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An Efficient ELM Algorithm for GSM Vehicle Tracking

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Abstract: Intelligent Transportation System (ITS) provides service for the different transportation modes which favor information to the user. The road transportation applies the technology of information as well as communication. The cellular network provides the signal to track the location which is called as Global System for Mobile communication (GSM). For procuring location, Received Signal Strength (RSS) is received from GSM. To achieve the better performance, here I proposed the advanced technology of Artificial Neural Networks (ANNs) that is Extreme Learning Machine (ELM). The ELM provides a Single Hidden Layer Feed forward Neural networks (SLFNs) and it chooses the hidden nodes randomly for determining the weight for the output. Learning is an important factor for designing a computational and intelligent process while classifying, clustering and controlling the data for training. ELM provides the extreme speed of learning. The received signal is de-noised with Gabor filter and matched with map for obtaining the current position of the vehicle.

Keywords: Received Signal Strength (RSS), Artificial Neural Networks (ANNs), Extreme Learning Machine (ELM), Single Hidden Layer Feed forward Neural networks (SLFNs)

I. INTRODUCTION

The overall goal of this project is to develop a low cost real-time AVL system that can report lane-level position information of vehicles. The developed system can consistently position the vehicle in lane level. In recent technology Intelligent transportation system (ITS) acts a major role in different mode of transportation which favors to the user. The emerging technologies are based on the process of accuracy and time consumption. The GSM provides the signal strength from the base station which is implemented all over the geological location. By using the GSM, the position of the vehicle is identified.

After getting the signal from the vehicle, received signal from the base station provide the response to the request of the location. For procuring the accurate information of vehicle the Extreme Leaning Machine is used. The ELM provide the more accurate performance in learning and providing the result. The filtering technique are used in the process to find the current vehicle position.

Neural network consist of three layers. Normally the number of hidden layers inside the ANNs provide more accuracy for positioning the vehicle location. The multi-layered feed forward technique provide the presentation with more accuracy in capturing the position of vehicle. The ELM provides the support for identifying the accuracy in performance of finding the location with the help of Single Hidden Layer Feed forward Neural network. Here in the proposed system the ELM is used for the better performance and the process leads to the accurate localization. After getting the input RI if the signals is not already trained, it start to learn with the received RI signal with the help of ELM. The filtering techniques are used to filter the details of the signals gained by the signal strength from GSM. The

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filtering technique provides the current position of the vehicle. The ELM provides the result with sequence collection of data input to achieve the better and accurate performance. The map matching algorithm is used to match the received position with the geographical location.
The research community has been aiming to enhance transportation systems with communication and information technology means to achieve better performances in terms of best possible route and optimize the overall transportation system "cost," the ITS most often rely on precise location information. One of the most prominent subgroups of the ITS uses vehicle location information which is called as Automatic Vehicle Location (AVL) systems. These systems obtain the geographic location of a vehicle and report the information back to the request originator. The AVLs are most often employed for fleet management of public transportation (buses, trains, and taxies) and emergency (police, fire fighters, and ambulance) vehicles and tracking of the mobile assets.

II. RELATED WORKS

The AVL system can acquire a vehicle's location information using satellite or terrestrial infrastructure. After determining the initial location the signal is performed, Inertial Navigation Systems (INSs) can be used to maintain the location estimate in case of poor infrastructure availability. Satellite infrastructure, through its most popular system, i.e., Global Positioning System (GPS), is widely used to estimate a vehicle's location in an AVL system. The reason for ubiquitous use of GPS for AVL is, foremost very good accuracy, compared to most of the other available positioning technologies. The accuracy of these systems has now come down to the lane determination level. On the other hand, there are urban areas with streets surrounded by tall and narrow buildings forming a sort of urban canyon. This environment is known to impair the availability of the GPS system.
The alternatives to GPS are usually in the form of Radio Frequency Identification (RFID) and Public Land Mobile Network (PLMN) location systems. In the case of RFID systems, the network infrastructure has to be deployed, therefore significantly increasing the cost of the entire system. On the other hand, most AVLs already use the PLMN terminals to report results back to the dispatch centre. That is why using the PLMN infrastructure for positioning has an advantage over GPS in lowering the system cost. The work presented in the existing paper aims at initial position determination using the PLMN's received signal strength (RSS) vector for vehicle and other mobile asset localization.
The concept behind the existing system is that it uses more number of base station to receive the signal strength. While receiving the signals from more than one neighbouring base station of vehicle to locate the position of the vehicle the base station provide the signal of the radio wavelength without any loss. The existing system uses the PLMN to lowering the cost. After the RI the process proceed with the concept of learning the new signals. The learning of input data that is RI from the base station starts to provide the pictorial representation of the RI. The RI list learn the methods by trained data set of the structure and relevant details and it forwarded the process to the layers of neural network. The existing system uses the filtering technique for filtering the process with 20×20 partitioning.
The neural network consist of three layers input layer, hidden layer, output layer. The middle hidden layer consist of multilayer structure which is used for feed forward network. In this multilayer feed forward technique , the RI list is deduced with the accuracy of that input data set to the output. While employing multi layer feed forward technique the subspace is partitioned for the comparison between the multi layer to the single layer feed forward structure. With this procedure the existing system provide the accuracy for the entire process. As mentioned before this procedure provides the outperformance with high time compared to SLFN.
The training Speed is low because of the hidden layers count. The count of the hidden layer provides the vehicle's position accurately. It takes time to forward data from input to the output layer because of the hidden layers. Kalman Filter(KF) is widely used for the denoising purpose in existing system. In contrast to its linear counterpart, the Extreme Kalman filter is *not* an optimal estimator If the initial estimate of the state is wrong or incorrectly the filter might quickly diverge for linearization. Another drawback with the Kalman filter is the covariance estimation matrix tends to underestimate the relevant covariance matrix and the risks becoming inconsistent in the statistical sense without the addition of "stabilizing noise".

III. PROPOSED SYSTEM

The proposed Vehicle Tracking System(VTS) uses the simulated data to train the ELM. The data are based on the RSS values and their corresponding base stations. The RSS value and the base station data are used for tracking the vehicle

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but there is some difference in the vehicle's position and the predicted position. This is because of the difference in the current vehicle's position and the time taken for the signal to reach the originator. To overcome these difficulties the denoiser gabor filter is introduced to calculate the time difference. After the position calculation the denoised RSS is checked with the ELM which is called as testing, testing the trained data with the denoised signal. If the denoised data is there in the ELM data it send the accurate position to the map matching. Otherwise ELM start to learn the data . Then the signal is matched with the road database. For matching the signal to the road database map matching technique is used and finally the current position of the vehicle is estimated.

The cellular network provides the signal to track the location which is called as Global System for Mobile communication(GSM). For procuring location received signal strength is received from GSM. The performance development of that transportation system is based on the accuracy which it provided by the neural network.

To achieve the better performance here the proposed system uses the advanced technology of neural networks with Extreme Learning Machine (ELM). ELM support to the vector machine for analysing the input data. The vector locating is based on the classifier and regression which estimate the area and position respectively.

The filtering technique is used to denoise the signal which is received as the input to the positioning system. For obtain the accurate and efficient positioning GABOR FILTER is assigned. Gabor filter technique is used for handling vehicle position in transportation by matching the received signal position and current position of the vehicle while the signal reaches to the user.

Extreme learning machine (ELM): ELM is an learning algorithm. ELM is a easy method which uses three-step for providing the trained network. The ELM training time is very low that it provides the network to be trained in a minimal consumption of time. The existing learning algorithm provides over fitting, improper learning rate and other local minima problem.

ELM supports the vector machines and it uses a Single Hidden Layer Feed forward method to provide the entire training process to move forward. The ELM uses the tree layers, first input layer, second hidden layer with single layer and finally output layer. The data are first identified, classified and clustered to set the target value. The target value is assigned by providing a numerical values to the relevant signals. The relevant data are classified and combined into a single group which is otherwise called as a clustering. The clustered value trained inside the ELM and the trained values are used further for testing.

ELM Algorithm: The ELM uses less time to train the data. Three-Step of Learning Model is described below.

Step1: Given a training set {(xi , ti)|xi 2 Rn, ti 2 Rm, i = 1,..,N}, activation function g, and the number of hidden nodes L, 1 Assign randomly input weight vectors or centres ai and hidden node bias or impact factor bi , i = 1,...., L.

Step 2: Calculate the hidden layer output matrix H.

Step 3: Calculate the output weight= H+T. where H+ is the Moore-Penrose generalized inverse of hidden layer output matrix H.

Filtering technique: Gabor filter is used as a filtering technique. Filtering technique is mainly used to filter the noised signal which is otherwise called as a denoiser. The signal is denoised and the denoised signal tackle the time difference between the signal received and reached time to the originator.

Gabor Filter is used to provide the denoised signal and the signal provide the desired level of the vehicle's position. The accurate position of the vehicle is observed with the denoised signal from the vehicle.

IV. SYSTEM ARCHITECTURE

The system architecture provides the design for implementing the VTS. The work applied in VTS are analysed and designed. Using this VTS, vehicles location are identified. The transportation modes uses the VTS for locationing the public transports and also for reducing the traffic condition but in this paper it is used to identify the car location. The other purpose is to identify the car while it is in theft. The traffic condition in lane-level and in the channels are also identify by the VTS. Finally it is also used for drivers to identify the location in the map while they are in offline, in other words without using the GPRS connection. The GSM network allow to identify the location of the vehicle.

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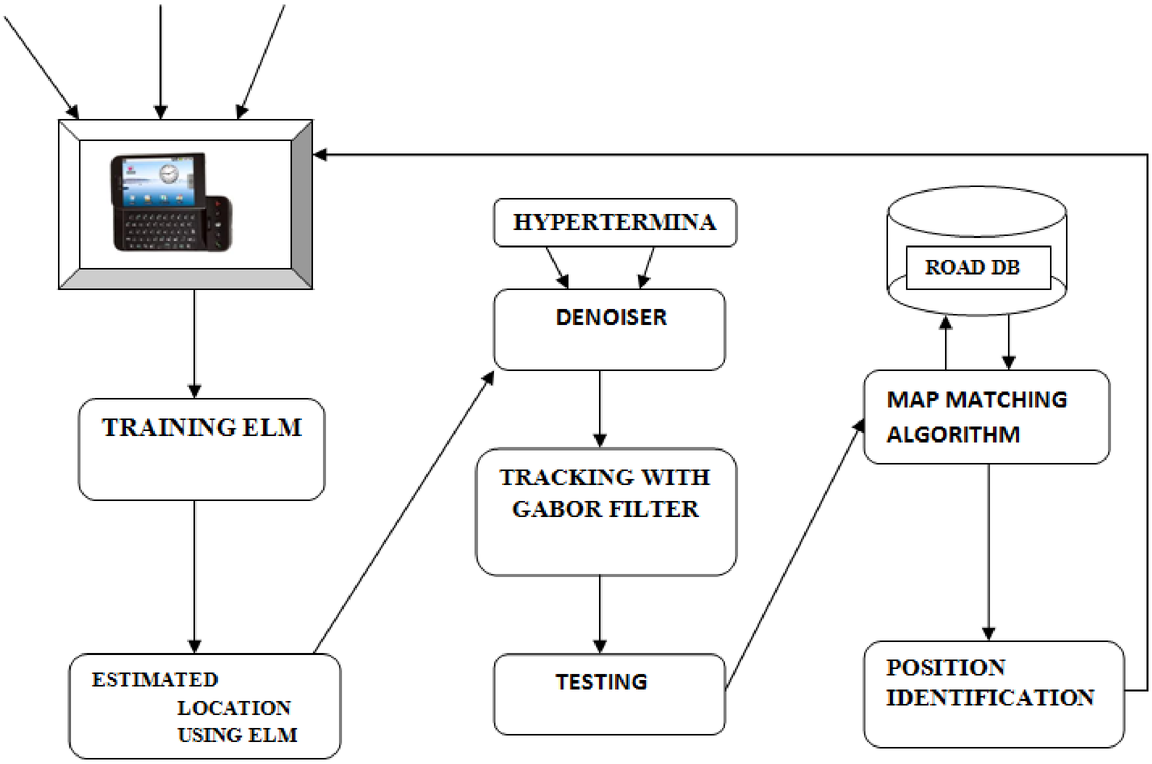

Figure1:POSITIONING OF VEHICLE THROUH GSM

V. IMPLEMENTATION

The implementation of VTS for this paper is applied in the mat-lab environment.
Creating an ELM: ELM Learning is a learning process in a neural network where the simulated data are used for training the ELM. To create a network and process the data for training ELM the simulated data are used. While training the data the data enter into the input layer . The input layer forwards the data to the hidden layer. Normally the ELM uses a Single Hidden Layer Feed forward network and finally the data forwarded into the output layer. The ELM provides the base station position and the signals for each and every distance. The signals and base stations position are trained with ELM procedure.
Received Signal Strength (RSS): The RSS is received from the GSM. The GSM provides the signal for the vehicle through the networks cell. The signal are received with the hyperterminal. The hyperterminal is a software used to receive the signal strength. The signal strength is calculated with 32 signals. Handover technique is used for sending and receiving the signal.
Handover is a technique which hand over the signal from one cell to other cell. Each base station consist of a radius. While moving from one cell radius to other radius or the low signal strength, it handover the signal to the other cell. low signal is measured with the threshold level mentioned in the hyper terminal. The signal strength here used is between -110 to -47 and these values are consider as a input signal for the VTS.
Searching the signal: From the hyperterminal the signal start to check the vehicle's location. The signals are send from one cell to another cell. This technique is called as handover technique. If the signal received from a cell is lower than the threshold level the signals are handover to the other cell radius where it receives the higher signal strength. The

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signal uses the inverse square law to provide the signal strength. The signal strength vary from one place to other place inside the GSM cell. While searching the signal from one cell radius to other radius the signal propagation is propagated in a spherical manner until it reaches the destination or receive any obstacles. After the interference if the interference is not the destination it start to reflect, refract, diffract or scatter the signal. The Dynamic Triangulation technique is used for initializing the signal to start the search.

Receiving the signal: For receiving the signal the grey prediction method is used in this VTS. When the signal takes multi propagation it reach the destination with some time difference. this difference in receiving the signal is mentioned as a delay. These delay are analysed and equalized with the equalizer. The received signal is received through the hyperterminal software. The hyperterminal uses the signal strength with the AT commands. These signals are divided into 32 signal levels. The 32 signals are received from the Broadcast Control Channel (BCCH). This BCCH acts in-between the base station and the base transceiver station.

Denoiser: Denoiser is used for denosing the noisy signals. The noisy data are filtered with the gabor filter. In signal the unwanted or the noisy signal are described as a signal delay from the location to the requestor. The requestor's application uses the denoiser to denoise the signals received from the GSM network. The relationship between the RSS and the originator are also trained in the ELM data to retrieve it back for a short time period. The denoiser, gabor filter matches the actual position with the predicted position. The noisy signal's position is not an accurate location because of the unwanted signal. The denoised signal provides the accurate values with time calculation and adjustment.

Testing: The testing is based on the ELM trained data and retrieval of the data related to the denoised signals. The denoised signal is entered into the denoiser for the vehicles position identification. The denoised signal is forwarded to the ELM trained data if the signal is matched with the trained ELM data, then it retrieve the base station position and the location of the signal strength from the base station.

The denoised signal is tested with the trained data. If the data is in the trained set ELM matches the denoised signal and send the location to the request originator. Otherwise the denoised signal is send to the map-matching technique and start to match the position.

Map matching: The map matching technique uses the road database to match the database with the received denoised signal. The map matching uses the matching technique to overcome the over fitting problem. The Point -to-Point matching is based on matching the data with the road's map in a straight road. If the data is matched with the Point-to-Curve then the lane level is a turning. If the curve fitting is used with map matching then the lane level is hairpin bends. These are the map matching technique. It matches the signal with road database and send a virtual position of the road and the location.

Position estimation: The position of the vehicle is finally estimated with the mat-lab environment and the application provides the localization of the vehicle with the signal. The position is estimated with the map and the road database. The accuracy in positioning the vehicle is high because of the recovery of over-fitting algorithm.

VI. EXPERIMENTAL RESULT

The simulated results for the vehicle tracking system provided the simulated results based on the training a neural network and receiving the signal strength.

THRESHOLD LEVEL(After splitting)	TARGET VALUE
92 115 120 94 84 102 106 79 84 102 102 83 101 126 133 103 92 112 118 85 84 103 104 81 102 126 134 104 88 121 128 100 84 107 113 87	3
72 94 90 72 72 89 94 76 72 89 98 76 76 87 91 74 76 87 91 67 71 87 87 70 75 91 96 71 75 87 93 67 71 87 89 67	4

Table1: Setting the target value for the data used in training ELM. The left side depicts the sample data and right side is the target value for the sample data. Target value is used for clustering the relevant data.

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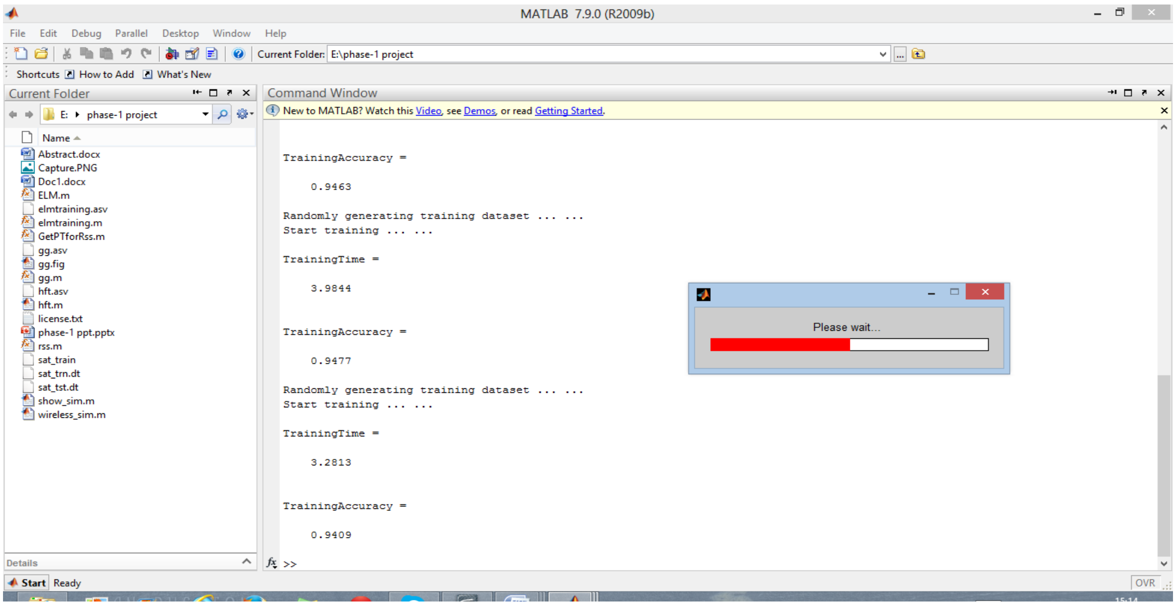

Figure2:Training the data(location and distance) with ELM- simulated screenshot.

The data used in this entire system provides the higher accuracy in training and retrieving the data with ELM.

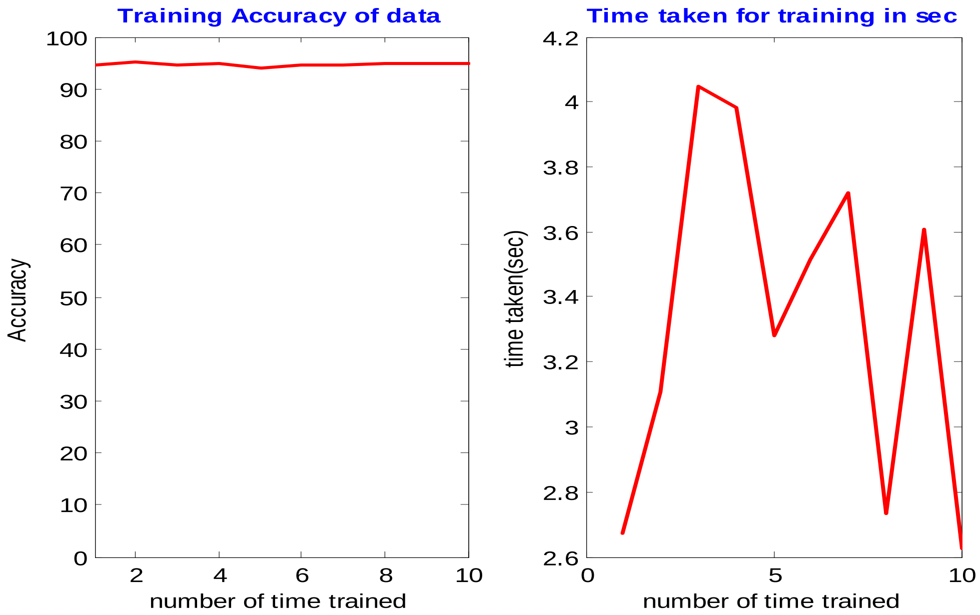

Figure3:Training accuracy and time duration of ELM

The neural network trained the data and retrieve the result with the high accuracy and low time consumption. Then the signals are received from the user location. The signal received to the application is based on the Broadcast Control Channel as 32 signals.

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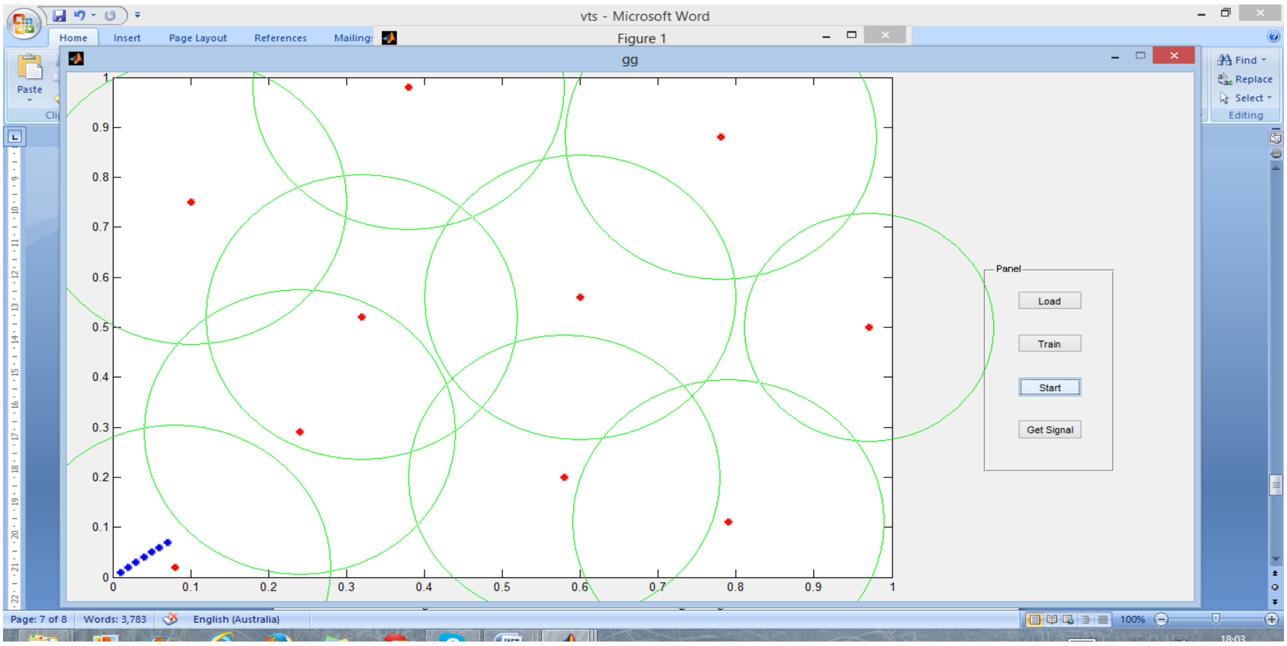

Figure4: Screenshot for Simulated Base Station with the coverage area, includes handover concept based on the signal strength.

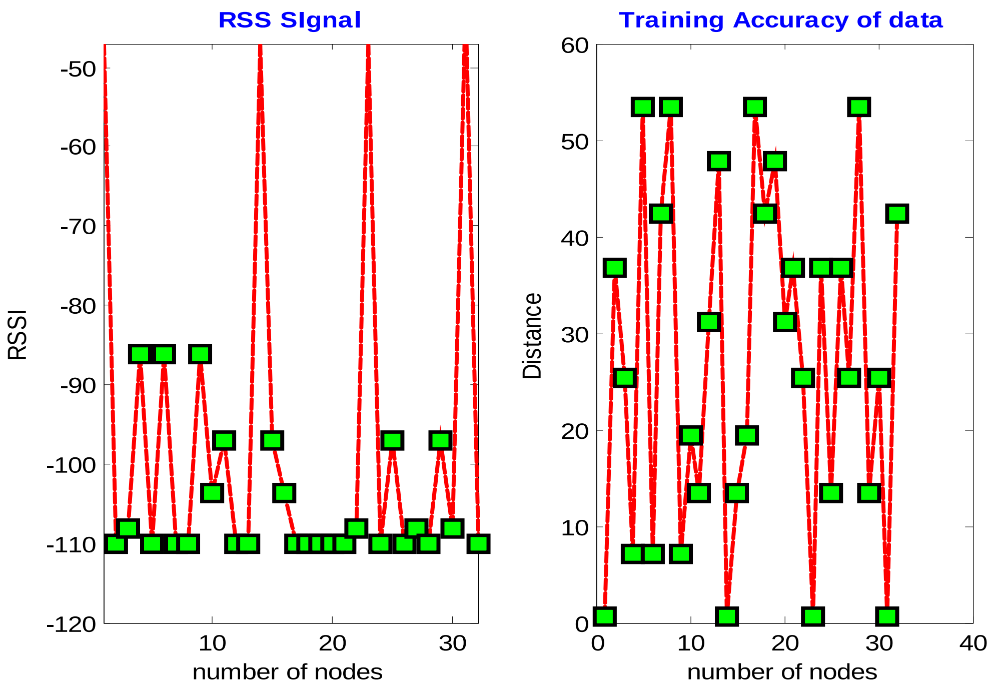

Figure5: Received signal strength (32 BCCH signals) received from the GSM network with Broadcast Control Channel.(BCCH)

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VII. CONCLUSION

The major issues in training a neural network is training time. The ELM overcomes the time consumption by single hidden layer. The entire VTS is designed to positioning the vehicle's location. The ELM uses the Single Hidden Layer Feed forward technique. The classification and clustering are maintained by the ELM. This clustered data are used for testing the values after denoising the signal. From the ELM matlab environment the application started to receive the signals RSS.

The RSS is used as a input signals for the VTS. The signal is received through the GSM network by dynamic triangulation, handover, grey prediction. The propagation channel uses the radio signal for sending the request and receiving the signal. The RSS input received from the GSM network is sub-grouped into 32 signal for identifying the signal strength based on the threshold level. The threshold level and the base station position provides the handover concept from one cell radius to other cell radius.

The RSS used in the VTS is denoised with gabor filter. The filter is mainly used to denoise the signal and remove the unwanted signals with the iteration to reach the desired value. This denoiser provide the actual signal by calculating the distance and signals. There is a time difference between receiving the signal from the vehicle and the time variance. The gabor filter is used to calculate the signal with the distance travelled from one place to another place.

After the noisy signal is removed by the gabor filter, the signal is tested with the trained ELM data. The actual signal and the trained ELM data are compared for the relevance in the location.

After finalizing the signal for the location the signal is matched with the map of the specified road. the road database and the map provides the location of the vehicle with the consideration of input signals to the map matching process.

Finally this paper provide the location of the vehicle with GSM network and by the ELM . This VTS provide the user accurate positioning by reducing the over-fitting and reducing the time consumption taken in the training period of data.

FUTURE ENHANCEMENT

This vehicle tracking system is done with the scanner in a real time work and for further enhancement this project can done with public transportation modes like train and bus to save the user time and reduce the traffic congestion.

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