(12) **United States Patent**
Chowanic et al.

(10) **Patent No.: US 6,175,803 B1**
(45) **Date of Patent: Jan. 16, 2001**

(54) **VEHICLE NAVIGATION ROUTE GENERATION WITH USER SELECTABLE RISK AVOIDANCE**

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(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **09/128,687**

(22) Filed: **Aug. 4, 1998**

(51) **Int. Cl.**[7] **G01C 21/00**

(52) **U.S. Cl.** ..... **701/209**; 701/23; 701/25; 701/26; 701/201; 701/209; 701/211; 73/178 R; 940/988; 940/990; 940/995

(58) **Field of Search** ..... 701/209, 211, 701/208, 23, 25, 26, 117, 201, 202; 340/990, 995, 988; 73/178 R

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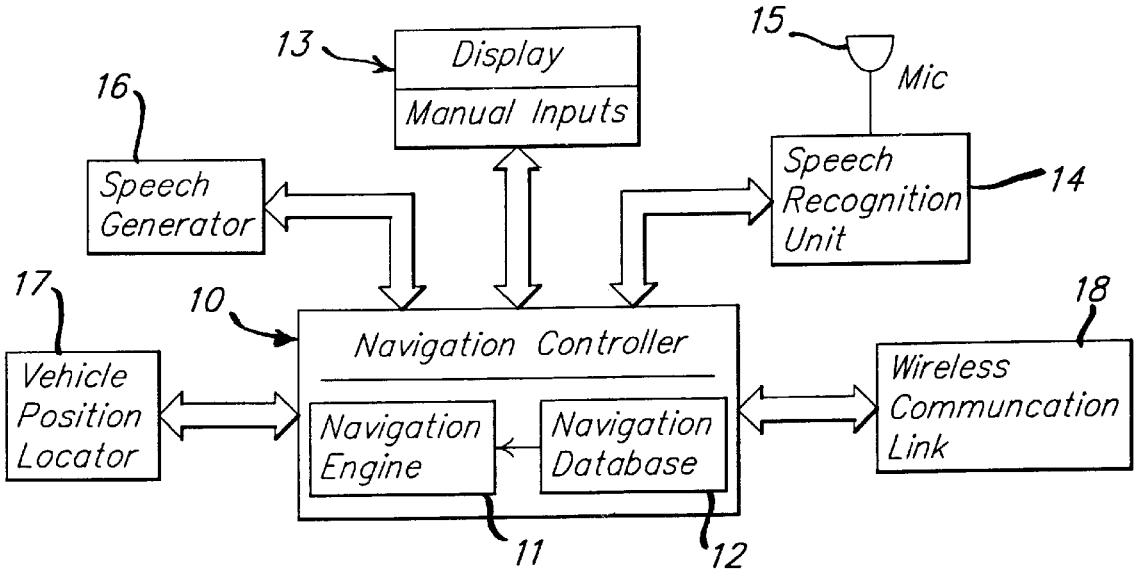
(57) **ABSTRACT**

A navigation system for automotive vehicles generates navigation routes between an initial location and a desired destination using a route criteria including a statistical risk index, such as a CAP crime index score. A user of the navigation system can customize their own desired risk threshold to be used in optimizing the navigation route. A particular route segment with a risk index above a risk threshold can be eliminated from potential routes except when the route segment contains the destination or is a freeway segment. In another embodiment, the weight or cost associated with including a route segment in a navigation route is adjusted according to its statistical risk index.

4 Claims, 3 Drawing Sheets



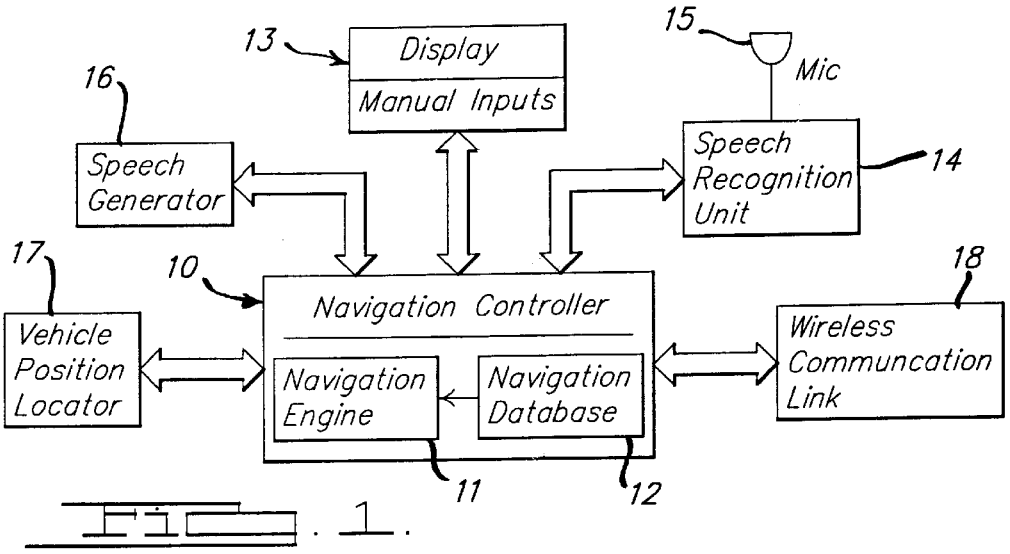


Fig. 1.

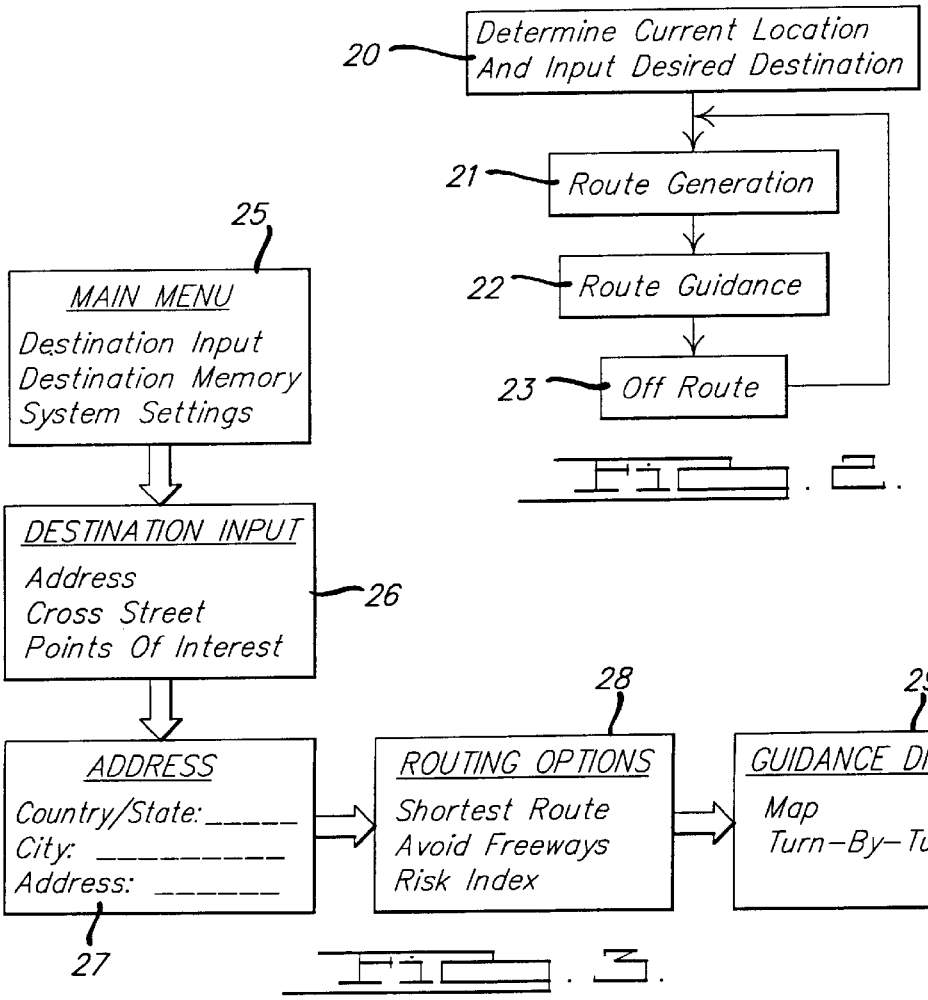


Fig. 2.

Fig. 3.

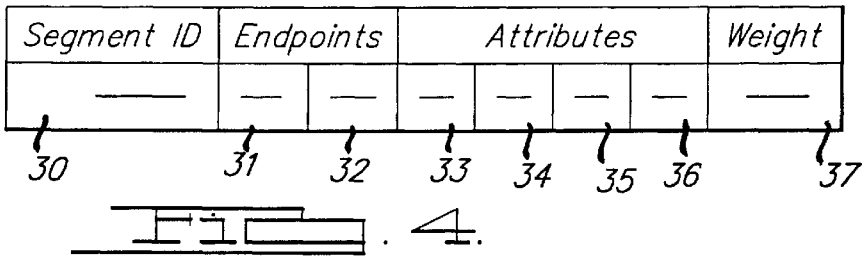
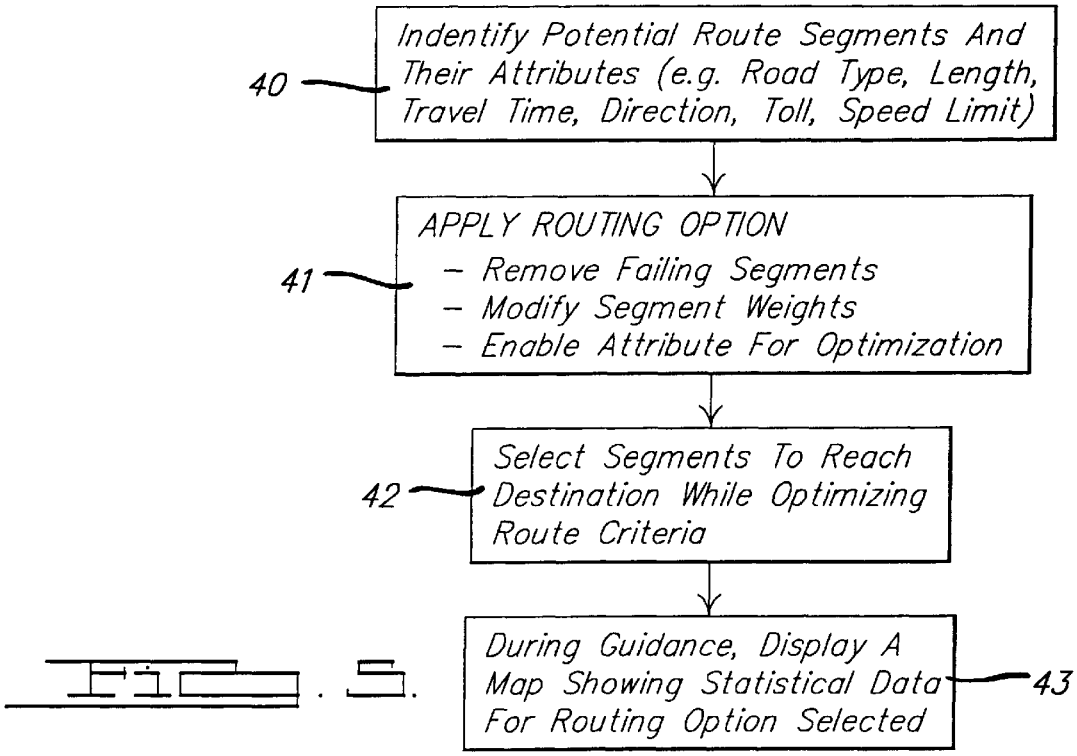


Fig. 4.



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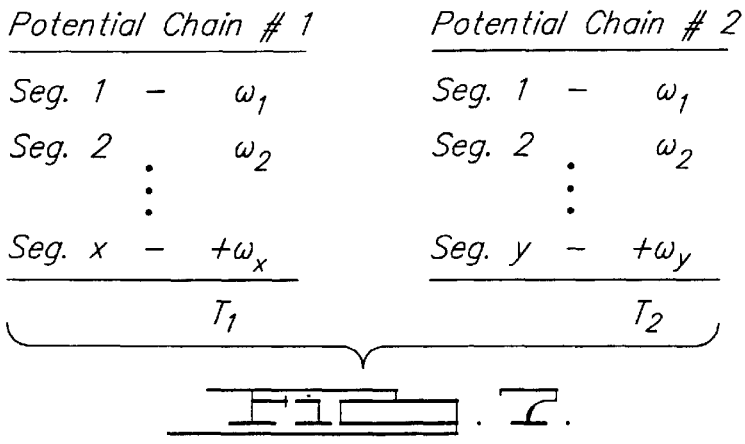

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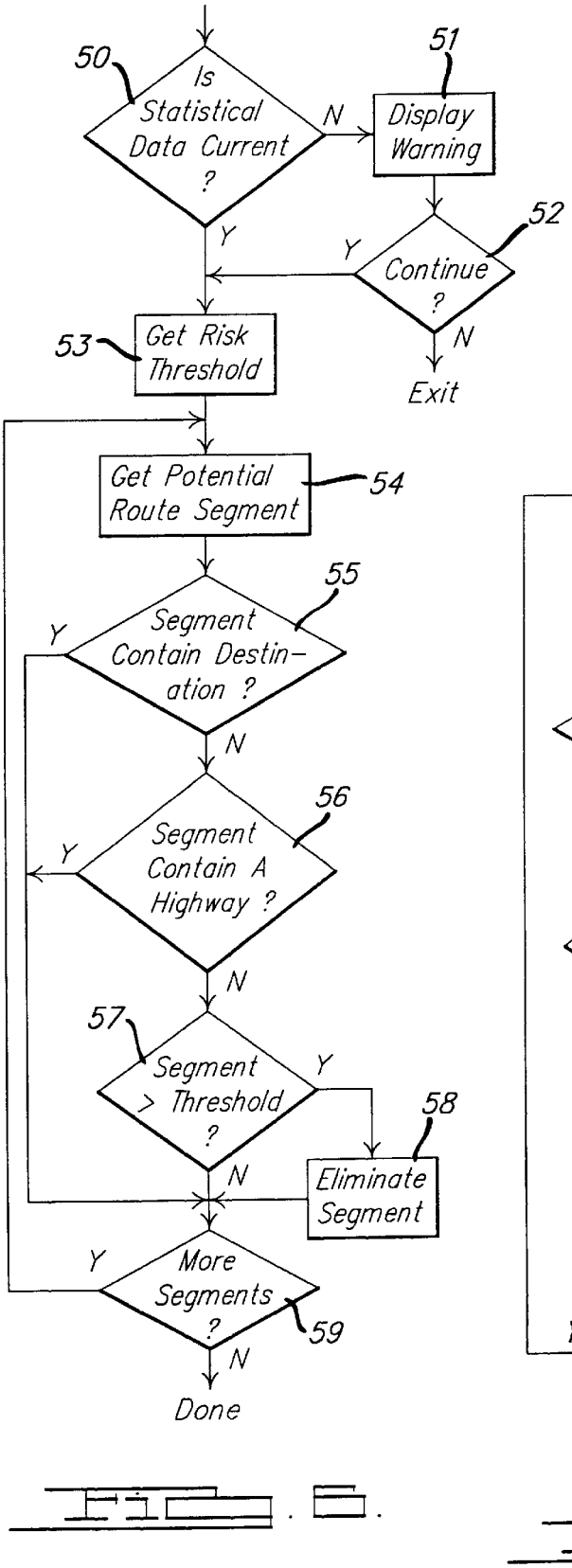

Fig. 3.

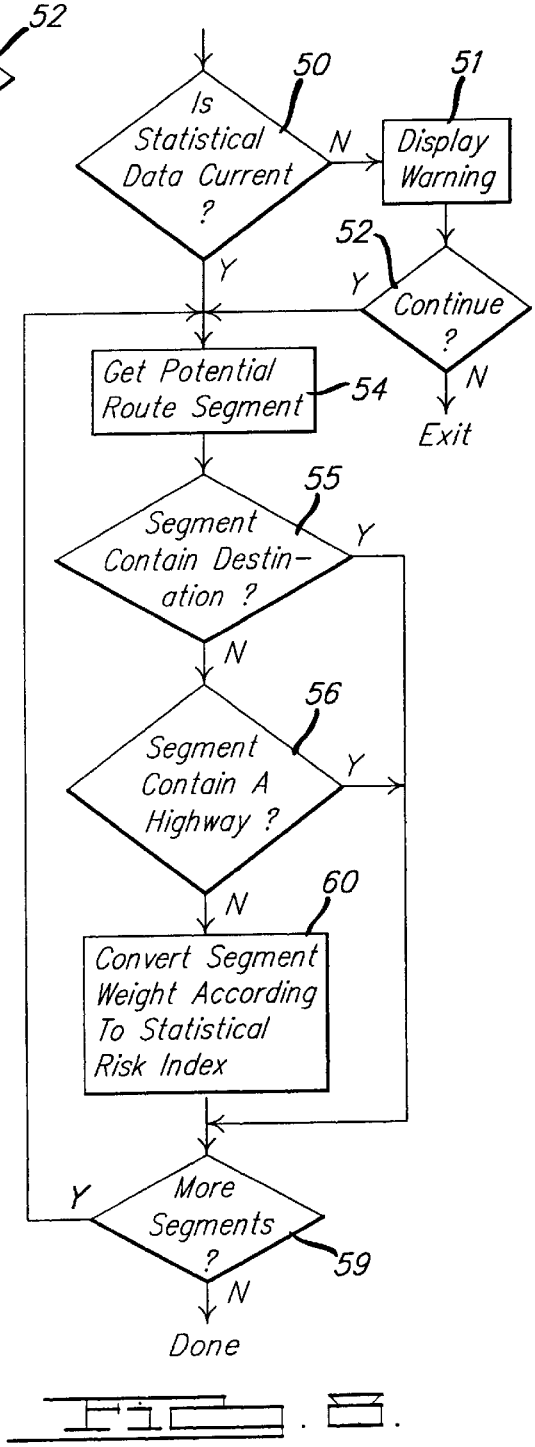

Fig. 4.

VEHICLE NAVIGATION ROUTE GENERATION WITH USER SELECTABLE RISK AVOIDANCE

BACKGROUND OF THE INVENTION

The present invention relates in general to route generation in vehicle navigation systems, and, more specifically, to route selection criteria including user selectable routing options such as a statistical risk index which allows the user to avoid or minimize the corresponding statistical risk along the generated route.

Vehicle navigation systems have become well known wherein a map database is used to provide navigational assistance to the driver of a vehicle. Based upon a current location and a desired destination, a navigation computer generates an optimum route between the two points. The route may then be displayed visually for the driver. Turn-by-turn instructions and/or a description of the route may be given visually and/or aurally.

Various techniques have been developed for constructing a route which is the most desirable according to predetermined optimization criteria. Typically, the map database is comprised of route segments, each segment connecting two endpoints or intersections. One widely used method for determining an optimal route is the Dijkstra method wherein each route segment in the map database has an associated cost or weight. The total weight of various potential routes between the current location and the destination are calculated and compared so that a route may be selected with the lowest overall weight.

In prior art systems, the optimization criteria is typically comprised of either the shortest route or the fastest route. In addition, selections have been provided for avoiding freeways, maximizing use of freeways, or avoiding tollways, for example. Thus, a route segment may have a plurality of weights and/or other attributes associated with it. For example, there may be a distance weight and a travel-time weight associated with a particular route segment. The generated route may be optimized using the various available weights according to the drivers preferred optimization. In addition, many prior art systems allow the driver to specify a specific route segment to be eliminated from consideration for use in a route, such as when a road is closed for construction or there is an error in the database. Nevertheless, drivers have had little control over route optimization criteria or how they are applied.

Navigation systems may be used to help a driver navigate through areas with which they are not familiar. Other than knowing that a route is optimized for distance, time or avoiding freeways or tollways, etc., the user of a prior art navigation system has not known the prevailing risk characteristics of the areas through which the route passes.

SUMMARY OF THE INVENTION

The present invention has the advantage of providing advanced navigation route generation employing route optimization using a statistical risk index. The user may establish a customized risk threshold for their individually optimized navigation route.

In one aspect, the present invention provides a method of generating a navigation route for a motor vehicle wherein the route connects an initial location with a destination. The navigation route includes a plurality of route segments selected from a database of route segments. The database includes respective attributes associated with respective route segments. The attributes include a statistical risk index that has been measured and indexed to respective route segments. A route criteria is established which is to be optimized over the navigation route. The route criteria includes the statistical risk index. Total weights are compared according to the route criteria for various potential navigation routes. The navigation route is selected as one of the potential navigation routes for which the routing criteria is substantially optimized.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram showing elements of a navigation system employing the present invention.

FIG. **2** is a flowchart showing the overall operation of a navigation system which may incorporate the present invention.

FIG. **3** shows successive display menus for controlling a navigation system according to the present invention.

FIG. **4** is a diagram showing the structure of a route segment in a map database.

FIG. **5** is a flowchart showing a method of operation of the present invention.

FIG. **6** is a flowchart showing one embodiment for applying the statistical risk index to route generation according to the present invention.

FIG. **7** shows the total weight comparison for different potential routes.

FIG. **8** is a flowchart showing an embodiment for modifying route segment weights according to the statistical risk index of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows a navigation system for a vehicle including a navigation controller **10** having a navigation engine **11** and a navigation database **12**. A man-machine interface (MMI) **13** includes a visual display, such as an LCD matrix display, and manual inputs, such as push buttons or a keypad. The man-machine interface may also include a speech recognition unit **14** connected to a microphone **15** and to navigation controller **10** for identifying spoken input from a user. A speech generator **16** may also be connected to navigation controller **10** in order to generate audible navigation instructions to the user. A vehicle position locator **17** is coupled to navigation controller **10** for supplying the current vehicle position. Locator **17** may be comprised of a global positioning system (GPS) receiver, vehicle movement sensors, and/or other known vehicle location means. The navigation system may also include a wireless communication link **18** coupled to navigation controller **10** for receiving remotely supplied navigation or traffic data, for example.

An overall method of operation of a navigation system is shown in FIG. **2**. In step **20**, the current vehicle location is determined and a user inputs their desired destination through manual or spoken inputs. A route is generated in step **31** for traveling from the current location to the desired destination. In step **22**, route guidance is provided to the driver so that turning instructions may be followed along the route. During route guidance, the position of the vehicle is monitored to coordinate delivery of turning instructions and for detection of movement off the planned route. If an off-route condition is detected, then an off-route routine is conducted in step **23** which may include recalculation of a new route in step **21**.

A series of display menus is shown in FIG. **3** for utilizing the risk index route generation method of the present inven-

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