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

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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 Stepsize 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 Researchareas 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 leraning

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

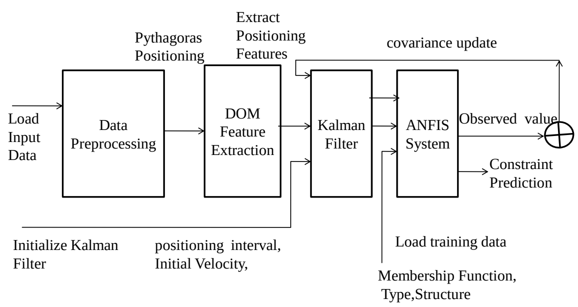

Fig 1 - Proposed method based on ANFIS

PREPROCESSING METHOD:

Pythagoras method is here used as preprocessing method to find differnce 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

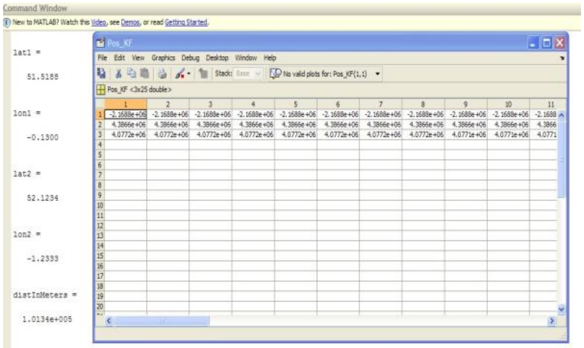

Fig 2 Pythagoras based Positioning

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

EXTRACTED PARAMETERS

POSITION FOR SPATIAL PROCESSING	TIME DIFFERENCE	DISTANCE IN METERS
1.8070e+006	-1.1602e+007	3.1806e+05E
8.6510e+006	-2.0853e+007	3.6432e+006E
1.2966e+007	-1.4356e+007	3.4063e+006N
1.4061e+007	7.4752e+007	4.8070e+006N
1.8059e+006	1.1603e+006	5.1456e+006E
8.6484e+006	-2.0855e+007	5.6722e+006E
1.2968e+007	1.8811e+oo6	1.2345e+006E
1.4058e+007	2.0736e+007	1.18974e+006E
1.8048e+006	1.6543e+007	2.4084e+006E
8.6458e+006	2.1932e+007	2.8745e+006E

Table 1 Extracted Features

KALMAN FILTER INITIALIZATION AND ESTIMATION OF FUTURE VALUES:

Kalman Filter is linear quardratic estimator here used mainly for future location prediction using previous values with inaccuracies.HereTracking 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,ifkalman 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.

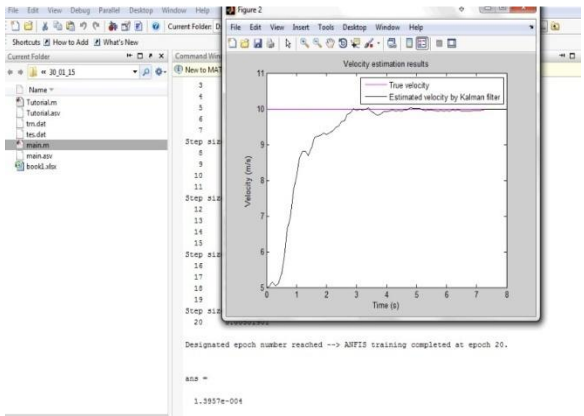

Fig 3 Velocity analysis in matlab 2013a

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 neural network.In this concept 3 fuzzy rules is used to update the covariance of GPS data and kalman residual measurement by training using Hybrid method and evaluating the input output modelling of trained output vs ANFIS output

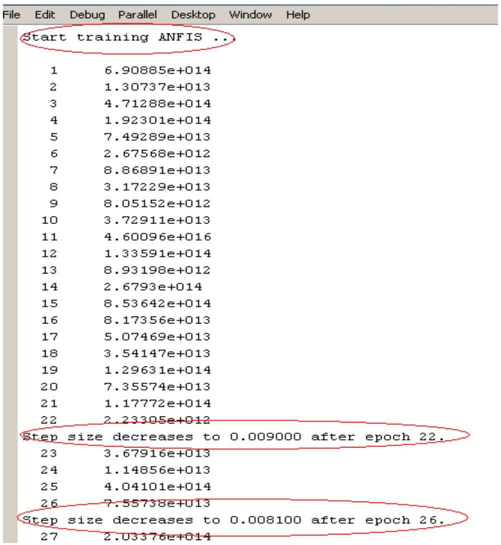

Fig 4 ANFIS Training input values

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.

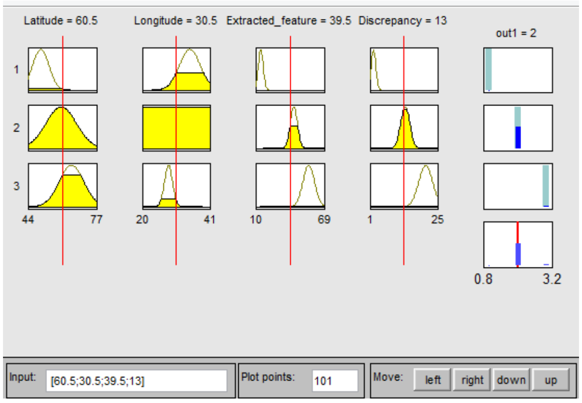

Fig 5 Viewing the Trained values in ruleviewer,Matlab 2013a

Totally 60 datapairs and 200 epoch was used.stepsize is an array of scalar values with RMSE errors of training data pairs returned after every epoch.

UPDATING COVARIANCE

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.

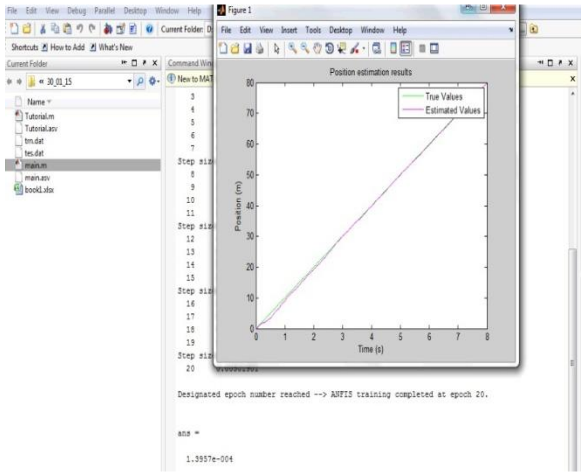

Fig 6 ANFIS evaluation Graph

Below is the GUI design that includes all the processes such as preprocessing, spatial data extraction, ANFIS training and updating covariance.

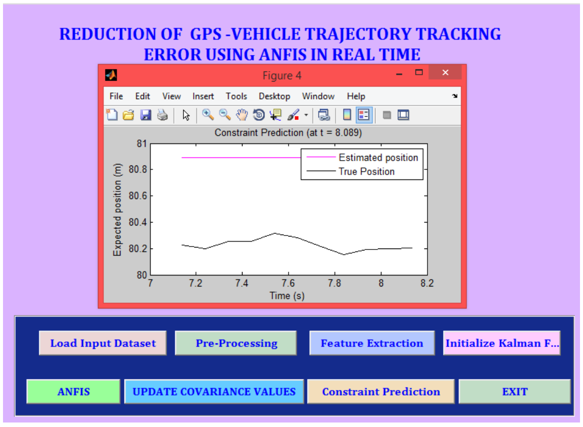

Fig 7 GUI design including all processess

RESULT:

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 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.

Tracking Method	Training and Testing Method	RMSE	ACCURACY
Spatio Temporal anlaysis	RBF-Training FCM - Testing	1.3657	83%
Constraint Prediction	ANFIS	0.01387	89.5%

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.

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