MODIFIED KALMAN FILTERING METHOD FOR REDUCING GPS - VEHICLE TRAJECTORY TRACKING ERROR USING ANFIS IN REAL TIME

K.Nithiya¹, Mr.A.Vinoth Kannan², Mr.M.Anantha Kumar³

1 Student, ME Applied Electronics, IFET college of Engineering, Tamilnadu, India
2 Assistant Professor, ECE, IFET college of Engineering, Tamilnadu, India
3 Assistant Professor, ECE, IFET college of Engineering, Tamilnadu, India

Abstract

Tracking a GPS equipped Moving vehicle in Real time still tends to have Errors while tracking using user segment Receivers and softwares. This paper proposes a Different method for tracking a vehicle moving with frequently changing speed using Genfis1 of ANFIS(Adaptive Neuro-Fuzzy Inference System) with Matlab 2013a. The Tracking Accuracy is focussed as important parameter to be improved than existing method of RBF based tracking and training method. Kalman filter is initialized with varied Step size and Covariance is updated in Real time and adjusted to reduce the Noise covariance of Observed GPS values.

Keywords: Kalman, Stepsize, ANFIS, Tracking, GPS, Training.

Introduction:

Accuracy of GPS Tracking is a major Application in Research areas nowadays for tracking GPS equipped vehicles, Fleet tracking by companies and spatial analysis using Trajectories softwares like ANFIS LAB, MATLAB with ANFIS is used to Train coordinates values obtained from accelerometers and GPS receivers. The Modified Kalman Filtering method Combined with ANFIS is used here to Train and track GPS latitude and longitude values from BU353 WAAS enabled GPS receiver. Kalman filter is more effective than Particle filter in terms of computational complexity.

Analysis of proposed method:

the training ANFIS discard the major Disadvantages of neural and ANN, RBF network by inserting Prior Knowledge as Fuzzy Rules into the Neural network. ANFIS generates Fuzzy rules by identifying the Membership Functions and optimize error by blending the learning Rule. Here the GPS trajectory is analysed upon 4 steps

1. Preprocessing stage
2. ANFIS Training Process
3. Kalman Filtering Initialization with Varied step size
4. Covariance Update and adjustment in Real time.
5. Observation of RMSE Errors.

PROPOSED TRACKING METHOD

Fig 1 - Proposed method based on ANFIS

PREPROCESSING METHOD:

Pythagoras method is here used as preprocessing method to find difference between 2 latitude longitude points. The distance in meters along is displayed as result of preprocessing method

This is used as input Estimated values for Error tracking in ANFIS training after defining the membership functions as Generalized Bell and defining Fuzzy rules. Since Pythagorus method tends to have less errors than great circle as method.
OBSERVATION OF PREPROCESSING METHOD

DOM FEATURE EXTRACTION:

Degree of Mismatch feature extraction helps to extract the essential contents of dataset, required ranges, conceptual data from any database. Here Excel is used to contain raw data values obtained from BU353 GPS user segment receiver. Raw data evolves with error and missing values are analyzed and the required values such as Latitude and Longitude is extracted.

Then cartesian coordinates of orbit parameters are converted to WGS84 datum indication direction with meters. True Trajectory vectors are extracted for measurements of confidence value analysis.

True value vs estimated values of Kalman filter was formulated by this DOM feature vectors

KALMAN FILTER INITIALIZATION AND ESTIMATION OF FUTURE VALUES:

Kalman Filter is linear quadratic estimator here used mainly for future location prediction using previous values with inaccuracies. Here tracking a vehicle, Kalman filter projects extrapolation of 20 seconds projection into the future and estimates the future values with respect to past trajectory values.

The Kalman filter can be thought of as operating in two distinct phases: predict and update. In the prediction phase, the vehicle's old position will be modified according to the physical laws of motion (the dynamic or "state transition" model). Vehicle can be equipped with a GPS unit that provides an estimate of the position within a few meters.

In addition, since vehicle is expected to follow the laws of physics, its position can also be estimated by integrating its velocity over time. Ideally, if Kalman cannot drift away from the real position in case of sudden change in velocity due to the ANFIS training and updating the covariance values, the GPS measurement should pull the position estimate back towards the real position but not disturb it to the point of becoming rapidly changing and noisy.

ANFIS TRAINING AND TESTING:

The Neuro-Fuzzy overcomes the main disadvantages of Neural network and it was a rare platform to be used to insert our prior knowledge as Fuzzy Rules into the neural network. In this concept 3 fuzzy rules is used to update the covariance of GPS data and Kalman residual measurement.

Table 1 Extracted Features

<table>
<thead>
<tr>
<th>POSITION FOR SPATIAL PROCESSING</th>
<th>TIME DIFFERENCE</th>
<th>DISTANCE IN METERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8070e+006</td>
<td>-1.1602e+007</td>
<td>3.1806e+006E</td>
</tr>
<tr>
<td>8.6510e+006</td>
<td>-2.0853e+007</td>
<td>3.6432e+006E</td>
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<tr>
<td>1.2966e+007</td>
<td>-1.4356e+007</td>
<td>3.4063e+006N</td>
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<td>1.4061e+007</td>
<td>-7.4752e+007</td>
<td>4.8070e+006N</td>
</tr>
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<td>1.8059e+006</td>
<td>1.1603e+006</td>
<td>5.1456e+006E</td>
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<td>8.6484e+006</td>
<td>-2.0855e+007</td>
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<td>1.2968e+007</td>
<td>1.881e+006</td>
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<td>1.4058e+007</td>
<td>2.0736e+007</td>
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<td>1.6543e+007</td>
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<tr>
<td>8.6458e+006</td>
<td>2.1932e+007</td>
<td>2.8745e+006E</td>
</tr>
</tbody>
</table>
by training using Hybrid method and evaluating the input output modelling of trained output vs ANFIS output

Rules include covariance values with positive negative values and state variation is proportional as the system evolves for 20 seconds. Training and testing process was completed in 1.6 seconds.

The Estimated values from kalman filter not only will a new position estimate be calculated, but a new covariance will be calculated as well. Perhaps the covariance is proportional to the speed of the vehicle because we are more uncertain about the accuracy, position estimate at high speeds but very certain about the position estimate when moving slowly. Next, in the update phase, a measurement of the truck's position is taken from the GPS unit. Along with this measurement comes some amount of uncertainty, and its covariance relative to that of the prediction from the previous phase determines how much the new measurement will affect the updated prediction.

The outcome of ANFIS module results in reduced Tracking error when inferring the updated covariance values. The Tracking error was Reduced upto 0.000139*10^4 when averaging all the 60 values. The fuzzy rules helps to infer

**RESULT:**

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the convergence values of extrapolation in meters/seconds for nearly 20 seconds into future. Accuracy is improved than Existing RBF based tracking results. Thus the Tracking error was drastically reduced than any Existing methods like RBF based training, Bayesian interpolation, FCM based trajectory prediction etc.

<table>
<thead>
<tr>
<th>Tracking Method</th>
<th>Training and Testing Method</th>
<th>RMSE</th>
<th>ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatio Temporal anlaysis</td>
<td>RBF-Training FCM - Testing</td>
<td>1.3657</td>
<td>83%</td>
</tr>
<tr>
<td>Constraint Prediction</td>
<td>ANFIS</td>
<td>0.01387</td>
<td>89.5%</td>
</tr>
</tbody>
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Table 2: Results and comparison

Spatio Temporal Analysis includes existing method which does not considers the tuning parameters and separate method for training such as RBF(Radial Basis Functions network)and Fuzzy based clustering for testing with RMSE values lesser than that of proposed ANFIS based tracking method. Accuracy of tracking is not declined for the desired parameters and accounts for about 89.5% which is greater than existing method.

REFERENCES:

AUTHOR(s) PROFILE

Author K.Nithiya completed her B.E ECE in PMU Tanjore, presently in the stage of completion of M.E Project Thesis in IFET college of engineering, Villupuram, India. Her interests include Wireless technologies and neural networks.

This Project was guided by Assistant Professor, Mr. A. Vinoth Kannan, ECE dept, IFET college of engineering, Villupuram. His interests include wireless and VLSI based circuit innovations.

Co-Author of this research article Mr. M. Anantha Kumar, ECE Dept, IFET College of engineering, Villupuram. His Interests include handling Neural based projects.