International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Efficiency of Different Filters in Removing Noise from GPS Data

Pratibha Singh[1], Shivnandan Singh[2]

[1, 2]M.Tech Scholar, Department of Computer Science and Engineering, Galgotias University, Greater Noida (U.P), India

Abstract: ***This paper concentrates on display and removal of errors like ionospheric delays, environmental delays, tropospheric deferrals, Multipath impacts and weakening of accuracy and so forth, influencing the GPS signals as they come out from satellite to client on Earth. The distortions occur because of the delayed transference of signals from sending to receiving end which eventually corrupts the proficiency and correctness of signals. Here, we have attempted to enhance the precision of GPS positioning by separating out the noise in the GPS signals by using Kalman Filter and Complementary Filter. A comparative analysis is done between Kalman Filter and Complementary Filter respectively.***

Keywords: Mean error, Noise covariance, GPS, GSM, Sensor

1. Introduction to GPS System

A vehicle navigating framework consolidates the utilization of automatic vehicle area in individual vehicles with programming that gathers the fleet of information for an extensive picture of vehicle areas. Advanced vehicle tracking frameworks normally use GPS or GLONASS engineering for spotting the vehicle, however different sorts of programmed vehicle area innovation can additionally be utilized. Vehicle data could be seen on electronic maps by means of the Internet or specific programming.

A GPS System uses an aggregate of 24 geodic earth observing satellites to screen the position of a unit. The target unit ought to be in the extent of least of 4 satellites to process its correct area. The GPS receiver is used to indicate the signals that are continuously transmitted by the satellites. The capability to locate the vehicle's present status and area correctly is the principle objective of a vehicular tracking framework. Tracking units incorporates the strategies of Global Positioning Systems, Embedded Systems, and Wireless Communication and so forth.

A GPS tracking unit decides the precise position of a vehicle, unit, individual, or an asset to which it is connected and records its position at general interims. The recorded information is stored inside the Unit, or it may be further transmitted to an incorporated information base, or inside a workstation utilizing a cell (GPRS) or GSM modem embedded in the unit.
A GPS recipient's employment is to place four or a greater amount of these satellites, evaluate the separation to every, and utilize this data to derive its area. This operation is focused around a basic scientific guideline called trilateration. In order to make the simple calculation of the location, then, the GPS receiver has to know two things:
1) The location of at least three satellites above you .
2) The distance between you and each of those satellites

2. Framework Overview

In this exploration, we have proposed to track the position of a vehicle by utilizing GPS and GSM innovation. We are utilizing GPS Tracking Unit which is an embedded requisition. It consistently screens a moving vehicle and stores the position of the vehicle on interest.

The current configuration is an embedded provision, which will consistently screen a moving vehicle and report the status of the vehicle on interest. . In this framework, an AT89S52 microcontroller is interfaced serially to a GSM modem and GPS receiver. A GSM modem is utilized to send the position of the vehicle from a remote place. The GPS modem will constantly give the information i.e the latitude and longitude demonstrating the position of the vehicle. The GPS modem gives numerous parameters as the yield, however just the NMEA information turning out is read and showed on the LCD. The same information is sent to the portable at the flip side from where the position of the vehicle is requested. An EEPROM is utilized to store the mobile number. The hardware interfaces to microcontroller are GSM modem and GPS collector. The configuration utilizes RS-232 convention for serial correspondence between the modem and the microcontroller. A serial driver IC is utilized for changing over TTL voltage levels to RS - 232 voltage levels. At the point when the request from client is sent to the mobile number at the modem, the framework consequently sends a return answer to that mobile demonstrating the position of the vehicle in terms of latitude and longitude.

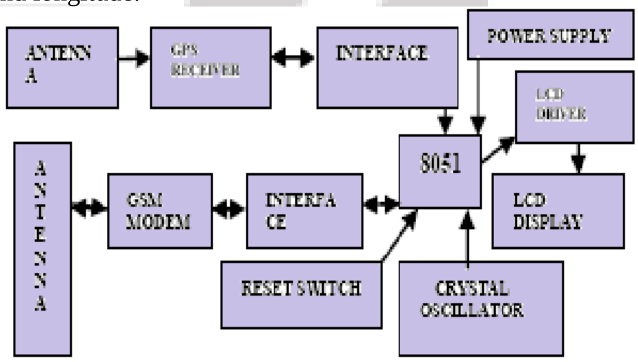

Figure 1: Diagrammatic representation of tracking System.

3. The Kalman Filter

The kalman Filter, also called linear quadratic estimation (LQE), is a procedure which utilizes an arrangement of estimation observed over intervals , holding noise (irregular varieties) and different inaccuracies and produces assessments of unknown variables that has a tendency to be more exact than those that would be focused around a single estimation alone. More formally, the Kalman Filter works recursively on streams of uproarious information to prepare a statistically ideal evaluation of the underlying framework state. This Filter acts as a computational algorithm which forms the estimations to reduce the error failure estimation of the framework. It examines the current state of the framework by measuring the changing figures of the framework, estimation commotion estimation failures and preparatory condition data. The advantages of kalman Filter are:

1. It gives the best possible area of the estimation of next frame.
2. It enhances the error recognition rate of the framework.
3. It minimizes the seeking time of the next frame; consequently it deduces the handling time.
4. The difference of the kalman Filter is more diminutive than fluctuation of the other versatile filters being used within extensive information sets.
5. It serves as one of the best smoothing algorithm.
6. It reduces the phantom detection rate.

The mathematical statements for the Kalman Filter are arranged into two categories which are Prediction and Correction. Prediction issue: predicts area of a object being followed in the next frame i.e distinguishing a region in which likelihood of discovering region is high. Correction issue: recognize predicted frame in the assigned region. A well-known result is Kalman Filter focuses around the use of state space strategies and recursive algorithms. It assesses the state of a dynamic framework. This dynamic framework might be aggravated by some noise, basically accepted as white noise. To enhance the evaluated state the Kalman Filter uses estimations that are identified with the states but disturbed as well. The correction issue is focused around symmetric metric to analyze present and past frame of an article. Tracking Unit is focused around information association, clustering, discovering current position of moving unit when there are more than one legitimate sample.

4. Numerical Formulation of Kalman Filters

The Kalman Filter addresses the general issue of attempting to estimate the state x ∈ $\Re$n, of a discrete-time controlled process that is administered by the linear stochastic differential equation.

$$X_K = A\ X_{K-1} + B\ U_K + W_{K-1} \qquad (1)$$

The n×1 framework B relates the discretionary control input x ∈ R1 to the state x. While the m×n matrix H in the measurement Equation (2) relates the state to the measurement Z_K. Here, W_k is the Process Noise while V_k is the Measurement Noise. They are assumed to be independent (of each other), white, and with normal probability distributions.

$$P\ (W) - N\ (0, Q) \qquad (3)$$
$$P\ (V) - N\ (0, R) \qquad (4)$$

The process noise covariance Q and measurement covariance R frameworks are shown in equation (3) & (4) which may change with one another. However, here we have assumed them to be constant. The Filter appraises the Process state sooner or later and then after gets feedback in the form of noisy measurements. Accordingly, the kalman Filter groups the equations in two categories: Time update and Measurement update which are stated in equation (5 & 6)-

$$X_k = AX_{k-1} + BU_K \qquad (5)$$
$$P_k = AP_{k-1}\ A^T + Q \qquad (6)$$

Time update equation extends the state and covariance estimates forward from time step k-1 to step k. Discrete kalman channel estimation upgrade comparisons (7, 8& 9) are stated as follows-

$$K_k = P_k\ H^T\ (H\ P_K\ H^T + R)^{-1} \qquad (7)$$
$$X_k = X_k + K_k\ (\ Z_k - H\ X_k\ ) \qquad (8)$$
$$P_k = (I - K_k\ H)\ P_k \qquad (9)$$

The time update equations are in charge of projecting the current state and error covariance estimates to acquire the prior estimates for post estimates. The estimation mathematical equations are responsible for the feedback. The time upgrade equations can additionally be considered as predictor equations, while the measurement update equations could be considered corrector equations. To be sure the last estimation algorithm looks like that of a predictor corrector algorithm for tackling numerical issues. Following figure shows the operation of Kalman Filter-

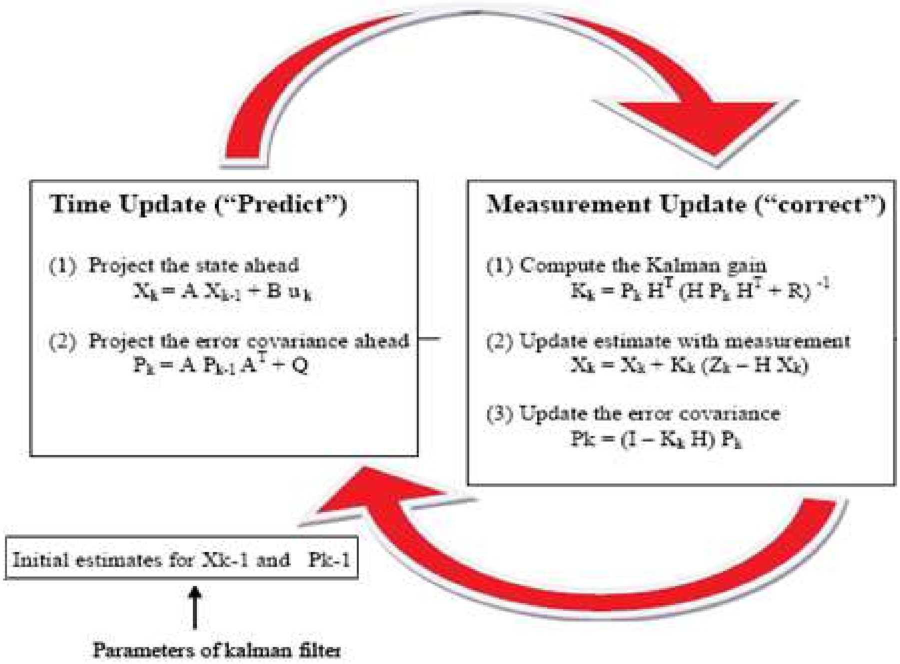

Figure 2: Operation Performed in Kalman Filter

5. The Complementary Filter

Complementary Filter is a filtering method used in frequency space. Two or more sensors, which give some state variables of measured framework, are considered as an input to the filter. This implies that one sensor supplements other in recurrence space. Accelerometers and Gyroscopes could be used together as the two sensors for a more correct perusing of orientation. A figured tilt angle from an accelerometer has a slow reaction time, while the incorporated edge from the gyroscope is subjected to float over time. The accelerometer information is valuable for long period while the gyroscope information is helpful in the short term. We have two sensors of the same state variable this condition for channel G1 and G2 ought to be satisfied as:

$G_1(S) + G_2(S) = 1$

The Complementary Filter is composed in order to utilize the quality of one sensor to conquer the shortcomings of the other sensor which is reciprocal to one another. It makes use of the gyro in brief time, and after that the low pass information from the accelerometer is utilized to remedy the drift angle over long time of time. The balance of the gyro sensor will additionally be persistently upgraded and amended. This will bring about a float free and quick reacting assessed tilt angle. The block diagram to Complementary Filter is shown in Figure 3-

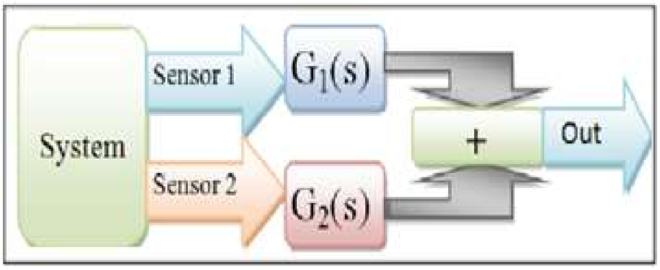

Figure 3: Block diagram of Complementary Filter

The equation of that makes up Complementary Filter is:

Estimated angle = ((α)*(previous angle+ (gyro*dt)) + ((1-α)*(accelerometer))

Where; α is Filter Coefficient and dt is Sampling Period. The Complementary Filter is generally used mainly due to simplicity of execution and for its straightforwardness.

6. Results and Discussion

In this paper, we contemplated and presented an idea using single frequency ML 300 GPS Receiver. Information is gathered at distinctive areas around Delhi, Noida and Meerut. In this way, comparative analysis of information gathered at diverse areas on the premise of Longitude, Latitude and Altitude is done using Kalman Filter and Complementary Filter. Using Kalman filtering procedures, with real time based vehicle tracking framework for evaluating accuracy and predicting the current area of the vehicle to yield better outcomes. On the premise of this system, we have arranged an comparative analysis to plot an information for distinctive areas that show bigger measure of fluctuations because of noise co-variance. This Co-variance is could be smoothened out by using Kalman Filter and Complementary Filter. The results are latitude mean failure is 0.02484, longitude mean error is 0.005087 and altitude mean error is 0.0047282 which is reduced by using Kalman Filter. While in complimentary Filter the latitude mean failure is 0.040454, longitude mean error is 0.080551 which is further reduced using Complimentary Filter. With a specific goal to gage the adequacy of the filter, a comparison needs to be made to obtain the genuine position of the vehicle. We have shown a graphical representation of the results and examination of the execution of the Filter. Figure (4) and (5) shows the processing of signals with and without Kalman Filter and Complementary Filter respectively.

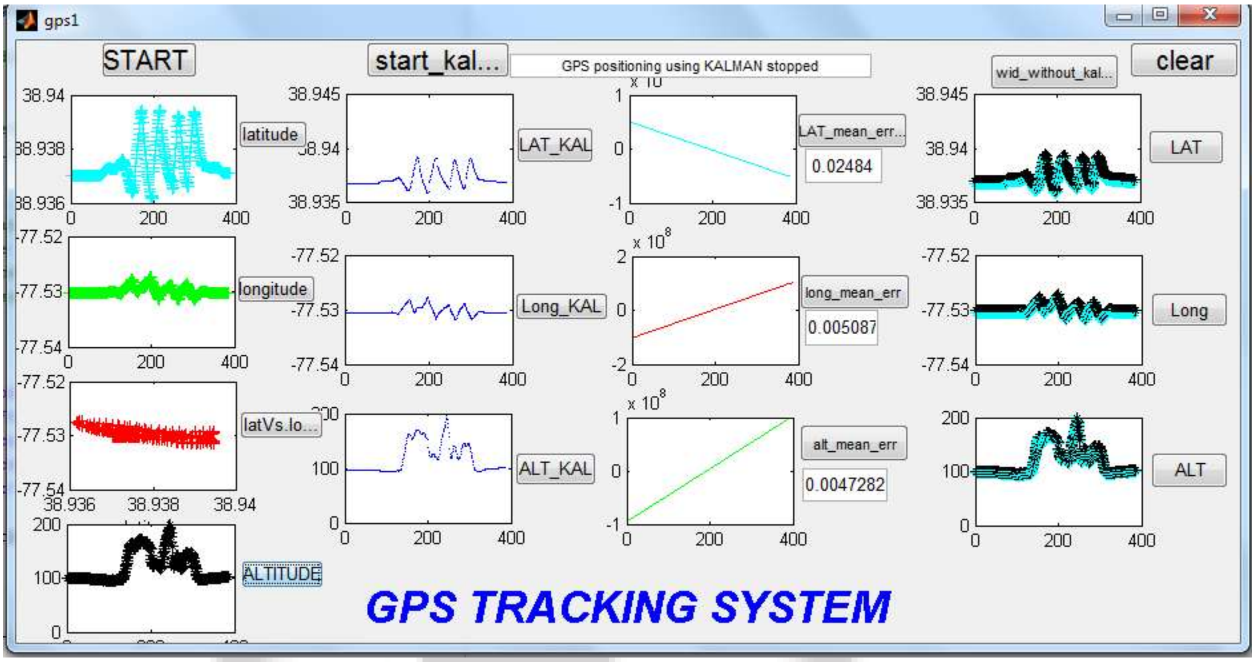

Figure 4: Signal Processing with and without Kalman Filter

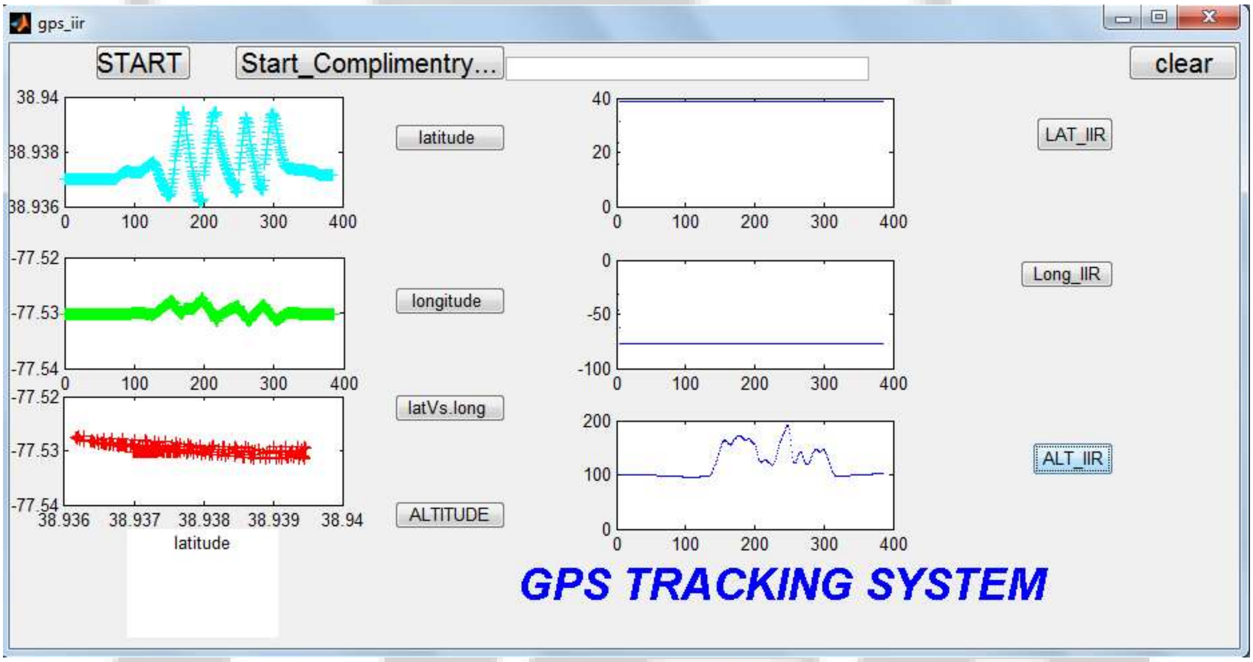

Figure 5: Signal Processing with and without Complementary Filter

7. Conclusion

In this paper, we have accumulated information from diverse areas. This information is plotted as graph which demonstrates bigger measure of fluctuations in the signals because of noise co-variance. GPS signals has notable disadvantages which causes distortions. These distortions are in the form of color noise, Gaussian noise, high temperature, background noise. These are constantly evacuated by applying kalman Filter and Complementary Filters.

The information is passed through Kalman Filter and Complementary Filter for the prediction of most probable area of the vehicle in order to yield better outcomes. It gives the precise estimation of the area. However the execution of this provision is used for the smoothening of the signal being transformed. It is shown that Kalman Filter gives the efficient results rather than the Complementary Filter in the same data set.

References

[1] Mohammad A. Al-Khedher, "Hybrid GPS – GSM Localization of Automobile Tracking System", International Journal of Computer Science & Information Technology (IJCSIT), Vol 3, No.6, Dec 2011.

[2] Y.Ruiguo and Z.Xinrong, "The Design and Implementation of Face Tracking in Real Time Multimedia Recording System", IEEE Transaction, no. 3, pp. 1-3, 2009.

[3] Malleswari B.L, MuraliKrishna I.V, LalKishore K, “Kalman filter for GPS Datum Conversion “, Mapworld Forum, Hyderabad, Vol 4 No.5, pp-34- 45 , 2007.
[4] E.David, B. Erich, K.Daniel and S.Anselm, “Fast and Robust Camshift Tracking”, IEEE Transaction no. 8, pp-1-8, 2010.
[5] J.Wang, F.He , X.Zhang and G.Yun , “Tracking Object throuth Occuusion Using Improved Kalman Filter”, IEEE 2010, no.6 , pp. 223-228, 2010.
[6] S. Afzal ,N. Vaswani ,A. Tannenbaum and Yezzi , “Kalman Filter for Object Tracking “, IEEE , no.6 ,pp. 4244-4249, 2009.
[7] X.Sun , H.Yao and S. Zhang , “ A Refined Particle Filter Method for Contour Tracking “, Visual Communications and Image Processing no.8 , pp-1-8 , 2010.
[8] S. Avidan, “Support Vector Tracking”, IEEE Conference on Computer Vision and Pattern Recognition, no. 8, pp-184-191, 2008.
[9] T.N Tan and K.D. Baker, “Efficient Image Gradient Based Vehicle Localization”, IEEE Tran. On Image Processing, Vol.9, No.8, pp.1343-1356, Aug.2008.
[10] Amir Salarpour, Arezoo Salarpur, “Vehicle Tracking using kalman filter and features”, International Journal (SIPIJ), Vol. 2., 2011.
[11] T.K Kishore, T.S Vardhan, and N.L Narayana, “Vehicle Tracking Using a Reliable Embedded Data Acquistion System with GPS and GSM “, International Journal of Computer Science and Network Security, Vol.10 no.2, pp. 286-291, 2010.
[12] B.L. Malleswari, I.V. MuraliKrishna, “The role of kalman filter in the modeling of GPS errors “, Journal of Theoretical and Applied Information Technology, Vol.6 No.4 , pp. 24-35,2008.
[13] H.W.Sorenson,” Least Squares Estimations: from Gauss to Kalman “, IEEE Spectrum (7), pp. 63-68, 2006.
[14] J.dubois ,”Traffic Estimation in Wireless Networks Using Filtered Doubly Stochastic Point Processes“ , IEEE conference on Electrical, Electronics and Computer Engineering ,Cairo , Egypt , Sept , 2006.
[15] Hsiao, W.C.M, S. K. J. Chang, “The optimal location update strategy of cellular network based traffic information system “, Intelligent Transportation Systems conference, volume 4, pp. 235-239. 2005.
[16] Kamal Upreti, Sushil Kumar Gangwar, Shitiz Upreti, ”Image Filtering of Colored Noise Based on Kalman Filter “, International Journal of Computing Science and Communication Technologies VOL.5 NO. 2, Jan. 2013 (ISSN 0974-3375).