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Reduction of Noise in GPS Using Kalman Filter

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ABSTRACT*:* Now-a-days location estimation and tracking of mobile stations have more attention. Key requirements for such applications are positioning system that provides accurate position information while spending minimal energy. Various types of techniques have been studied and combined for location tracking, eg., the least square method for location estimation associated with the Kalman filters for location tracking. A new variable is incorporated as an additional state within the Kalman filtering formulation to assign the nonlinear behavior in the measurement update process. The new variable and the desired location estimate are applied in the state update process of Kalman filter. In observation the global positioning system is generally less accurate in urban areas, so it suffices to turn on GPS only as often as necessary to achieve accuracy. To predict the accuracy of GPS use Kalman filter to clean up the noise.

KEYWORDS: GPS, Kalman filter, Location Tracking, Accuracy.

I. INTRODUCTION

In recent years location tracking using GPS provides the position information. GPS is often preferred over its alternatives such as GSM/Wi-Fi based positioning system because it is known to be more accurate. Location-based applications will have to deal with the level of error using application-specific methods, such as map matching or map-snapping. There is significant uncertainty in GPS-reporting positions, and location aware applications must adapt to this using application-specific methods. Using location API, a small program records the raw data from GPS reading. Later, we use Google maps API to plot the points. The points provide more information unnecessarily. To reduce the points, we use Kalman filter. These schemes are primarily adopted with the features of limited computation power and less requirement on positioning accuracy. To provide precise location estimation, range-based schemes are considered, which include received signal strength. The received signal strength schemes record the incoming signal strength from different wireless base stations for converting to distance measurement, and the angle of arrival methods are in general implemented at the base station to observe the signal bearing. The system collects the location of buses usually by broadcasting of sensor values depending on the radio capacity. Typically, automatic location systems are based on GPS measurements where the data acquired in each vehicle were uploaded to a main server with a large periodicity (commonly daily), to a synchronous method. The positioning estimator is full implementation of Kalman filters. Variation of the filtering that performs real time operation, single frequency data processing will be straightforward. Several standard error corrections must be applied to the data while filtering to ensure the accuracy of the result. First to state the important conclusion is that accuracy of positioning point solution is dominated by the accuracy of satellite. The major difficulty is that relatively slow coverage of filter due to large amount of noise in data. After coverage of the position state contain noise at the few-centimeter level, sensibly due to obsolete and clock error.

Much of the improvement has resulted directly from improving algorithm that removes noise before estimation process. Algorithm properly handles the atmosphere delay which is frequency dependent and it affects false range and phase differently. The range is more important because it contains geometric information needed for positioning and timing. The errors on the ranges contain information on receiving noise and also remove before processing. Multipath is small but potentially a source of position error, although averaging long times should be sufficient to mitigate it strongly. Routes which typically consist of two states with very similar paths, but inversely ordered. Timestamps are assigned to previously

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defined schedule time. Such timestamps may be composed of an expected arrival time plus some dropping time. However, in high-frequency routes timetabling can also be defined by setting up the time between two consecutive trips in the same route. The Automatic location tracking information enabled the possibility to extend the analysis to other granularity such as route based, segment based or stop based. A passenger wait cost-based model is developed in to find the optimal bus stop spacing based on historical Automatic location tracking data. To predict instability and unreliability of the network while the buses are operating is a difficult challenge. Not much research focuses on more than one preventive action. One of the most promising research areas is learning from data streams. Maintain schedule reliability using metrics such as on-time performance, movement constancy. Schedule coordination at terminals and hubs to facilitate transfer and possible to divide the process into a two-stage are filtering and tracking.

II. A CLASSIFICATION OF FILTERS AND GPS MODELS

A. *Kalman filtering models*

First, Kalman Filters have been used extensively for predicting bus arrival time and many more. The basic function of the model is to provide estimates of the current state of the system. But it also serves as the basis for predicting future values for improving estimates of variables at earlier times, it has the capability of reducing noise. The algorithm consisting of two components: tracking and prediction. The use a Kalman filter model to track a vehicle location and Statistical estimation for prediction of bus arrival time. The developments of Kalman filter algorithms to predict running times and delay times separately. To develop a dynamic and real-time models updated the prediction of bus arrival time and departure time. Kalman filtering techniques outperformed the historical models, regression models, and time lag recurrent neural network models in terms of accuracy, demonstrating the dynamic ability to update itself based on new data that reflect changing the characteristics of transit-operating environment. In general, Kalman filtering algorithms give promising results on providing a dynamic travel time estimation which other most models lack.

Algorithm:
Repeat {every ΔT_p}
Read location information from Bdb
Extract all the measurements from Bdb within interval [t_k- ΔT_{db},t_k]
For b=1 to B do {bus index}
If there are HF-badge events for b then
Set estimation position of b to the location of the HF badge reader according to recent detection event
Else
Select measurements related to bus b
Select reference location information according to the selected measurements
If there are measurements of b then
Estimate the mobile position using KF
Else
Position estimation is not available and do not do any estimation
End if
End if
Display the estimated position on the map
Update the estimated position to the Bdb
End for
Pause if ΔT_p is not fully consumed
Until stop

The Kalman filter smoothes out and tracks the estimation errors by adopting linear prediction from the previous estimation data while the bus is dynamically moving. The formulation of scheme, a feasible accuracy can be acquired for location

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tracking, including position, distance, and time. However, the accuracy is significantly affected by the precision of the external location estimator.

B . Global System for Mobile communication

Global System for mobile communication [5] is a standard set developed by European standards institute. GSM is a cellular networks it is mainly developed to describe protocols for digital cellular networks. There are base station subsystems, network switching subsystems, GPRS core network and operation support system. GSM contains four different cells micro, macro, Pico, femto, and umbrella cells. GSM uses GPRS for data transmission. Goal of GSM is to provide the mobile phone to roam throughout the Europe and provide voice services compatible ISTN and PSTN. There are three types of services in GSM. They are Bearer services, Tele services, Supplementary services. Bearer services comprises of all service that enables the transparent transmission of data between the interfaces to the network. Two type of bearer services. There are Transparent bearer services, Non-transparent bearer services. Tele services are application specific and need all the 7 layers of ISO/OSI reference model. Services are specified end to end. These Tele services are voice oriented Tele services. GSM offers supplementary services are User identification, Call redirection/forwarding, closed user group, multiparty communication.

1) *Global positioning system*

The Global Positioning System (GPS) [5] is perhaps the most popular and well-known location determination system and has been deployed in many outdoor location based applications. Each GPS signal transmission consists of a specific code, called a course acquisition (CA) code, which includes the satellite's location, the GPS system time and its clock error. To provide accurate and synchronized time estimates, the GPS transmitters on the satellites utilize very sensitive atomic clocks. The GPS satellites actually send out two different kinds of beacons, one intended for public usage and the other reserved for use under the authorization of the U.S. Department of Defense. Smartphone's have smaller antennae, are often carried by clothing or bags, are often indoors and frequently power off. As such, location-aware smart phone applications will have application-specific ways to deal with inaccuracies. Smartphone GPS use is known to be an energy drain, and many power consuming users like manual activate and de-activate GPS to conserve battery. The movement detection is used to prevent Rate adaptive positioning system [7] from activating GPS when the user has been stationary. The activity ratio is performing according to estimation of current velocity based on historical correlations between velocity and activity. Whenever Rate adaptive positioning system gets a new position update, it calculates the average velocity relative to the previous position, and associates the velocity and recent activity ratio with the previous space-time coordinate. Rate adaptive positioning system use only the activity ratio whenever we have sufficient history to perform velocity estimation and retreat to using both distance estimation and activity ratio only if there is insufficient history. Rate adaptive positioning system needs to decide when to activate GPS, and then calculates the current position uncertainty according to estimated current velocity and the activity ratio. Minimize GPS activation, we can use the accelerometer to detect motion. Continuous sequences of accelerometer possible to detect whether a user is stationary or not using an onset detection technique.

To determine the possible of using cell-tower information to adaptively activate GPS, we first empirically examined the information from a single cell-tower can reliably detect user movement. Plot the maximum, average, and minimum distance between two GPS updates with different received signal strength values within same cell Id. Although the average distance shows a rough trend in which an increasing received signal strength difference correlates with increasing distance and the variance of distance is too high to be used as a measure of distance.

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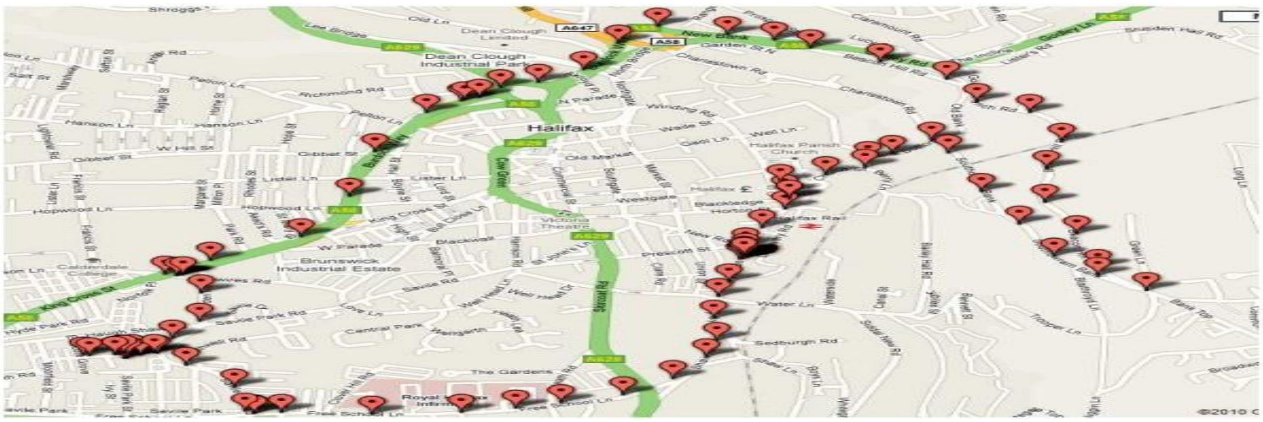

Fig. 3 continuous plots in Global positioning system [3]

In fig.3 continuous plots are specified and are useful for defining the routes and location. The prediction of timely accurate position can be defined. In high-frequency route, timetabling can also be defined by setting the time between trips in the same route.

2)Tracking unit

The tracking unit is a device that uses global positioning system to determine the correct location of a vehicle, person, or asset to which it is attached and to record the position at regular intervals. The recorded location of data is stored within the tracking unit and it transmitted to a central location data base. This allows asset's location to display against a map backdrop either in real time or when analyzing the track using global positioning system. The tracker essentially contains GPS module to receive the GPS signal and calculate the coordinates. It is necessary to identify and estimate which was the real arrival time to each one of the schedule points. Sometimes, it is need to employ regression or other estimation models to fill the gaps on the Automatic location stream. In the second stage, it is necessary to transform the Automatic location tracking data into estimates of tracking dynamic states.

Typically, such information can be inferred by employing a Kalman filter or a time series model. The researchers did so by discovering the demand patterns using both a stochastic demand scheduling model and heuristic-based methods to solve the models. Another approach to evaluate schedule reliability on a route is the segment-based. It consists of identifying segments and parts of a route where there are greater schedule deviations and therefore, the Schedule planning should be adjusted by changing the timetable or by introducing bus priority lanes and traffic signals in intersections. Schedule planning strategies aim at reducing the likelihood of schedule deviations responding to persistent and predictable problems.

III . OVER VIEW OF FILTER AND GPS

The linear aspect is directly processed within the Kalman filtering formulation, whereas the nonlinear term is received in the form of an external measurement input to the Kalman filter. The Kalman filter is only utilized to deal with linear behavior of location tracking problem by adopting these two types of architectures. The nonlinear terms are considered outside of the Kalman filter by performing least square linearization technique, which can result in information loss and cause larger location tracking errors. This type of structure can result in information loss, which causes larger location tracking errors. Moreover, both algorithms require sufficient numbers of signal sources. In the measurement update of the Kalman filter, the nonlinear Parameter is utilized to linearize the measurement equation by assigning all the nonlinear terms

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into an extra state variable. The constraint between this extra variable and the estimated position is further considered in the state update process of the Kalman filter. The simulation scenarios for validating the proposed Hybrid unified Kalman tracking algorithm are to consider ideal network environments with only Gaussian noises and sufficient signal sources. We are merely interested in determining whether and when GPS should be activated. While this data is being populated, Rate adaptive positioning system aggressively activates GPS, and frequently measures cell tower-RSS information. Subsequent velocity estimation at that location can underestimate the true velocity. Classification system is accurate regardless of position/ orientation of sensors and that a generic classifier is feasible. GPS will turn on continuously when the user is moving outdoors to provide location tracking. To determine the feasibility of using cell-tower information suitably activate GPS, we first empirically examine whether information from a single cell-tower can reliably detect user movement. The average GPS activation interval is an important indication of energy consumption, but a more complex view when we consider the breakdown of power consumption across hardware components.

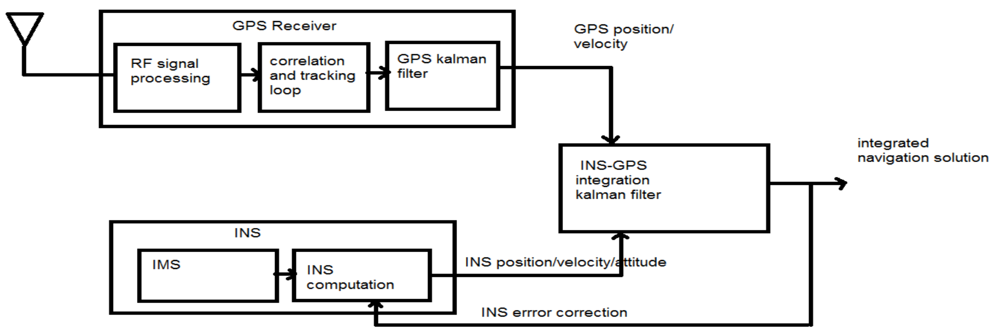

Fig. 4 combination of GPS and Filters [5]

In fig.4 describes that Global positioning system (GPS) receiver consist of 1)Radio frequency signal processing 2)correlation and tracking loop 3) GPS Kalman filter. The Radio frequency signal receives the information of location in specified location is defined according to request in correlation and tracking loop, and then reduces the plotted points of specified location in GPS Kalman filter. The position and velocity are specified and transfer to integrated navigation solution. The Kalman filter is integrated according to the navigation in maps the navigation solution is computed and combines to define the particular location.

IV. PERFORMANCE EVALUATION

Kalman filter that filters out the noise and combine different measurements to compute result. Without a matrix math package, they are typically hard to compute. For e.g., suppose we have GPS ranges to satellites the errors of any one set of measurements will be correlated, in nominal case is when one is higher and the other will be lower. They have separate clock based measured errors and pass through different areas of the atmosphere. The solution of computing position from the absolute ranges are done by matrix least squares mathematics, which can be rearranged as an iterative non-linear solution that improves an estimate of location till the error approaches zero. Good GPS systems usually take that formulation a bit farther and rewrite as a Kalman filter. A Kalman filter for navigation can also be combining the different kind of noise, fractional carrier, accelerometers, etc. Suppose you had two measurements of the same thing, the position measured by GPS and the velocity measured by an accelerometer. The measured techniques do not vary the same way because the sources of noise are unrelated and the amount of noise is typical of a measurement system, it is Gaussian. This provides good example of how a Kalman filter can really use the low noise information to correct position information. The Kalman filter learns the velocity over time, and basically trust the velocity information to update position estimate more than the position measurement. If we introduced a jumping position, the position would jump and the filter would re-adapt.

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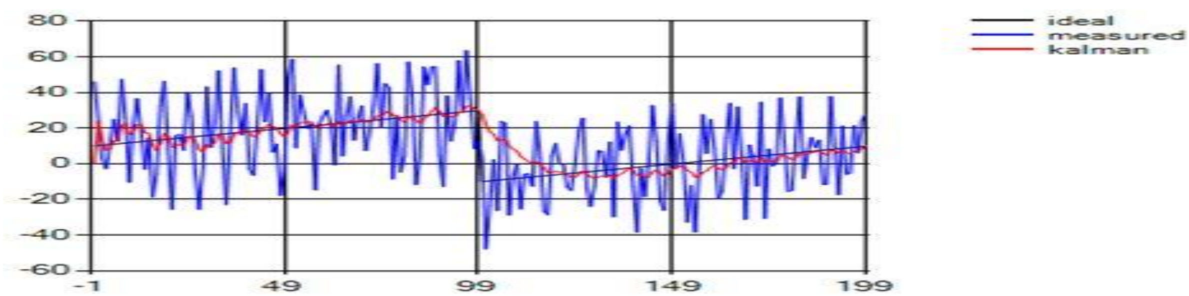

Fig. 5 irregular measure of jumping

In fig.5 ideal line is normal state, measured is determining of jumping process in regular and then kalman is to determine the jumping process in reduction of noise. If any change in regular process with the signal as same as most tracking signal problems do, then scenarios are

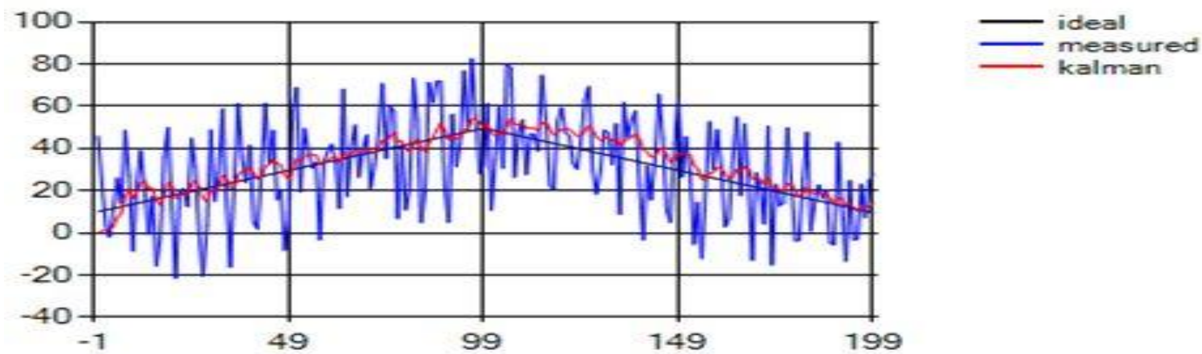

Fig. 5 measure of jumping is smoothed using noise value

In this case, the velocity changes from 0.4 to -0.4. In the middle of the test the sudden change in velocity was smoothed based on the noise value used.

V. CONCLUSION

In this paper, certain GPS receives the positioning information by using latitude and longitude coordinates are converted to Cartesian coordinates the position fit the quantization grid. The dimension of the quantization grid varies from each point on the terrestrial surface that usually ranges from decimeter in size. The Kalman filter implementation applied to data from these low-cost GPS receivers has reduced the quantization errors and the standard deviation without introducing positioning delays.

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