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(71) Applicant: MOTOROLA INC. [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US).

(72) Inventors: KIRSON, Allan, M.; 1830 Lawrence Lane, Highland Park, IL 60035 (US). SMITH, Bernard, Clarkson; 2718 Crystal Way, Crystal Lake, IL 60012 (US). BARNEA, Michael; 1725 Heather Lane, Highland Park, IL 60035 (US). SEYMOUR, Leslie; 861 Shoreline Road, Barrington, IL 60010 (US).

(74) Agents: HOPMAN, Nicholas, C. et al.; Motorola Inc., Intellectual Property Dept., 1303 East Algonquin Road, Schaumburg, IL 60196 (US).

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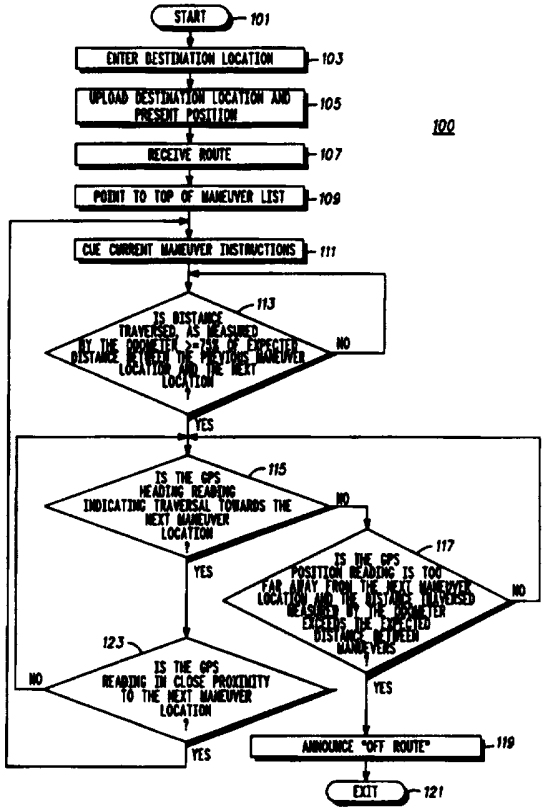
(54) Title: ROUTE GUIDANCE WITH OFF-ROUTE DETECTION

(57) Abstract

A method of route guidance for a vehicle with off-route detection includes determining a previous maneuver location and a next maneuver location of the vehicle, then waiting until a distance traversed by the vehicle is greater than a first portion of a distance between the previous maneuver location and the next maneuver location (113). Then, providing a route guidance instruction (111) if a heading of the vehicle indicates traversal towards the next maneuver location. Also, an off-route indication can be provided (119) if a heading of the vehicle indicates traversal away from the next maneuver location.



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# ROUTE GUIDANCE WITH OFF-ROUTE DETECTION

## Field of the Invention

This invention is generally directed to the field of terrestrial vehicular navigation, and specifically for route guidance with off-route detection.

## Background of the Invention

Contemporary vehicular Route Guidance systems are complicated and are very computational resource demanding. Real time precise positioning necessary to support these contemporary vehicular Route Guidance systems requires GPS (Global Positioning System) processing, Dead Reckoning processing and Map Matching which all demand a fast CPU (Central Processing Unit), large memory arrays and fast mass storage.

What is needed is an improved method of route guidance with off-route detection that is much less resource demanding.

## Brief Description of the Drawings

FIG. 1 is a flow chart of a method in accordance with a preferred embodiment of the invention; and

FIG. 2 is a system block diagram of an apparatus for executing the preferred method steps shown in FIG. 1.

## Detailed Description of a Preferred Embodiment

A method of route guidance for a vehicle with off-route detection includes determining a previous maneuver location and a next maneuver location of the vehicle, then waiting until a distance traversed by the vehicle is greater than a first portion of a distance between the previous maneuver location and the next maneuver location. Then, providing a route guidance instruction if a heading of the vehicle indicates traversal towards the next maneuver location. Also, an off-route indication can be provided if a heading of the vehicle indicates traversal away from the next maneuver location. Further qualifiers are also used to cue the provision of the route guidance instruction and the off-route indication. Further details of the inventive aspects of the new approach will be better appreciated after FIG.s 1 and 2 are introduced.

FIG. 1 is a flow chart of a method in accordance with a preferred embodiment of the invention. The preferred method will be described after the introduction of FIG. 2.

FIG. 2 is a system block diagram of an apparatus for executing the preferred method steps shown in FIG. 1. A route guidance computer 201 can be constructed using various common computer components. Preferably, a Motorola MC68HC332 microcontroller is used. The MC68HC332 microcontroller is complemented by EPROM or Electrically Programmable Read Only Memory which is used to store native MC68HC332 code representative of the method steps shown in FIG. 1. The route guidance computer 201 also comprises temporary memory in the form of RAM or Random Access Memory for temporary storage of variables.

The route guidance computer 201 receives an incremental position measurement from a transmission odometer pickup 203, and an absolute position measurement from a global positioning system

205. The transmission odometer pickup 203 generates a constant number of pulses per unit of distance traveled (e.g. 8000 pulses per mile), independent of vehicle direction or speed. Alternatively, any sensory system that indicates incremental distance traversed by the vehicle may be used in substitution for the transmission odometer pickup 203.

The Global Positioning System (GPS) receiver derives absolute position based on signals received from GPS system satellites, whenever sufficient number of satellites are in view. The accuracy of the calculated position is affected by Selective Availability (SA) and available if and only if at least three satellites are in view of the antenna - therefore the receiver alone is not sufficient for a route guidance system. Alternatively, any sensory system that indicates absolute position of the vehicle may be used instead of the GPS receiver.

The route guidance computer 201 also connects to an operator interface 207. This operator interface 207 is used to receive input from an operator and communicate route guidance instructions and off-route indications via a display. Alternatively, a voice output interface may be used if preferred. A radio frequency – RF modem 209 is used to interface the system to a remote route planner. This approach is used to simplify the complexity of the system., reduce the system resource load and reduce the over all cost of the system. Alternatively, a map database can be stored on a CD-ROM disk and a local route planner function could be implemented.

Returning to FIG. 1, a routine 100 commences with a start step 101. Next, in step 103 the operator is requested to enter a trip destination location. Typically, this destination location is input in terms of a street address. Alternatively, intersection, latitude and longitude coordinates may be entered. This trip destination location is stored in the provided temporary memory.

Then, in step 105 the MC68HC332 microcontroller uploads the trip destination location and a current position of the vehicle to a

remote route planning station via the RF modem 209. Note that the current position is fetched from the global positioning system 205. Many contemporary route planners have been detailed in the literature and most are sufficient to plan a route for the present embodiment.

Next, in step 107 a route is received back from the remote route planning station via the RF modem 209. This route is in the form of a maneuver list. The maneuver list comprises a linear list of maneuvers along the planned route which are intended to guide the vehicle's operator from the operator's current position to the operator's trip destination location. The maneuver list is traversed in sequence as each maneuver is cued to the operator.

In step 109, the microcontroller points to the top of the maneuver list which indexes a first maneuver, which is the maneuver to be cued next, or the next maneuver location.

Then, in step 111, the maneuver is queued to the vehicle's operator (e.g. "proceed West"). Given the current position and the location of the next maneuver as defined in the maneuver list, the microcontroller calculates the distance between maneuvers and monitors the distance traversed by counting the pulses output by the transmission odometer pickup 203.

Next, in step 113, microcontroller continuously monitors the distance traversed and compares it to an expected distance between the previous maneuver to the next maneuver location, and waits until a distance traversed by the vehicle is greater than a first portion of a distance between the previous maneuver location and the next maneuver location. Preferably the first portion is between 75% and 90% of the expected distance between maneuvers.

Then, in step 115, microcontroller examines vehicle heading as calculated by the GPS receiver. If the heading indicates traversal toward the next maneuver location, then step 123 is executed next. Otherwise, step 117 is executed.

Next, in step 123, if the present vehicle position, as calculated by the GPS receiver, is close to the next maneuver location as described

in the list, step 111 is executed. Closeness is measured by a second predetermined distance. Preferably, the second predetermined distance is less than 25% percent of the expected distance between the previous maneuver location and the next maneuver location. If the present vehicle position is not close to the next maneuver location then step 115 is re-executed.

In step 117, the vehicle is heading away from the maneuver point. If the distance traversed exceeds the distance between maneuvers and vehicle position is far from maneuver point, "OFF ROUTE" is cued to the operator in step 119.

"OFF ROUTE" is not announced as long as the vehicle is heading towards the maneuver - allowing for temporary deviations from the prescribed route.

In conclusion, an improved method of route guidance with off-route detection that is much less resource demanding has been detailed which includes an off-route indication.

What is claimed is:

## Claims

1. A method of route guidance for a vehicle with off-route detection comprising the steps of:

determining a previous maneuver location and a next maneuver location;

waiting until a distance traversed by the vehicle is greater than a first portion of a distance between the previous maneuver location and the next maneuver location; and

providing a route guidance instruction if a heading of the vehicle indicates traversal towards the next maneuver location.

2. A method in accordance with claim 1 wherein the step of providing a route guidance instruction, comprises:

providing a route guidance instruction if a heading of the vehicle indicates traversal towards the next maneuver location, and if a distance between a current position of the vehicle and the next maneuver location is less than a second predetermined distance.

3. A method in accordance with claim 1 further comprising the step of:

determining an expected distance dependent on a difference between the previous maneuver location and the next maneuver location; and

wherein the first portion of the expected distance is greater than seventy-five percent of the expected distance.

4. A method in accordance with claim 1 further comprising the step of:

determining an expected distance dependent on a difference between the previous maneuver location and the next maneuver location; and

wherein the first portion of the expected distance is less than ninety percent of the expected distance.

5. A method in accordance with claim 2 wherein the second predetermined distance is less than twenty-five percent of a distance between the previous maneuver location and the next maneuver location.

6. A method of route guidance for a vehicle with off-route detection comprising the steps of:

determining a previous maneuver location and a next maneuver location;

waiting until a distance traversed by the vehicle as indicated by the odometer is greater than a first portion of a distance between the previous maneuver location and the next maneuver location; then

providing an off-route indication if a heading of the vehicle indicates traversal away from the next maneuver location.

7. A method in accordance with claim 6 wherein the step of providing an off-route indication, comprises:

providing an off-route indication if a heading of the vehicle indicates traversal away from the next maneuver location, and if a distance between a current position of the vehicle and the next maneuver location exceeds an expected distance between the previous maneuver location and the next maneuver location by more than thirty percent.

8. A method in accordance with claim 6 wherein the step of providing an off-route indication, comprises:

providing an off-route indication if a heading of the vehicle indicates traversal away from the next maneuver location, if a distance between a current position of the vehicle and the next maneuver location exceeds an expected distance between the previous maneuver location and the next maneuver location by more than thirty percent, and if the distance traversed by the vehicle is greater than a distance between the previous maneuver location and the next maneuver location.

9. A method in accordance with claim 6 further comprising the step of:

determining an expected distance dependent on a difference between the previous maneuver location and the next maneuver location; and

wherein the first portion of the expected distance is greater than seventy-five percent of the expected distance.

10. A method in accordance with claim 6 further comprising the step of:

determining an expected distance dependent on a difference between the previous maneuver location and the next maneuver location; and

wherein the first portion of the expected distance is less than ninety percent of the expected distance.

11. A method of route guidance for a vehicle including an odometer and a global positioning system with off-route detection comprising the steps of:

determining a previous maneuver location and a next maneuver location;

determining a first distance traversed between the previous maneuver location and the current position of the vehicle;

determining a heading of the vehicle at the current position of the vehicle;

determining a second distance dependent on a distance between a current position of the vehicle and the next maneuver location;

waiting until the first distance traversed by the vehicle is greater than a first portion of a distance between the previous maneuver location and the next maneuver location, then providing a route guidance instruction if the heading of the vehicle indicates traversal towards the next maneuver location and if the second distance is less than a second predetermined distance away from the next maneuver location; and

waiting until a distance traversed by the vehicle as indicated by the odometer is greater than a first portion of a distance between the previous maneuver location and the next maneuver location, then providing an off-route indication if a heading of the vehicle indicates traversal away from the next maneuver location, if a distance between a current position of the vehicle and the next maneuver location is more than a third predetermined distance away from the next maneuver location, and if the distance traversed by the vehicle is greater than a distance between the previous maneuver location and the next maneuver location.

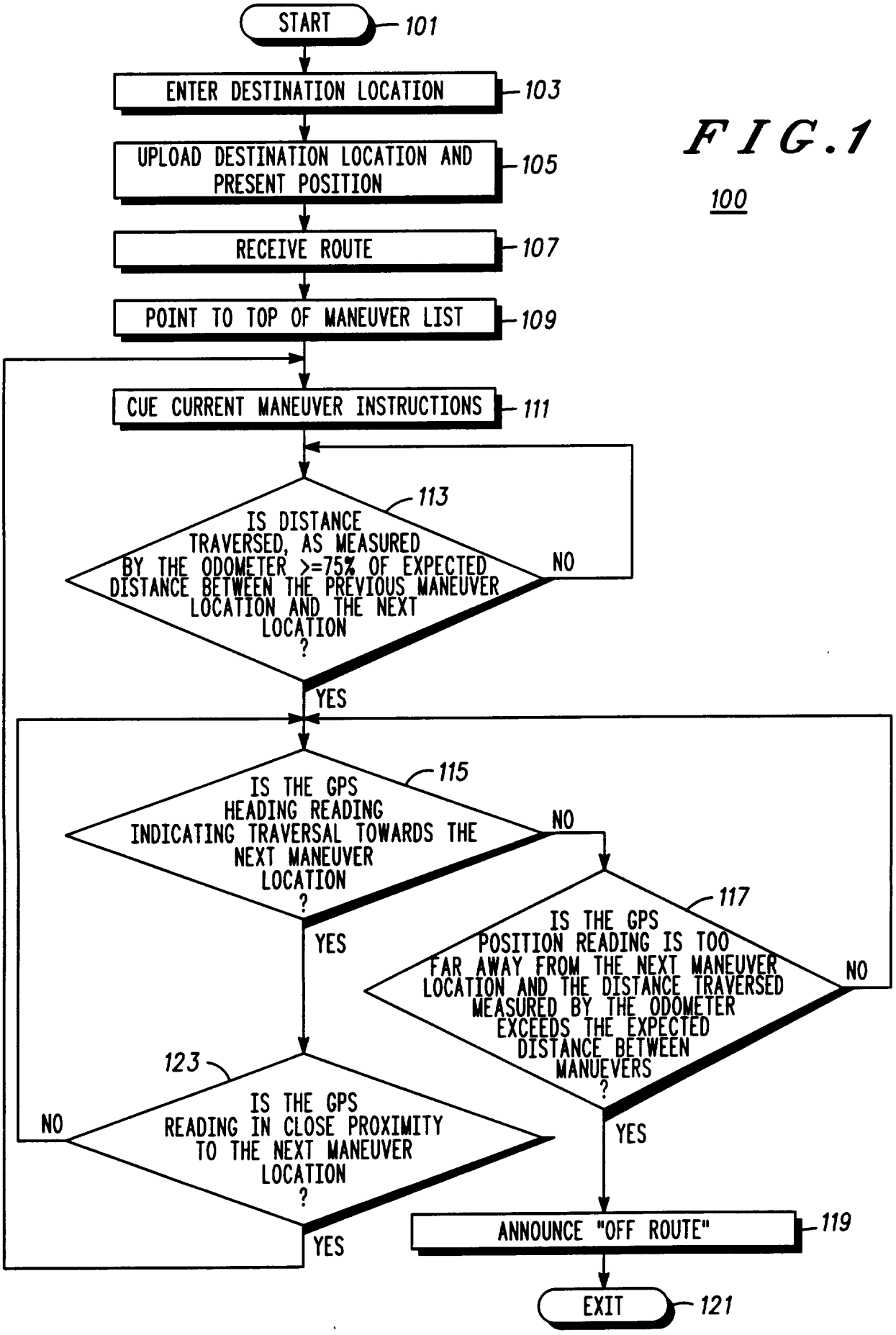
START
101
ENTER DESTINATION LOCATION
103
UPLOAD DESTINATION LOCATION AND PRESENT POSITION
105
RECEIVE ROUTE
107
POINT TO TOP OF MANEUVER LIST
109
CUE CURRENT MANEUVER INSTRUCTIONS
111
113
IS DISTANCE TRAVERSED, AS MEASURED BY THE ODOMETER >=75% OF EXPECTED DISTANCE BETWEEN THE PREVIOUS MANEUVER LOCATION AND THE NEXT LOCATION ?
NO
YES
115
IS THE GPS HEADING READING INDICATING TRAVERSAL TOWARDS THE NEXT MANEUVER LOCATION ?
NO
YES
117
IS THE GPS POSITION READING IS TOO FAR AWAY FROM THE NEXT MANEUVER LOCATION AND THE DISTANCE TRAVERSED MEASURED BY THE ODOMETER EXCEEDS THE EXPECTED DISTANCE BETWEEN MANUEVERS ?
NO
YES
123
IS THE GPS READING IN CLOSE PROXIMITY TO THE NEXT MANEUVER LOCATION ?
NO
YES
ANNOUNCE "OFF ROUTE"
119
EXIT
121

FIG. 1

100

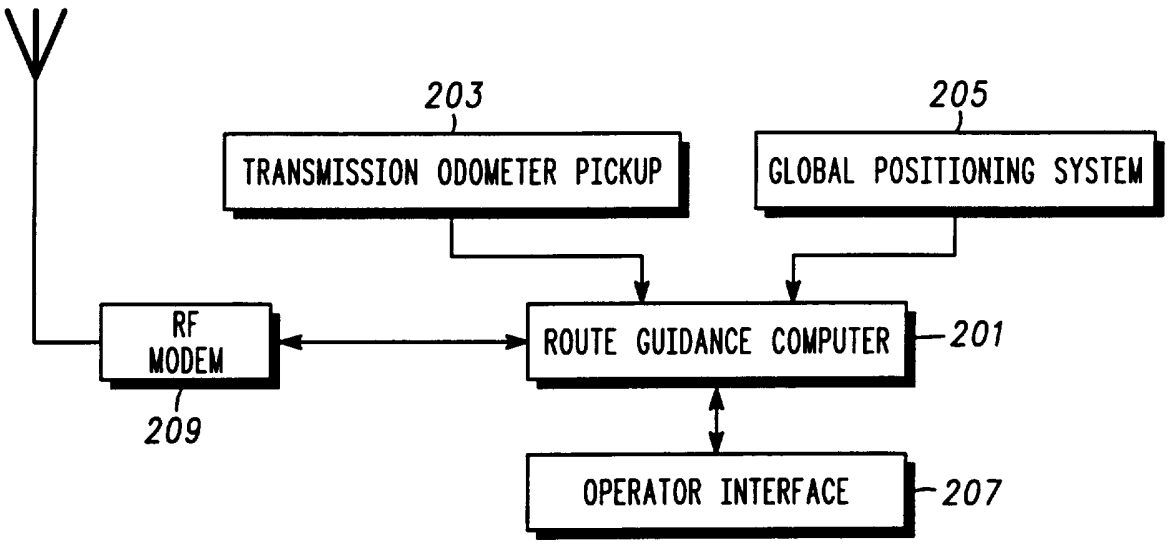
203
TRANSMISSION ODOMETER PICKUP
205
GLOBAL POSITIONING SYSTEM
RF MODEM
209
ROUTE GUIDANCE COMPUTER
201
OPERATOR INTERFACE
207

FIG. 2

# INTERNATIONAL SEARCH REPORT

Int ational application No.
PCT/US95/15010

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 165:00
US CL :364/443, 444, 449; 73/178R; 340/988, 990, 995
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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| X | US, A, 5,243,528 (LEFEBVRE) 07 September 1993, col. 4, lines 30-55. | 1-11 |
| A | US, A, 5,359,529 (SNIDER) 25 October 1994, see figure 3. | 1-11 |
| A | US, A, 5,303,159 (TAMAI ET AL) 12 April 1994, see figure 4. | 1-11 |
| A | US, A, 5,262,775 (TAMAI ET AL) 16 November 1993, see figure 4. | 1-11 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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