A Novel Technique for Enhancing the Localization Accuracy of (VANET) Vehicles Using GPS , INS and RBFNN

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Abstract - ***The demand for seamless positioning has been significantly high in vehicular applications, such as navigation, intelligent transportation systems, collision avoidance, etc. Most seamless positioning techniques are based on integrated methods. the inertial navigation system (INS) and the global positioning system (GPS) are two complementary technologies that can be integrated to provide reliable positioning and navigation information for vehicles. The accuracy enhancement of INS and the integration of INS with GPS are the subjects of widespread research. This paper presents a novel GPS-INS integrated approach to enhance the localization accuracy of VANET vehicles using RBFNN. The performance of the proposed localization system is evaluated using MatLab.***

Key Words: *Vehicular, localization, GPS, INS, RBFNN , etc…*

1. INTRODUCTION

The demand for seamless positioning has significantly increased since the introduction of 'ubiquitous computing' in the late 1980. Vehicle's localization[1] is a key issue that has recently attracted attention in the wide range of application. GPS technology [2, 3] provides good localization accuracy when vehicle is traveling in open environment, but during long GPS outage (multipath environment) INS, RFID technologies plays an important role to provide localization accuracy.

This paper introduces an integrated technology of GPS and INS based on Kalman Filter & RBFNN which provides better localization accuracy. This Paper is organized as follows. Next section shows implementation of GPS-INS integrated scenario. Kalman Filter and result are discussed in detail in section III. Section IV gives the details of advance localization technique with results. Section V provides our conclusion.

2. DEFAULT SCENARIO FOR PROPOSED SYSTEM

For the implementation of the proposed system default scenario is considered and the values of the default parameters are shown in the Table 1.

Table -1: Scenario Parameters with default values

Scenario Parameter	Default Values
Length of Straight road	5 KM
Total regions (open & multipath environment)	7
Speed of the vehicle	constant
The Simulation Period	300 Sec (vehicles velocity is 60 km/hr).
First region (Open environment)	2000 meter.
Second region (Multipath environment)	500 meter.
Third region (Open environment)	500 meter.
Fourth region (Multipath environment)	500 meter.
Fifth region (Open environment)	500 meter.
Sixth region (Multipath environment)	500 meter.
Seventh region (Open environment)	500 meter.

By using above mentioned default parameters, the implementation of proposed scenario is carried out and the effect of the scenario parameters on accuracy is observed.

The default VANET scenario developed for simulation is as shown in Fig-1 Road length of 5 Km is considered for simulation.

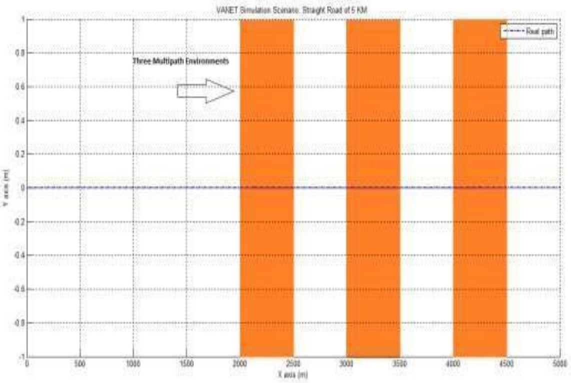

Fig-1: VANET Vehicle Simulation Scenario consists of four Open and three Multipath

3. KALMAN FILTER AND RESULTS

Kalman filter is used to integrate GPS & INS reading[4]. Figure II shows the Kalman Filter estimation of localization of a vehicle travelling over 5 km straight road with constant velocity of 60 km/hr. It shows the effect of multipath environment on Kalman Filter output.

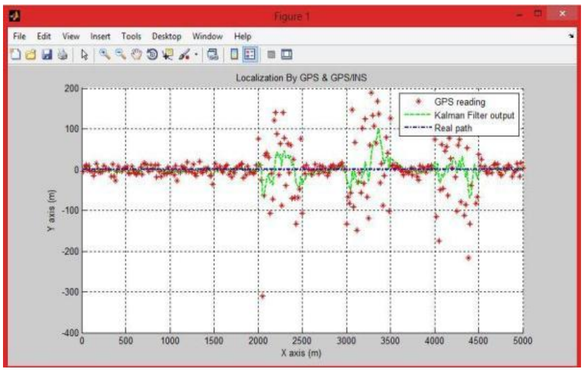

Fig -2: Localization Technique by using Kalman Filter to integrate the GPS receiver measurement and INS measurement in an open as well as multipath environment along straight road.

In an open environment region Kalman Filter localization gives minimum variation while it is affected in multipath environment. The coordinates in multipath environments are absolutely different as compared with real paths coordinates while they are closely appearing with real path in an open environment. Next part of experiments is to detect that multipath environment and reduce the variations present in it. The error calculations of Kalman Filter are given in tabular form, in which mean error and standard deviations are calculated by localization error. The random results are given below because is a consideration of random process of localization.

Table - 2: Error calculations for the localization using the GPS & GPS/INS (KF).

Sr. No.	Type of Environment	Mean Error(m)		SD of Error(m)	
		GPS	GPS-INS(KF)	GPS	GPS-INS(KF)
1.	First Open Environ.	-0.68	-1.29	12.26	3.34
2.	First Multipath Environment	-8.72	-0.80	94.82	33.23
3.	Second Open Environ.	-2.60	-4.37	25.90	10.37
4.	Second Multipath Environment	18.84	10.55	97.04	42.64
5.	Third Open Environ.	2.33	4.01	16.15	10.12
6.	Third Multipath Environment	-9.37	-5.27	96.11	25.04
7.	Fourth Open Environment	2.30	0.67	10.22	2.96

4. PERFORMANCE OF ANN IN DETECTING MULTIPATH ENVIRONMENT

The performance of ANN is very important to detect multipath environment. A Radial Basis Function Neural Network is used to detect multipath environment since it falls under the supervised learning category of Artificial Neural Networks (ANN)[5, 6]. Inconsistency value is defined for open environment and multipath environment and then simulation is carried out for the RBFNN network.

4.1 GPS noise with respect to time:

When a vehicle does not experience any multipath effect, the accuracy of the GPS accuracy is good and the inconsistency value be small. However, if a vehicle experiences a multipath effect, the accuracy of the GPS is drastically affected and the inconsistency values be totally and randomly different.

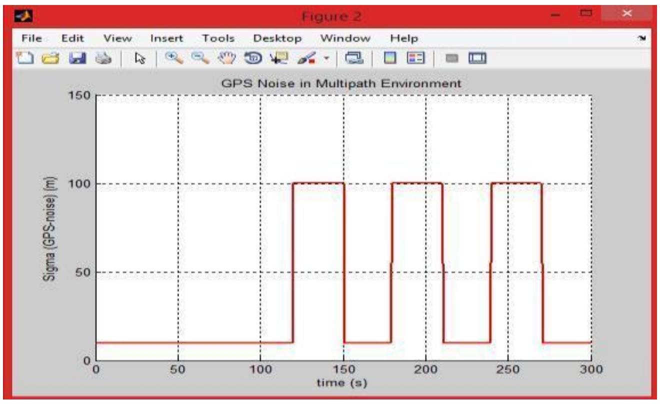

Fig - 3: GPS noise: 10 m(Open) & 100 m(Multipath) Environment

4.2 Inconsistency value with respect to time:

The inconsistency value is the difference between time update estimate of KF and GPS receiver measurement.

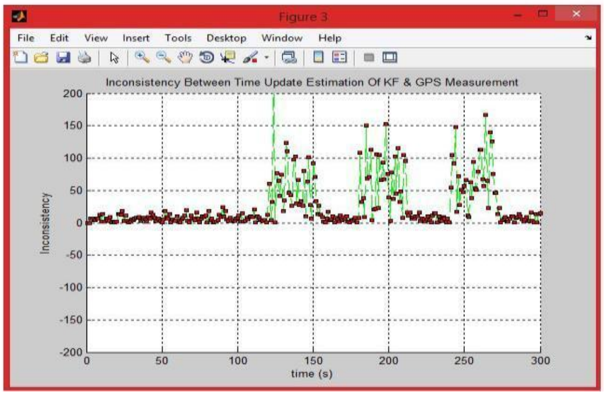

Fig - 4: Inconsistency value with respect to time.

4.3 RBFNN output before Thresholding:

In simulation near about 1.5 value is set as a threshold. Below graph shows output of RBFNN before thresholding in which RBFNN gives the target value 1 and 2 for open and multipath environment respectively.

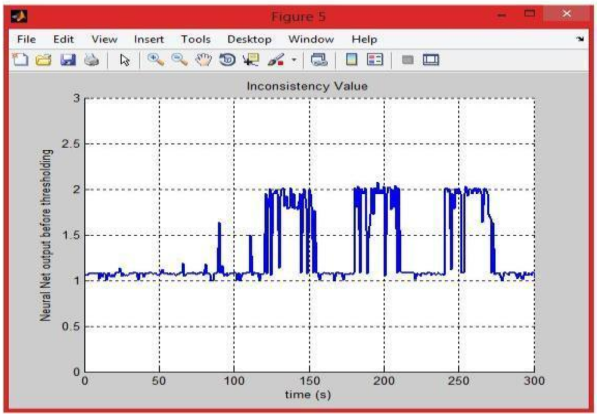

Fig -5: ANN output before Thresholding

4.4 RBFNN as a Multipath Detector (Classifier):

Basically RBFNN was trained by using inconsistency value randomly generated in open environment and multipath environment in simulation. After thresholding the RBFNN has given the output in the form of 1 and 2 which is shown in fig - 6.

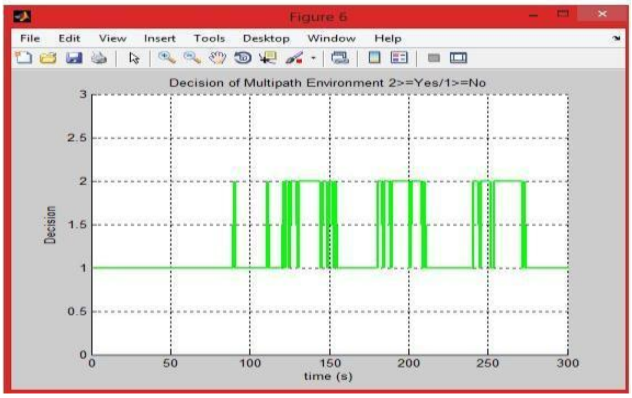

Fig -6: The decision of the RBFNN(Classifier):2>=Yes and 1>=No

5. ADVANCE LOCALIZATION TECHNIQUE IN MULTIPATH ENVIRONMENT WHICH IMPROVES THE ACCURACY

This advance localization technique is basically depends on least square optimization which minimizes the error in localizing a target vehicle using other vehicles as a reference nodes and those are not or less affected by multipath environment and they are more accurate about their localization.

Fig - 7 shows the Localization of a Vehicle by Advance Localization Technique.

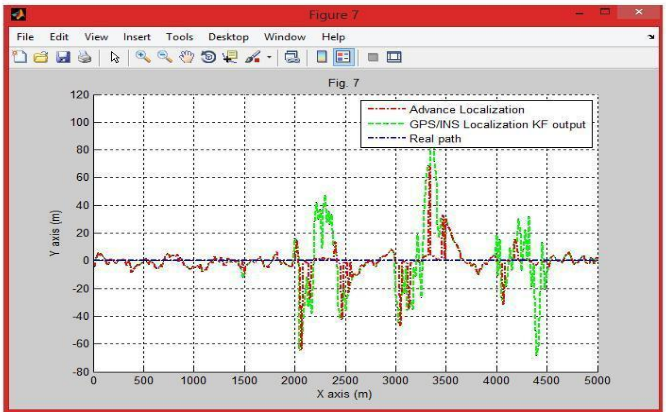

Fig -7: Localization of a Vehicle by Advance Localization Technique.

Advance Localization is shown by red dashed lines, Kalman Filter„s localization is shown by green dashed lines and the real path is shown by blue dashed lines. Since it can be proven that the advance localization technique outperforms the Kalman Filter„s localization. Next table -3 gives the error calculation for advance localization technique.

Table - 3: Error calculations for the localization using the Advance Localization Technique.

Sr. No.	Type of Environment	Mean Error(m)	SD of Error(m)
1	First Open Environ.	-1.20	3.18
2	First Multipath Environment	-3.47	15.27
3	Second Open Environ.	-1.84	6.70
4	Second Multipath Environment	1.15	17.79
5	Third Open Environ.	4.01	10.12
6	Third Multipath Environment	-0.47	6.98
7	Fourth Open Environment	0.84	2.48

5.1 Comparison of Advance Localization with GPS and GPS/INS(KF)

Table - 4 shows the error calculation for GPS, GPS/INS localization technique and advance localization technique. This shows that the effect of multipath environment is very high for GPS, GPS/INS localization but it minimum in advance localization. The performance of advance localization is very effective during multipath areas i.e. mean and standard deviation errors become very less as compared with mean and standard deviation errors of GPS & GPS/INS localization technique [7, 8, 9].

Table - 4 : Comparison of Error calculations for the localization using KF Localization and the Advance Localization Technique.

Type of Environment	Dist (m)	Mean Error(m)			SD of Error(m)		
		GPS	GPS-INS(KF)	Adv. Loc.	GPS	GPS-INS(KF)	Adv.Loc.
First Open Environ.	2000	-0.68	-1.29	-1.20	12.26	3.34	3.18
First Multipath Environment	**500**	**-8.72**	**-0.80**	**-3.47**	**94.82**	**33.23**	**15.27**
Second Open Environ.	500	-2.60	-4.37	-1.84	25.90	10.37	6.70
Second Multipath Environment	**500**	**18.84**	**10.55**	**1.15**	**97.04**	**42.64**	**17.79**
Third Open Environ.	500	2.33	4.01	4.01	16.15	10.12	10.12
Third Multipath Environment	**500**	**-9.37**	**-5.27**	**-0.47**	**96.11**	**25.04**	**6.98**
Fourth Open Environment	500	2.30	0.67	0.84	10.22	2.96	2.48

Fig - 8 and 9 shows a comparison of the three techniques with mean error and standard deviation error respectively. The performances of the techniques are somehow similar in an open environments but drastically changes in multipath environments.

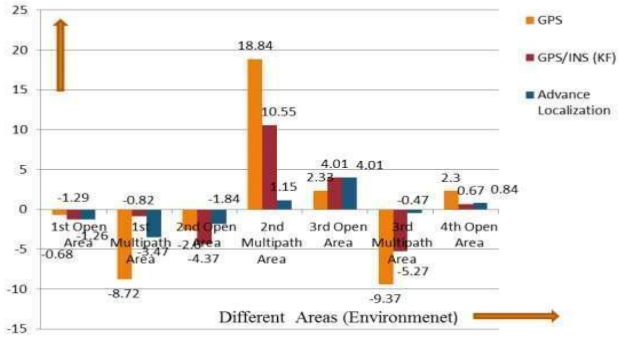

Fig - 8: Comparison of GPS, GPS/INS and Advance Localization: Mean Localization Error Related with Different Environments

Fig - 9 shows the comparison of standard deviations The standard deviation is also similar in an open environment for all techniques but it is different in multipath environments.

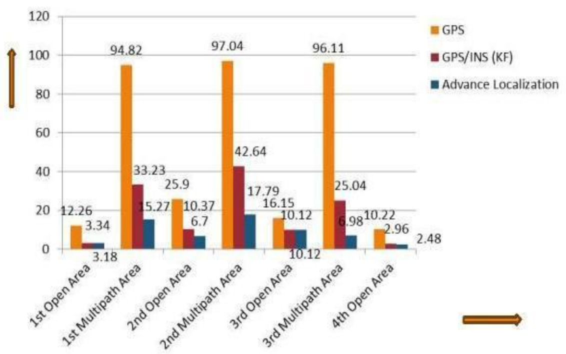

Fig - 9: Comparison of GPS, GPS/INS and Advance Localization: Standard Deviation of Error of Localization Error Related with Different Environments.

6. CONCLUSION

The GPS-INS integrated system is implemented using MATLAB software and above results shows that GPS-INS integrated technique based on RBFNN gives better results. Also the advance localization technique reduces errors presents in multipath environment and improves the localization accuracy of a vehicle traveling through it. So this system is very efficient in indoor as well as outdoor environment to localize vehicles.

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BIOGRAPHIES

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