

Differential Global Positioning System Based on FIS with Extended Kalman Filter for Real Time Applications

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Abstract

The global position system is subject to many types of errors such that the final readings are not in acceptable limits to eliminate the errors of GPS. Differential global position system having one static and another moving. So for target tracking solution, non-dynamical models are required. The main objective is an accurate target tracking solution suitable for navigation for naval ships and spacecraft. Extended Kalman Filter and fuzzy logic systems have been combined to make the GPS measurements more accurate. The impureness and uncertainties of measurements are taken care by selecting suitable membership functions along with appropriate if-then rules. Methods can be accurately utilized in tracking targets that are required in airspace as well as in naval encounters. In this proposed hybrid fuzzy extended common Kalman filter method the efficient outputs can be observed.

Keywords: GPS, Fuzzy, EKF, FEKF, DGPS

I. INTRODUCTION

GPS is basically a user-friendly positioning system for exactly locating the connect coordinates, longitude, latitude of a definite position on the earth's surface. The input is from the radio information received from a network of satellite orbiting around the global. The disturbing factor in the process of interpretation of data is an intentional disruption termed as selective availability which has pattern of unpredictable frequency in noise form. This noise is introduced by the satellites artificially for the justification of security. Large errors of the order of 100m may be caused by such factors. In contrast to this situation, Differential GPS uses a dual GPS system in which one GPS is fixed and the other becomes a moving system for monitoring [1]. The fixed GPS gives the part of reference for the mobile counterpart. The effect of selective availability (SA) is negatively linked to

coordinates where as DGPS can give a accurate relative coordinates existing between the two GPS positions [2].

The most important predicament with GPS system including DGPS is that related to slow updates radio interference & loss due to absorption of GPS type of radio waves. For improving the overall results reliable many methods have been suggested. A method based on rate gyro wheel speed sensor was proposed earlier using on sensor fusion. The effects of noise and interference were reduced by this technique which has the demerit of failing in congested area. Costly equipment based on multisensory method was proposed later. The prohibitive cost did not allow wider application. Utilizing navigation altimeter, GPS have been improved [3].

The main objective of this paper is to use sensor fusion techniques on fuzzy logic based Kalman

filter. The measurements of vehicular DGPS and gyro rate gyro /speed sensors are fed accurately to sensor input. Fuzzy algorithm optimizes the filter parameters whose algorithm works on interrelation of sensors. Presence for complex variable techniques helps to reduce load of computation [4]. From the experimental results it is evident that FLKF path tuning is accurate as well as reproducible.

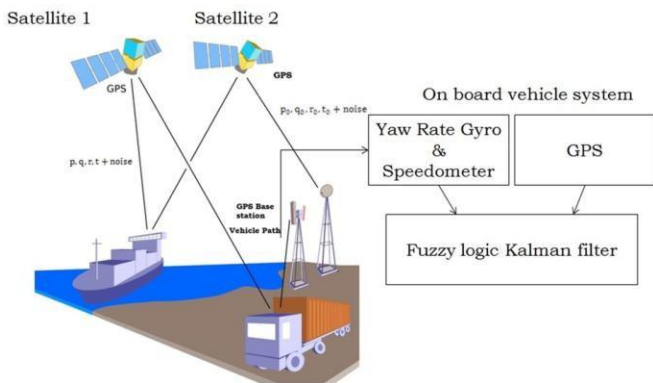


Figure 1: Configuration for proposed global positioning method

II. STATEMENT OF THE PROBLEM

The basic assumption is that the accurate model of moving object is not known and the only available data is related to position measurements. A fuzzy tracking solution can be obtained by tracking [5] a large class of such objects for target. The problems due to Kalman filter are circumvented by this process of *if then rules* [6-10].

III. METHODOLOGY

Kalman filter provides a method which was based on observations taken on certain period of time having statistical noise as well as a line in accessories. It produces estimation of unknown variables which tend to be relatively accurate by having joint probability type of estimation. The procedure is based on 2 steps process. During the first step it gives estimation of current state variables and the uncertainty involved. Later, once the result of the next observation having discrepancies and some noise is noticed, the estimates and updated utilizing a weighted average is provided with greater surety. In real

applications only present inputs are required with no dependence on past information.

Extensions and generalized approaches have led to EKF and other higher order filters. This model is identical to hidden Markova model with difference of continuity of latency of variables. Moreover, the latency and observations normally are based on Gaussian distribution. Most popular application of Kalman filter is in guiding, navigating and controlling of vehicular parameters covering automobiles, space vehicles and ships.

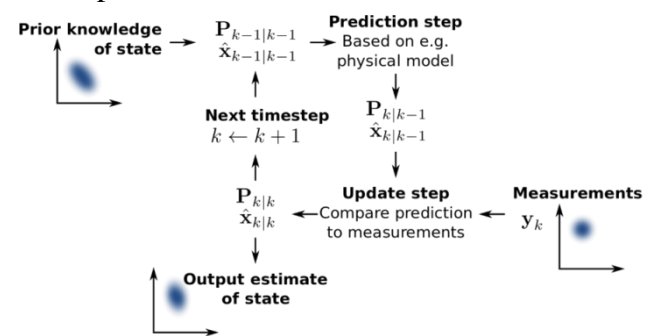


Figure 2: Basically Fuzzy Inference System uses multiple valued logic in which the truth could be estimated in the range of 0 to 1.

This helps handling of logic involving partial truth ranging from totally true to completely false. On the other hand conventional logic has only 0 and 1. Moreover linguistic Hedges can be used to express degree of membership function.

This procedure formulates transformation known input to corresponding output based on fuzzy concepts. This transformation helps in providing the premise out of which logical conclusions can be drawn and patterns can be suitable distinguished.

FIS involves

- Fuzzification concepts
- Logic operations
- IF THEN concepts.

In any type of interface are used in MATLAB Fuzzy Logic Toolbox the output Fuzzy sets which after aggregation had defuzzification. The constituents are

- Evaluation of inputs
- Use of Fuzzy logic in antecedent

c) Simplification of antecedent to consequents by IF THEN concepts and defuzzifying procedure.

This is a modification of a basic filter for linearizing values of mean and covariance suitable in navigation system and GPS. For a trajectory where linear section is done by continuously re updating with state values from the observations, then the filter becomes extended Kalman filter.

$$S = f(s, ud, t) = u(t) \tag{1}$$

$$Z = h(s, t) + v(t) \tag{2}$$

Here f and H are standard functions ud can be determined. Z gives cross conditions

Here s(f) is nominal or reference trajectory. The actual strategy may be expressed as

$$s(t) = s(t) + \Delta s(t) \tag{3}$$

Equations (1) and (2) can be modified as

$$S^* + \Delta = f(s^* + \Delta s, udt) + u(t) \tag{4}$$

$$Z = h(S^* + \Delta s, t) + v(t) \tag{5}$$

IV SIMULATION RESULTS:

The filter is likely to adjust to the environment of satellite condition by varying the factor C2 as a function of distance and GD [16]. Again, second adaptation for taking into consideration unavailable GPS signals is to reset C; whenever the useful satellite date is absent. The rules of IF - THEN logic are used

Rules set A

If distance (a) is small and GDOP (a) is small then C2 is small

If distance (a) is small and GDOP (a) is large then C2 is medium

If distance (a) is large and GDOP (a) is medium then C2 is large

If distance (a) is large and GDOP (a) is large then C>2 is large

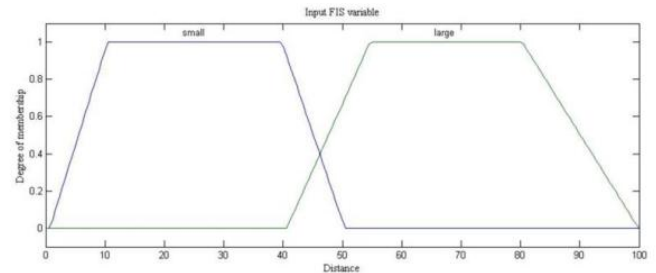


Figure 3: Specifying inputs and outputs in the FIS editor

In above figure 7 the fuzzy inference system the error which is increased with the distance and GDOP (geometrical delusion of precision) are taken as inputs .and rate of measurement taken as output. The distance range is considered as 0 to 100. The GDOP error range is taken as 0 to 100. Then the membership ship functions are assigned to each of the input parameters. Here triangular membership functions are considered. If-Then rules are applied to get the best estimate of filters. Here distance, GDOP are taken as inputs and assigned the membership functions to each of the inputs based on the three different filters and finally the ROM (rate of measurement) output

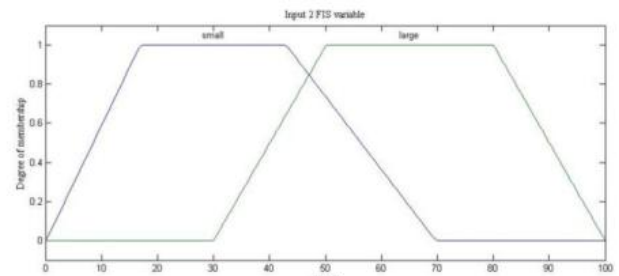


Figure 4: Representing input of the GDOP

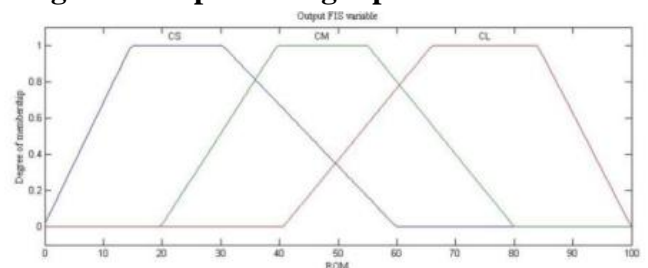


Figure 5: Representing the output of the rate of measurement

In figure 5 depicts the GDOP memberships function. The range is assigned from 0 to 100. In between small GDOP, large GDOP ranges are assigned.

Figure 6 depicts the GDOP membership function

[2]. The range is assigned from 0 to 100. In between R small, R medium, R large ranges are assigned.

Figure 7 and 8 explaining about the inputs distance and GDOP with fuzzy rules outputs for rule set 1

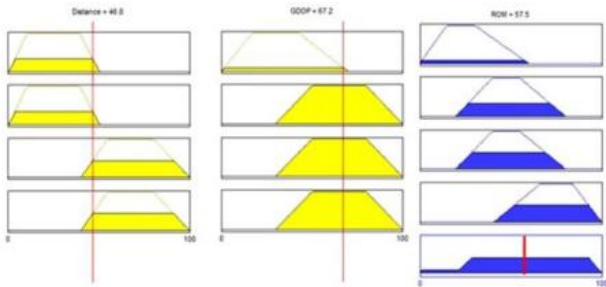
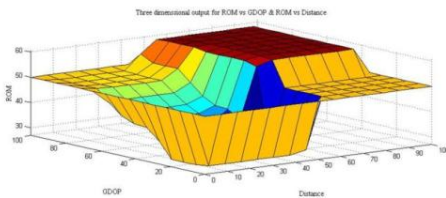
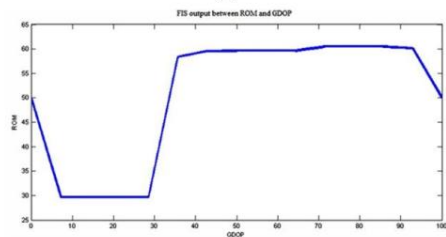


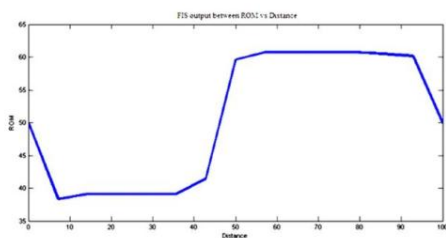
Figure 6 depicts the GDOP membership function



(a)



(b)



(c)

Figure 7: Represented a) 3D noise variations, b) FIS output between ROM vs DGOP. c) FIS output between ROM vs Distance

Rules set B

If the prediction error p is large then multiply C_i by two factors

If the prediction error p is small then multiply C_i

by one factor

From the figure 7 the error is large the factor is two similar in figure 8 if the error is small the alpha output factor is one.

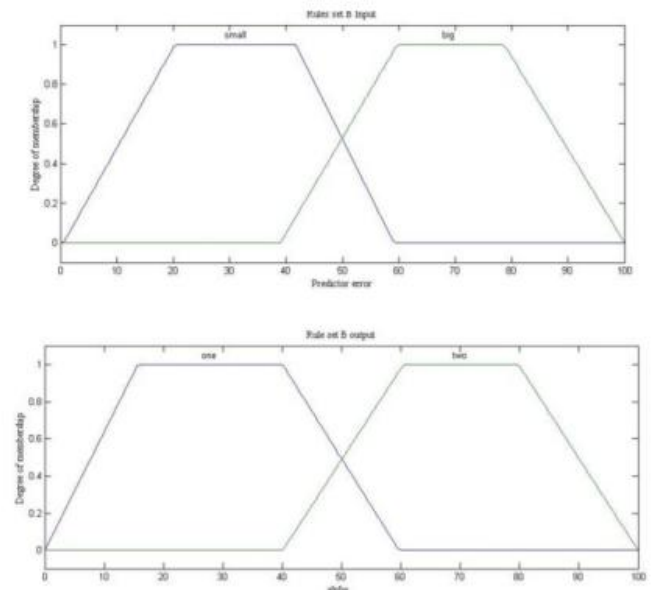


Figure 8 shows that fuzzy rule set B prediction error and alpha

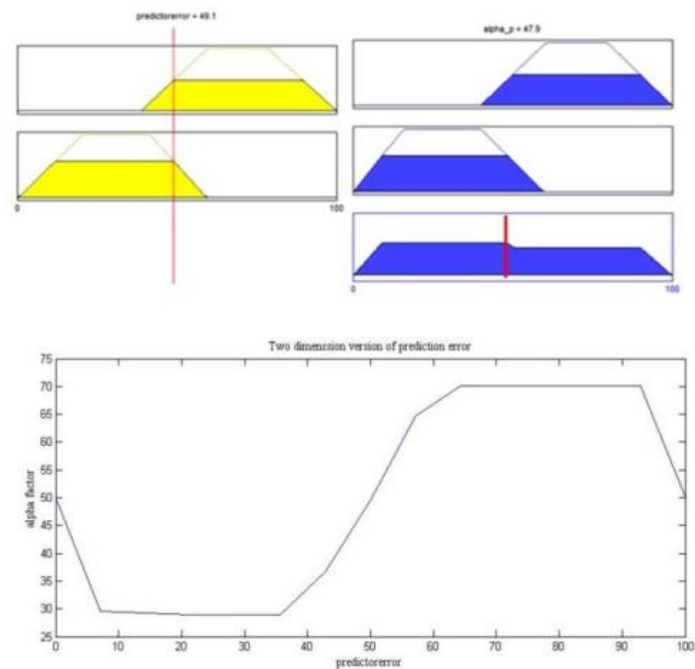


Figure 9 two dimensional version of alpha vs predict error

Explaining the general membership function prediction error rule set B for alpha and predicts error.

CONCLUSION

It is observed that comparisons with EKF the performance of FIS is superior. The hybrid system consists of FEKF is even superior to the simple fuzzy method. Applications of ANFIS are expected to improve the results for wider applications.

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