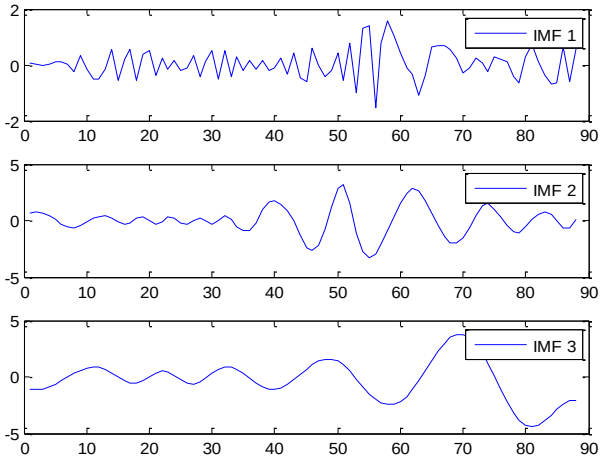



**Fig. 6:** IMF's of Data 2.

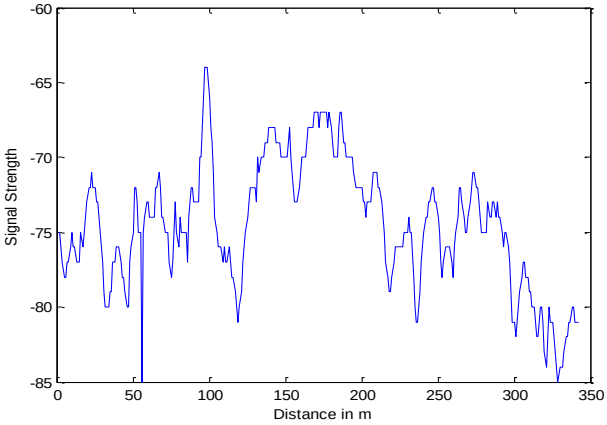



**Fig. 7:** Rural Data 3.

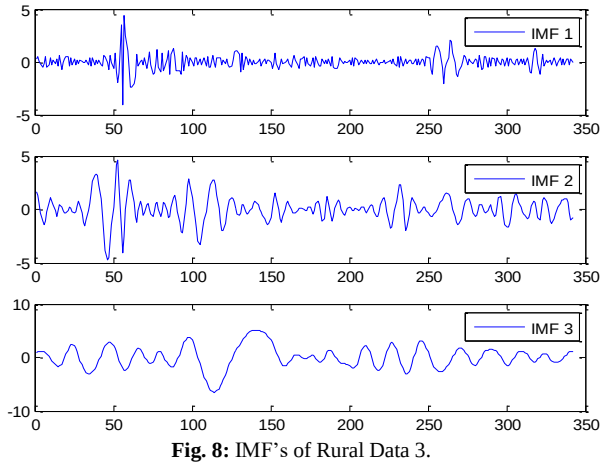



**Fig. 8:** IMF's of Rural Data 3.

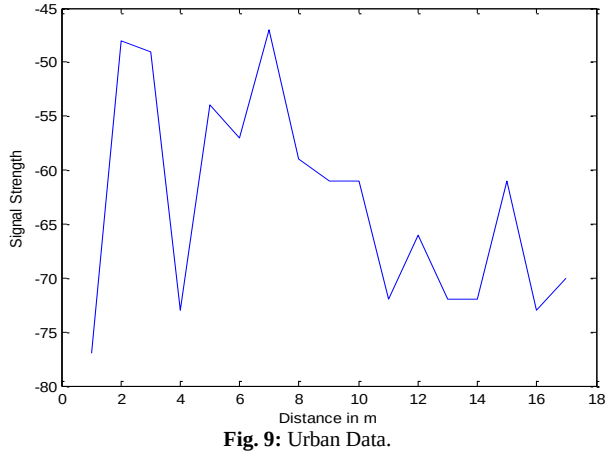



**Fig. 9:** Urban Data.

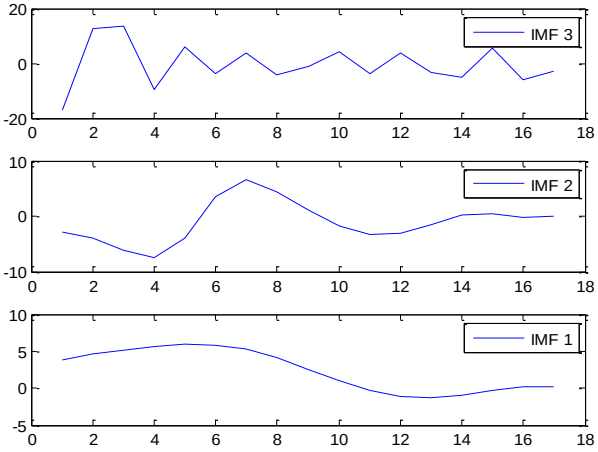



**Fig. 10:** IMF's for Urban Data.

## 8. Comparison

The Empirical Mode Decomposition (EMD), which forms the base for the Hilbert Huang Transform, will be highly enamored for the method it uses to decompose the signal, which is not that easy when do with Fourier Transforms. Wave let analysis is the one of the frequency analysis tools. Wavelet analysis and other transforms stumble over finding and amicable approach while that is not the case with Empirical Mode Decomposition (EMD).In general, when there is a dire to find out the frequency versus time or the signal's frequency content. But then having a disparity with wavelets (Wave let analysis) is the reason why the Hilbert Huang Transform becomes the cynosure. The efficacy of Hilbert Huang Transform is so called as Empirical Mode Decomposition which as ability to preserve the changes in the frequency. So ultimately Hilbert Huang Transform is better in resolution than any. With reference to wavelet analysis, the real time measurements for the mobile position were scrupulously examined and the position of mobiles for the close monitoring is justified as the strength of -85dB as received signal strength at the neighboring IDKR2073 (base station),with the tower height of 200 meters whose longitude is (81.0221) and latitude (16.4336).While in the present study, the application of Hilbert Huang Transform(HHT) which is basically an application of Empirical Mode Decomposition, as the name suggests that it is empirical, not mathematical(wavelet analysis and Fourier Transform), Therefore obtaining the Intrinsic Mode Functions(IMF),where in the residue has got the signal strength range of -300dB to 0dB,there by ultimately proving the superiority of this non-linear data analysis over other transforms ,wavelet analysis in particular[4].

## 9. Conclusion

Thus from this experimental work states that even the mobile which does not have any inbuilt GPS facility in its internal core, they can presumably be navigated and this is not mere flattery that the approach of Hilbert Huang Transform can be used extensively but when it is implemented in a concentrated concept of navigating GSM mobile, the results obtained are prolific and stupendous.

## Future scope of the work

Although the proposed work is unique in the estimation of the mobile, the authenticity of it lies in the estimation of GSM mobiles particularly of low cost by the usage of Hilbert Huang Transform (HHT) in this very field of mobile estimation. By the application of Empirical Mode Decomposition (EMD), the changes in the frequency can be preserved there by the ultimate aim of analyzing the real time, non-linear and non-stationary signals (signal strengths here) is accomplished. Hence-forth HHT is the ideal case to analyze the real time natural signals, which can widely be used in all the future applications.

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