An Algorithm for Map Matching For Car Navigation System

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The Global Positioning System is the most popular choice for positioning in car navigation systems. But in real life, the various noise sources affecting the signals and the instrumentation used by the positioning system, along with the map inaccuracies, result in the estimated position not necessarily being overlaid onto the road network. The process of mapping the output from the positioning system on to the road network is called map matching. In this paper a new map matching algorithm is proposed. The proposed algorithm is a modified version of one of the topological map matching algorithms called Quddus's algorithm. In order to show the effectiveness of the proposed algorithm, it is tested on the city map Arak and then the result is compared with the result obtained for Quddus's algorithm. In this paper, Correct mapping the output from GPS on the road network parameters is our purpose. The input to the system comes from Gps receiver (Gpsmap 76CS) and Arak map database. In this paper, the results show that the proposed algorithms can be effectively used to map matching. Quddus's algorithm combines several defined parameters with special weight factor such as speed, heading and vehicle angle with intersection. Quddus's algorithm has done some matching incorrectly, especially in intersection shown in below.

In general, a digital map is represented as a graph constructed by nodes and links that, indicates crossroads and roads. In map vectorizing process, a link is a section of street between junctions. In other hand a few link together represent a street. A graph is constructed by central line of street. Length of the link assigned to a piece of the street is equivalent the length of the same piece of the street. Length of the link represented by L_R .

In this algorithm; maximum length of a link has been defined as a new parameter and represented by L_{max}. L_{max} is length of link plus half of width of the previous street traveled by the car (W_P). L_R is fixed for each street. But L_{max} depends on the route traveled by the car, because W_P is half of width of the previous street traveled by the car. For example in Fig .1, L_{2max} is equal to L_{2R} plus to width of the street 1and L_{1max} is equal to L_{1R} plus to width of the street 5.

$L_{max=} L_R + W_P/2$ (1)

The limitation that most map matching algorithm does not work well in the situation Illustrated in Fig1. In Fig.1, the car moves on the street 1 and Red points are received by Gps. the real distance traveled by the car is more than L_{1R} obviously. For example P_{20} is the position of the car received by Gps. as we know the traveled route by the car is more than L_{1R} , it is impossible for the car to move on street 1,it should move on the street 3 or street 2. Since the car hasn't turned, every map matching algorithm selects street 3, but it's not true. The problem has been derived from the car movement in every location of street's width. Using the new parameter has improved the algorithm's results as shown in the following Figs. The new algorithm uses the following Steps to assign the vehicle on the correct link.

1. Receive the GPS point

2. Find the closest node from the first GPS point. Select all the road segments that pass through the closest node, otherwise take this point as the initial point and go to step 1

3. Using the Quddus weighting formula to choose the correct link. These two points (i.e. initial point and its next point) should be matched to this link.

4. Determine the vehicle position on the correct link for each of the two points using Quddus formula.

5. Receive next GPS point. If $\Delta\beta \succ 45^\circ$ ($\Delta\beta$ is the difference between the new GPS point and previous GPS point heading) then go to step1 else if $\Delta\beta \prec 45^\circ$, then It means the car is still moving in previous route and hasn't changed the direction. Now you should determine whether the car has passed the junction in the same direction or not? To find the answer follow the following level.

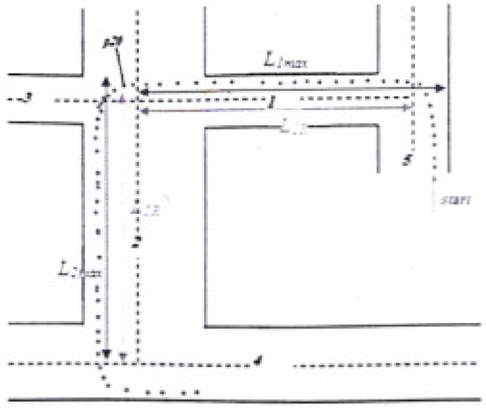
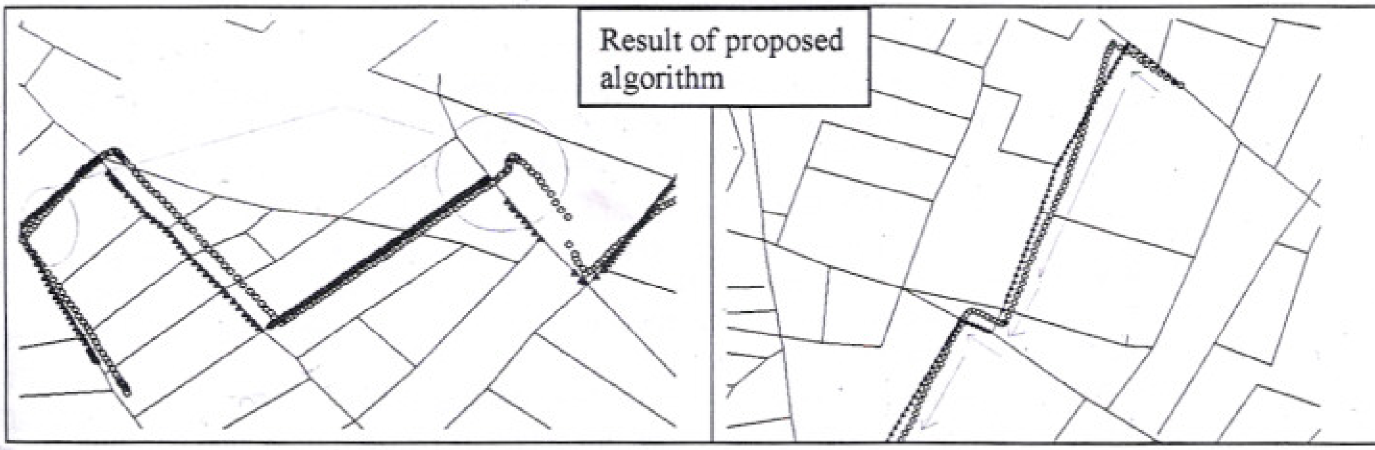


Fig .1, a general problem with matching

5-1) calculates the traveled distance by the car from the previous junctions to the current junction. If this distance is more than L_{max} same link Eq.(1), surly the car has passed the current junction without changing the direction. We select a new edge connected to the previous edge and in the same direction; otherwise we select an edge connected to the junction different from the previous direction. Go to step 5



References

[1] Christopher E. White, David Bernstein, Alain L. Kornhauser, "*Some map matching algorithms for personal navigation assistants*", a Department of Operations Research and Financial Engineering, Princeton University, (2000).

[2] Bernstein, D. and A. Kornhauser, "*An Introduction to Map Matching for Personal Navigation Assistants*", Technical Report, New Jersey TIDE Center, New Jersey Institute of Technology, New Jersey, NY, USA, 1996. http://www.njtide.org/reports/mapmatchintro.pdf

[3] Greenfeld, J. S., "*Matching GPS Observations to Locations on a Digital Map*", Proceedings of the 81st Annual Meeting of the Transportation Research Board, 22-27 May, Washington, DC, USA, pp. 376-384, 2002.

[4] Syde, S. and Cannon K., "*Fuzzy Logic Based Map Matching Algorithm for Vehicle Navigation System in Urban Canyons*", Department of Geometrics Engineering, University of Calgary, Alberta, Canada, 2004

[5] Zhou, J., "*A Three-step General Map Matching Method in the GIS Environment Travel and Transportation Study Perspective*", Department of Geography, University of California Santa Barbar, 2004

[6] Quddus, M.A., W. Y. Ochieng, Z. Lin and R.B. Noland,"*A General Map- Matching Algorithm for Transport Telematics Applications*", GPS solutions, Volume 7, No. 3, pp. 157-167, 2003.