High Resolution Optical Satellite Remote Sensing Images in Road Tracking System using UPF

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***Abstract* - A typical way to update map is to compare recent satellite images with existing map data, detect new roads and add them as cartographic entities to the road layer. At present image processing and pattern recognition are not robust enough to automate the image interpretation system feasible. For this reason we have to develop image interpretation systems that rely on human guidance. More importantly road maps require final checking by a human due to the legal implementations of error. Our proposed technique is applied to Indian Remote Sensing and IKONOS satellite images using Unscented Particle Filter. Unscented particle filter is used for tracing the median axis of the single road segment. The Extended Kalman Filter is probably the most widely used estimation algorithm for road tracking. However, more than 35 years of experience in the estimation community has shown that is difficult to implement and is difficult to tune. To overcome this limitation, unscented particle filter is introduced in road tracking which is more accurate, easier to implement, and uses the same order of calculations as linearization. The principles and algorithm of unscented kalman filter and unscented particle filter were also discussed. The core of our system is based on profile matching. Unscented Particle filter traces the road beyond obstacles and tries to find the continuation of the road finding all road branches initializing at the road junction. The completeness and correctness of road tracking from the Indian Remote Sensing and IKONOS images were also compared**.

I. INTRODUCTION

Network of roads is an essential mode of transportation, and provides the backbone for human civilization. Hence, it is vital to maintain and restore roads to keep our transportation network being connected. Roads usually appear as dark lines while viewing from satellite images which are mostly true in rural as well as sub-urban areas. Ongoing research has led to a gamut of methods that automate the digitization process. Digitization methods for road extraction are either automatic or semi-automatic in nature. In the literature, an automatic method implies a fully automatic process. Theoretically, a fully automatic approach requires no human intervention, but this is not practical. Consider a method of automatic method; no human intervention is needed for road feature extraction at the initial or post-processing stage. Some of the automatic initialization system has been proposed based on Geographical Information System(GIS) or geographical database This paper proposes a method based on UKF. The UKF component is responsible for tracing axis coordinates of a road beyond obstacle or an intersection, tracing road branches on the other side of a road junction. There are also other improvements in our works in comparison with previous methods. The most common way of applying the KF to a nonlinear system is in the form of the extended kalman filter(EKF).In the EKF, the probability distribution function(pdf) is propagated through a linear approximation of the system around the operating point at each time instant. In doing so, the EKF needs the Jacobian matrices which may be difficult to obtain for higher order systems. Further the linear approximation of the system at a given time instant may introduce errors in the state which may lead the state to diverge over time.In order to overcome the drawbacks of the EKF,other nonlinear estimators have been developed such as the unscented kalman filter(UKF),the ensembled Kalman filter(EnKF).The overall impression is that the performance of the UKF is better than the EKF in terms of robustness and speed of convergence. The computational load in applying the UKF is comparable to the EKF. The principels and algorithm of EKF and UKF. The results of the road tracking and junction detection using UKF To compare recent satellite images with existing map data. To detect new roads and add them as cartographic entities to the road layer. At present image processing and pattern recognition are not robust enough For this reason we have to develop image interpretation systems that rely on human guidance. More importantly road maps require final checking by a human due to the legal implementations of error. So it is difficult to implement and is difficult to tune. To find the continuation of the road finding all road branches initializing at the road junction we use UPF filter

II. SYSTEM OVERVIEW

The road tracking process starts with an initial human input of a road segment, which indicates the road centerline. From this input, the computer learns relevant road information, such as starting location, direction, width, reference profile, and step size. This information is then used to set the initial state model and the related parameters

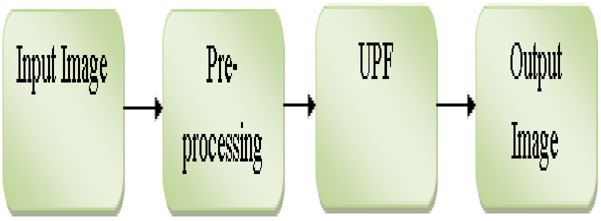
A. Prototype of the road tracking system

In most of the road tracking methods the following assumptions are made regarding road characteristics as mentioned in

- Roads are elongated,
- Road surfaces are usually homogeneous,
- There is adequate contrast between road and adjacent areas.

However these assumptions are not always true. In curved areas or ramps, the road may not be elongated. The road surface may be built of various materials that appear quite difference in the image. Background objects such as trees, houses, vehicles and shadows may occlude the road surface and may strongly influence the road appearance. Road surfaces may not have adequate areas because of road texture, lighting, and weather conditions. Preprocessing stage includes the reference profile extraction and seed point selection. Monochromatic imagery is utilized in this technique. The tracking module is composed of the UKF module. The starting point includes the co-ordinates of the road center, road direction and a course estimate of the road width at that point. Starting from the initial point ,UKF module can sequentially proceed to the next point on the road by using some artificially defined time step .The distance along the road is considered to be as the time steps .In each step the process uses noisy measurement to obtain the best estimate of the state of the road at that point, with reference with the updated profile. Since road profile is usually different at the intersection (ie) it is usually wider, hence the result of the profile matching is not reliable for obtaining measurement. The UKF will stop after S number of steps. The value of S must be large enough to let the PF module to pass over regularsized obstacles and junctions. If UKF module cannot find any valid road branches after S steps, it will announce that the road is a dead-end road.

Figure.1 A sample of a high resolution IKONOS image



III. PREROCESSING

The preprocessing module consists of two components namely reference profile extraction and estimation of road width.

A. Reference profile extraction

An initial reference profile is extracted as a vector of grey levels from the road segment entered by the human operator. Later, new profiles are extracted from new human inputs and placed into a profile list for further use. To improve robustness of the system, we use two dimensional road features, i.e. in addition to searching along a line perpendicular to the road direction; we also search a line along the road direction. The method uses the least square error profile matching to measure the similarities between any two profiles and also to estimate the optimum shift that exist between them. Profile are extracted in both directions and combined.

The parallel profile is useful since grey level values vary little along the road direction, whereas this is not the case in off-road areas. Thus the risk of of-road tracking is reduced and, in turn, tracking errors are reduced. From each human input, we obtain a profile sequence that contains the road surface texture information which may include occluding objects we also search a line along the road direction. whereas this is not the case in off-road areas. Thus the risk of of-road tracking is reduced and, in turn, tracking errors are reduced. From each human input, we obtain a profile sequence that contains the road surface texture information which may include occluding objects

B. *Extraction of road width*

Road width determines whether road profile can be
correctly extracted or not. In our approach the road width is the road width is estimated at the beginning of the tracking. A road segment is entered by the human operator with two consecutive mouse clicks with the axis joining the points defining the road center line. We assume that the roadsides are straight parallel lines on both sides of the road axis. Road width can be estimated by calculating the distance between the roadsides.Road edges, in turn can be calculated by means of sobel gradient mask.The gradient of the profile along the profile direction is calculated and one point is selected at both sides of the axis point where the largest gradient is found.

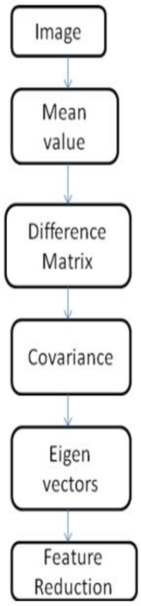


Fig1. Flow of band reduction process

IV. PRINCIPLES AND ALGORITHM OF EKF AND UPF

The state vector contain the variable of interest It describes the state of the dynamic system and represents its degree of freedom. The variable in the state vector cannot be measured directly but they can be inferred from values that measurable. In case of road tracking from an image ,it includes where rk and ck are the coordinates of road axis points, θk is the direction of the road, t θ & and is the change in road direction. The distance along the road is considered to be as time variable.

A. EKF

To illustrate the principle behind the EKF, consider the following example. Let W be a random vector and

$$y = g\ (x)\ (1)$$

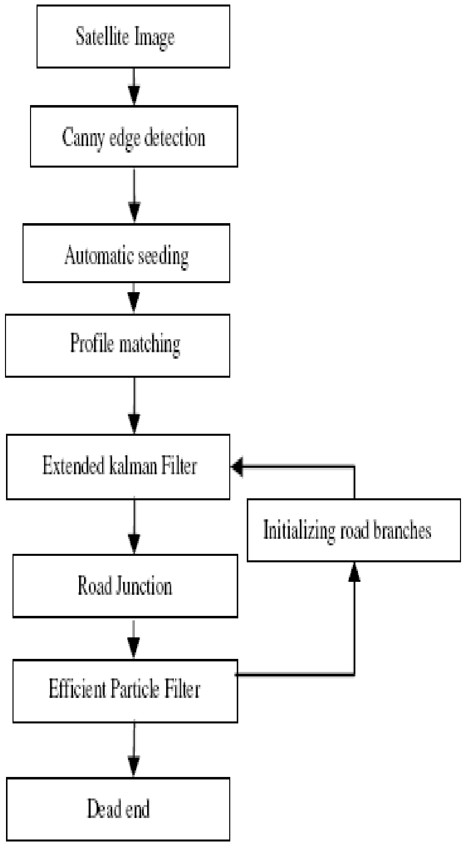
be a nonlinear function, g : Rn → Rm. The question is how to compute the pdf of y given the pdf of xi For example, in the case of being Gaussian, how to calculate the mean (y) and covariance (Σy) of y> If g is a linear function and the pdf of x is a Gaussian distribution, then Kalman filter (KF) is optimal in propagating the pdf. The state vector contain the variable of interest. It describes the state of the dynamic system and represents its degree of freedom. The variable in the state vector cannot be measured directly but they can be inferred from values that measurable. In case of road tracking from an image, it includes where rk and ck are the coordinates of road axis points, θk is the direction of the road, t θ & and is the change in road direction. The distance along the road is considered to be as time variable.

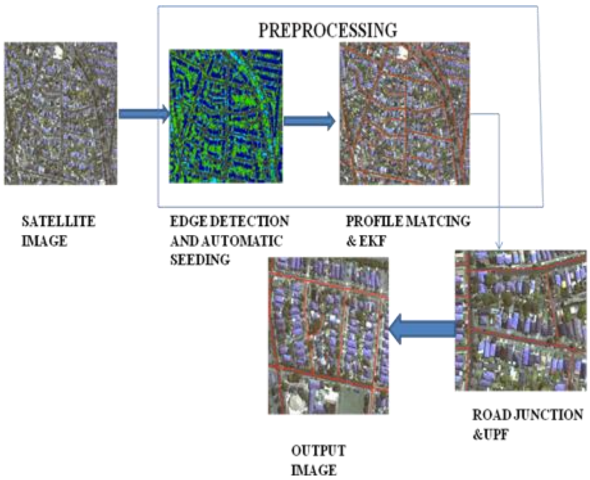
PARTICLE FILTERING

Multiple dynamics models are used to account for the motion uncertainty due to target We assume the motion mode state According to the idea of variable-structure multiple-model approach, whereas the stopped mode is active only when there is no detection. The stopped mode is added to the active mode set when the target is no longer detected and removed after the target is detected again. The target dynamics models for different target modes have the same linear Gaussian structure large process noise along the road is used, which is of the order of the magnitude of the maximum acceleration. Much smaller process noise is used. In the stopped model, the process noise is set to zero. The target velocity in the stopped target model is also set to zero

ALGORITHM

A number of semi-automated RNE approaches require a human operator to specify the seed points before a higher level operation can continue with the extraction process, Automating the seeding process reduces the total extraction time of such a system significantly. According to Harvey the performance of automatic road tracking algorithm depends to a large extend on the quality of starting points. Apart from automating process the quality of the seed points is consequently also imperative.





Automatic seeding

The workflow of the road extraction method is as shown in Fig 3. In the content of road extraction, seeding is the process whereby a marker is placed at certain points of interest within a road network. These points of interest can include markers along the centre of the road, point of high curvature, or intersections. The seeds are typically single points but can also be centreline segments or road regions. Seeding is not an extraction technique itself, but the marker are used as initialization points for extraction technique, such as road tracker and snakes

3.2 Canny edge detection

The Canny method finds edges by looking for local maxima of the gradient of the image. The gradient is calculated using the derivative of a Gaussian filter. The Canny method applies two thresholds to the gradient: a high threshold for low edge sensitivity and a low threshold for high edge sensitivity. Edge starts with the low sensitivity result and then grows it to include connected edge pixels from the high sensitivity result. This helps fill in gaps in the detected edges. Thus canny edge detection is considered to be the best edge detection when compared to other technique.

Profile matching

A gray-level profile, extracted perpendicular to the road direction, is a very characteristic property on a road. It often shows a good contrast between the road surface and its vicinity. Thus, like in, we also utilized the method of gray-level profile matching to acquire observations needed in the tracking algorithm. The method in uses the least square error profile matching to measure the similarities between any two profiles and also to estimate the optimum shift that exists between them. In our approach, the correlation coefficient and the difference between the profile means are used to calculate the error or difference between any two profiles.

Extended Kalman Filtering

The state vector contain the variable of interest. It describes the state of the dynamic system and represents its degree of freedom. The variable in the state vector cannot be measured directly but they can be inferred from values that measurable. In case of road tracking from an image, it the direction of the road,& and is the change in road direction.

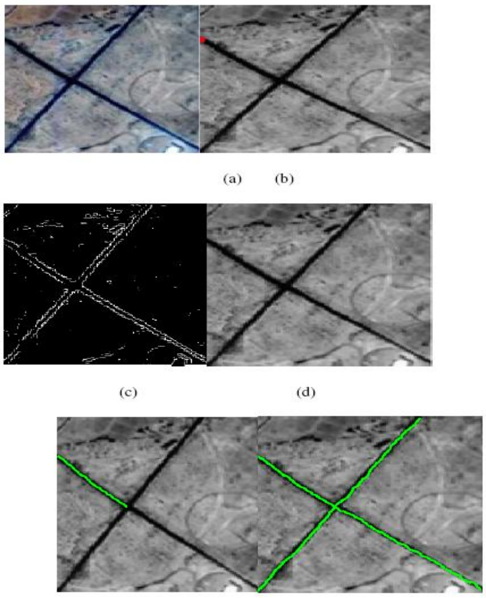
Particle Filtering

Multiple dynamics models are used to account for the motion uncertainty due to target We assume the motion mode state According to the idea of variable-structure multiple-model approach, whereas the stopped mode is active only when there is no detection. The stopped mode is added to the active mode set when the target is no longer detected and removed after the target is detected again. The target dynamics models for different target modes have the same linear Gaussian structure large process noise along the road is used, which is of the order of the magnitude of the maximum acceleration. Much smaller process noise is used. In the stopped model, the process noise is set to zero. The target velocity in the stopped target model is also set to zero

EFFICIENT PARTICLE FILTERING

The efficient particle filter for road-constrained target tracking is designed based on the optimal particle filtering theory for jump Markov linear Gaussian systems. Analytic approximation is made for the target state distribution; approximation is needed mainly because the observation model is nonlinear, though the target dynamics is modeled as linear system with Gaussian noise.

V.RESULTS AND DISCUSSION FOR EXPEECTED OUTPUT



Automatic road tracking results from an IRS image using Efficient particle filtering (a) Satellite image (b) Monochromatic imagery (c) Automatic seeding (d) Edge detection using Canny edge detection (e) Road tracking by EKF (f) Road tracking by Efficient particle filtering and EKF.

VI. CONCLUSION

The method of extraction developed in this research, and the proposals for future work aimed at automating the initial step of the identification and selection of road segment points, may only work on high-resolution images. As, these processes need edge information for extraction, and geometric (width)and radiometric radiometric/intensity variation) characteristic information across the road along the direction of road, to identify and select road segment points. This information may exist only in high-resolution images, where roads exist as long continuous features with uniform width; in the case of low-resolution images, roads exist as long bright lines that may disappear or exist as very thin features after the pre-processing step. A deficiency of the algorithm is the slow operation of the PF module. Hence, to overcome this drawback a set of training data sequence can be used to automatically optimize the parameters of a particle filter. Furthermore ,performance of the algorithm on more complex uran areas is yet to be evaluated, which might necessitate some Advantage of High performance accuracy, Accurate Detection & Edge preservation is high for recognition and. Applications is Computer Vision &Pattern Recognition

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