

NAVIGATION METHOD AND APPARATUS, ELECTRONIC DEVICE, AND STORAGE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Chinese Patent Application No. 202110338827.3, filed to the China National Intellectual Property Administration on March 30, 2021 and entitled “NAVIGATION METHOD AND APPARATUS, ELECTRONIC DEVICE, AND STORAGE MEDIUM”, the disclosure of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The disclosure relates to the technical field of vehicle navigation, and specifically, to a navigation method and apparatus, an electronic device, and a storage medium.

BACKGROUND

[0003] An unmanned vehicle is also called as an autonomous vehicle, which refers to an automobile that can perceive an ambient environment and drive autonomously without human participation. During the traveling of the unmanned vehicle, it is usually required to rely on a pre-built high-precision map to assist in positioning and navigation. Therefore, how to efficiently determine a navigation route in real time based on the high-precision map has become an urgent problem to be resolved.

SUMMARY

[0004] Embodiments of the disclosure provide at least one navigation solution.

- [0005] According to a first aspect, an embodiment of the disclosure provides a navigation method. The method includes the following operations.
- [0006] A current positioning location and a navigation destination of a target vehicle as well as a navigation line associated with at least one lane on a road from the current positioning location to the navigation destination are acquired. The navigation line is generated in advance.
- [0007] A target navigation line of the target vehicle from the current positioning location to the navigation destination is generated based on the navigation line. The target navigation line is formed by splicing the navigation line of at least one lane.
- [0008] The target vehicle is controlled to travel according to the target navigation line.
- [0009] In the embodiment of the disclosure, the navigation line associated with each lane where the target vehicle travels may be generated in advance. In this way, during the traveling of the target vehicle, the target navigation line from the current positioning location to the navigation destination may be rapidly determined according to the pre-generated navigation line, so that navigation efficiency can be enhanced.
- [0010] In a possible implementation, the navigation line includes a first navigation route configured to guide a traveling path of a vehicle in the lane.
- [0011] The operation of generating the target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line includes the following operations.
- [0012] Based on pre-stored lane connection relationships, a first group of lanes passed through by the target vehicle from the current positioning location to the navigation destination is acquired in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined not to pass through an intersection. The first group of lanes includes at least one lane.
- [0013] The first navigation route corresponding to at least one lane in the first group of lanes is extracted.

[0014] The first navigation routes respectively corresponding to the first group of lanes are spliced in an order from the current positioning location to the navigation destination, to obtain the target navigation line.

[0015] In the embodiment of the disclosure, in the case that the target vehicle is determined not to pass through the intersection in a process of reaching the navigation destination from the current positioning location, the first navigation routes respectively corresponding to at least one lane passed through may be successively connected, so as to rapidly obtain the target navigation line configured to indicate that the target vehicle reaches the navigation destination from the current positioning location.

[0016] In a possible implementation, the navigation line further includes a second navigation route corresponding to an intersection connected to the lane. The second navigation route is configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection.

[0017] The operation of generating the target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line includes the following operations.

[0018] Based on the pre-stored lane connection relationships, a second group of lanes passed through by the target vehicle from the current positioning location to the navigation destination and a first intersection set passed through are acquired, in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined to pass through an intersection. The second group of lanes includes at least two lanes, and the first intersection set includes at least one intersection.

[0019] The first navigation route corresponding to at least one lane in the second group of lanes and the second navigation route corresponding to at least one intersection in the first intersection set are extracted.

[0020] The first navigation routes respectively corresponding to the second group of lanes and the second navigation routes respectively corresponding to the intersection set are spliced in the order from the current positioning location to the navigation destination,

to obtain the target navigation line.

[0021] In the embodiment of the disclosure, in the case that the target vehicle is determined to pass through the intersection in the process of reaching the navigation destination from the current positioning location, the first navigation routes respectively corresponding to at least one lane passed through and the second navigation routes respectively corresponding to at least one intersection may be successively connected, so as to rapidly obtain the target navigation line configured to indicate that the target vehicle reaches the navigation destination from the current positioning location.

[0022] In a possible implementation, the operation of generating the target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line includes the following operations.

[0023] Intersection information about the road from the current positioning location to the navigation destination is acquired.

[0024] The road is divided into a plurality of road segments according to the intersection information.

[0025] A target navigation sub-line of at least one of the plurality of road segments is determined based on the navigation line.

[0026] The target navigation sub-lines are spliced to obtain the target navigation line.

[0027] In the embodiment of the disclosure, the road may be segmented according to the intersection information about intersections included in the road from the current positioning location to the navigation destination. In this way, the target navigation line configured to indicate that the target vehicle reaches the navigation destination from the current positioning location may be further rapidly obtained based on the target navigation sub-line of each road segment.

[0028] In a possible implementation, the navigation line includes a first navigation route configured to guide a traveling path of a vehicle in the lane and a second navigation route corresponding to an intersection connected to the lane. The second navigation route

is configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection.

[0029] The plurality of road segments include at least one first road segment, and the first road segment passes through at least one intersection.

[0030] The operation of determining the target navigation sub-line of at least one of the plurality of road segments based on the navigation line includes, for the at least one first road segment, the following operations.

[0031] A third group of lanes and a second intersection set in the first road segment are determined. The third group of lanes includes at least two lanes, and the second intersection set includes at least one intersection.

[0032] The second navigation route corresponding to at least one intersection of the second intersection set and the first navigation routes of target lanes indicated and connected by the second navigation route in the third group of lanes are extracted.

[0033] The first navigation routes of the target lanes and the second navigation route corresponding to at least one intersection in the second intersection set are spliced according to a passing order in the first road segment, to obtain the target navigation sub-line of the first road segment.

[0034] In the embodiment of the disclosure, in a process of determining the target navigation sub-line of each first road segment to pass through at least one intersection, the target navigation sub-line for guiding the target vehicle to pass through the first road segment may be rapidly determined according to the second navigation route corresponding to each intersection included in the first road segment and the first navigation routes indicated and connected by the second navigation route in the third group of lanes included in the first road segment.

[0035] In a possible implementation, the plurality of road segments further include at least one second road segment, and the second road segment does not pass through an intersection.

[0036] The operation of determining the target navigation sub-line of at least one of the plurality of road segments based on the navigation line includes, for the at least one second road segment, the following operations.

[0037] A start lane and an end lane in the second road segment are determined based on the target navigation sub-line of the first road segment connected to the second road segment.

[0038] Based on pre-stored lane connection relationships, a first navigation route corresponding to at least one lane in the second road segment from the start lane to the end lane is extracted.

[0039] The first navigation route corresponding to at least one lane in the second road segment from the start lane to the end lane is spliced according to a passing order in the second road segment, to obtain the target navigation sub-line of the second road segment.

[0040] In the embodiment of the disclosure, in a process of determining the target navigation sub-line of each second road segment not passing through the intersection, the start lane and the end lane in the second road segment may be determined according to the target navigation sub-line of the first road segment connected to the second road segment, and based on the pre-stored lane connection relationships, the first navigation route of each lane in the second road segment from the start lane to the end lane may be further spliced according to the passing order, so that the target navigation sub-line for guiding the target vehicle to pass through the second road segment is rapidly determined.

[0041] In a possible implementation, the first navigation route is generated in advance according to the following steps.

[0042] For any lane in a road scenario, a plurality of location points are respectively extracted from lane lines indicating boundaries on two sides of the lane and corresponding to the lane, to form a plurality of location point pairs.

[0043] Geographical locations of a plurality of center location points of the lane in the road scenario are determined based on geographical locations of the plurality of location point pairs in the road scenario. Each location point pair corresponds to one center

location point.

[0044] A first navigation route corresponding to the lane is determined based on the geographical locations of the plurality of center location points in the road scenario.

[0045] In a possible implementation, the operation of respectively extracting the plurality of location points from the lane lines indicating the boundaries on the two sides of the lane and corresponding to the lane, to form the plurality of location point pairs includes the following operations.

[0046] Lengths of the two lane lines included in the lane in the road scenario are acquired.

[0047] The number of the plurality of location points is determined based on the length of the longest lane line of the two lane lines included in the lane.

[0048] Based on the number of the plurality of location points, the plurality of location points are respectively extracted from the two lane lines included in the lane according to an interpolation manner.

[0049] The plurality of location points on at least one lane line included in the lane are sorted in a traveling direction of the lane, and then two location points having a same serial number in different lane lines are formed into one location point pair.

[0050] In the embodiment of the disclosure, the number of the location points is determined by means of the length of the longest lane line in the two lane lines included in the lane, and the location point pairs matching the shape of the lane may be obtained, so that the center location point with higher accuracy is obtained.

[0051] In a possible implementation, the operation of determining the geographical locations of the plurality of center location points of the lane in the road scenario based on the geographical locations of the plurality of location point pairs in the road scenario includes the following operations.

[0052] For at least one location point pair, a geographical location of a center location point of a connection line of the location point pair in the road scenario is determined

based on the geographical location of at least one location point in the location point pair in the road scenario.

[0053] In a possible implementation, the operation of determining the first navigation route corresponding to the lane based on the geographical locations of the plurality of center location points in the road scenario includes the following operations.

[0054] Curve fitting is performed on the plurality of center location points based on the geographical locations of the plurality of center location points in the road scenario, to obtain a first fitting curve.

[0055] A plurality of points on the first fitting curve are extracted according to a preset interval, and geographical locations of the plurality of points extracted on the first fitting curve in the road scenario are acquired.

[0056] The geographical locations of the plurality of points extracted on the first fitting curve in the road scenario are used as a traveling trajectory of the first navigation route corresponding to the lane.

[0057] In the embodiment of the disclosure, a center line of the lane may be first obtained by fitting the plurality of center location points of the lane. Then, the plurality of points are further extracted on the center line. In this way, a traveling trajectory configured to guide the target vehicle to travel in a same lane may be accurately obtained.

[0058] In a possible implementation, lanes of different road connected to the same intersection include a first lane and a second lane. The second navigation route is generated according to the following steps.

[0059] A first center location point passed through during traveling into the intersection from the first lane and a second center location point passed through during traveling into the second lane from the intersection are respectively acquired. The first center location point is a last one of center location points on the first lane, and the second center location point is a first one of center location points on the second lane.

[0060] A first direction vector for characterizing the traveling into the intersection

from the first lane is determined based on geographical locations respectively corresponding to two adjacent center location points on the first lane including the first center location point, and a second direction vector for characterizing the traveling into the second lane from the intersection is determined based on geographical locations respectively corresponding to two adjacent center location points on the second lane including the second center location point.

[0061] A traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane is determined based on the first center location point, the second center location point, the first direction vector and the second direction vector.

[0062] In the embodiment of the disclosure, before the second navigation route is determined, a start location and an end location of the target vehicle at the intersection, in which direction to traveling into the intersection from the start location, and in which direction to traveling into a destination from the intersection are planned. Through such a method, the traveling trajectory of the second navigation route with higher accuracy may be obtained.

[0063] In a possible implementation, the operation of determining the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the first center location point, the second center location point, the first direction vector and the second direction vector includes the following operations.

[0064] A steering angle for traveling into the second lane from the first lane is determined based on the first direction vector and the second direction vector.

[0065] A plurality of target control points configured to control a shape of the second navigation route is determined based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector.

[0066] The traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane is determined based on the plurality of target control points.

[0067] In the embodiment of the disclosure, it is proposed that, when the second navigation route is determined, the plurality of target control points configured to control the shape of the second navigation route may be first determined through the steering angle for traveling from the first lane to the second lane, the first center location point, the second center location point, the first direction vector, and the second direction vector, so that the traveling trajectory of the second navigation route with higher accuracy is obtained.

[0068] In a possible implementation, the operation of determining the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector includes the following operations.

[0069] A center point of a connection line between the first center location point and the second center location point and a first distance between the first center location point and the second center location point are determined, in a case where the steering angle is less than a preset angle.

[0070] A first target point that is obtained after an extension by a preset multiple of the first distance is made from the first center location point in a direction indicated by the first direction vector is acquired.

[0071] A second target point that is obtained after an extension by the preset multiple of the first distance is made from the second center location point in a direction indicated by a vector opposite to the second direction vector is acquired.

[0072] The plurality of target control points are formed by the first center location point, the first target point, the center point of the connection line between the first center location point and the second center location point, the second target point, and the second center location point.

[0073] In the embodiment of the disclosure, it is proposed that, in a case where the steering angle between the two lanes is less than the preset angle, the second navigation route corresponding to the two lanes at the intersection may be rapidly determined based on the first center location point, the second center location point, the first direction

vector and the second direction vector.

[0074] In a possible implementation, the operation of determining the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector includes the following operations.

[0075] A first safe obstacle-avoidance distance of the target vehicle traveling into the intersection from the first lane is determined based on size information of the target vehicle and an obstacle area corresponding to the first lane, in a case where the steering angle is greater than or equal to the preset angle.

[0076] A second safe obstacle-avoidance distance of the target vehicle traveling into the second lane from the intersection is determined based on the size information of the target vehicle and an obstacle area corresponding to the second lane.

[0077] The plurality of target control points are determined based on the first center location point, the second center location point, an intersection point of the first direction vector and the second direction vector, the first safe obstacle-avoidance distance and the second safe obstacle-avoidance distance.

[0078] In the embodiment of the disclosure, in a process of determining the second navigation route corresponding to large angle steering, a start point and an end point during the traveling of the target vehicle at the intersection and an obstacle-avoidance distance are required to be considered, to enhance the safety during the traveling of the target vehicle at the intersection.

[0079] In a possible implementation, the operation of determining the plurality of target control points based on the first center location point, the second center location point, the intersection point of the first direction vector and the second direction vector, the first safe obstacle-avoidance distance and the second safe obstacle-avoidance distance includes the following operations.

[0080] A third target point that is obtained after an extension by the first safe obstacle-avoidance distance is made from the first center location point in a direction indicated by

the first direction vector is acquired.

[0081] A fourth target point that is obtained after an extension by the second safe obstacle-avoidance distance is made from the second center location point in a direction indicated by a vector opposite to the second direction vector is acquired.

[0082] A plurality of other target points in addition to the third target point and the fourth target point are determined based on the third target point, the fourth target point, and the intersection point.

[0083] The plurality of target control points are formed by the third target point, the plurality of other target points that are determined, and the fourth target point.

[0084] In a possible implementation, the operation of determining the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the plurality of target control points includes the following operations.

[0085] A second fitting curve at the intersection during the traveling into the second lane from the first lane is determined based on the plurality of target control points.

[0086] A plurality of points on the second fitting curve are extracted according to a preset interval, and geographical locations of the plurality of points extracted on the second fitting curve in a road scenario are acquired.

[0087] The geographical locations of the plurality of points extracted on the second fitting curve in the road scenario are used as a traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane.

[0088] In the embodiment of the disclosure, the traveling trajectory configured to guide the target vehicle to travel at the intersection may be accurately obtained by means of the planned second navigation route configured to indicate the traveling of the target vehicle at the intersection and the geographical locations of the plurality of points in the second navigation route in the road scenario.

- [0089] In a possible implementation, the operation of controlling the target vehicle to travel according to the target navigation line includes the following operations.
- [0090] A geographical location of an obstacle in the road scenario is acquired in a case where the obstacle is detected during the traveling of the target vehicle according to the target navigation line.
- [0091] The target navigation line is adjusted based on the geographical location of the obstacle to control the target vehicle to bypass the obstacle, in a process of controlling the target vehicle to travel according to the target navigation line.
- [0092] In the embodiment of the disclosure, in the process of controlling the target vehicle to travel according to the target navigation line, if a dynamic obstacle is detected, obstacle avoidance may be performed based on the geographical location of the dynamic obstacle in the road scenario, so that traveling safety can be enhanced.
- [0093] According to a second aspect, an embodiment of the disclosure provides a navigation apparatus. The apparatus includes an acquisition module, a generation module, and a control module.
- [0094] The acquisition module is configured to acquire a current positioning location and a navigation destination of a target vehicle as well as a navigation line associated with at least one lane on a road from the current positioning location to the navigation destination. The navigation line is generated in advance.
- [0095] The generation module is configured to generate a target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line. The target navigation line is formed by splicing the navigation line of at least one lane.
- [0096] The control module is configured to control the target vehicle to travel according to the target navigation line.
- [0097] According to a third aspect, an embodiment of the disclosure provides an electronic device. The electronic device includes a processor, a memory and a bus. The

memory stores machine-readable instructions executable by the processor. When the electronic device is operated, the processor communicates with the memory by using the bus. Steps of the navigation method described in the first aspect are performed when the machine-readable instructions are executed by the processor.

[0098] According to a fourth aspect, an embodiment of the disclosure provides a computer-readable storage medium. The computer-readable storage medium stores a computer program. When the computer program is executed by a processor, steps of the navigation method described in the first aspect are performed.

[0099] According to a fifth aspect, an embodiment of the disclosure provides a computer program product. The computer program product includes computer-readable codes or a non-volatile computer readable storage medium carrying the computer-readable codes. When the computer-readable codes are operated in a processor of an electronic device, the processor of the electronic device performs steps of the navigation method described in the first aspect.

[00100] In order to make the above purposes, features and advantages of the disclosure more obvious and easy to understand, detailed descriptions of preferred embodiments are made below with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[00101] In order to more clearly explain the technical solutions of the embodiments of the disclosure, the drawings used in the embodiments will be briefly introduced below. The drawings herein are incorporated into and constitute a part of the specification, which illustrate embodiments in accordance with the disclosure and together with the specification are used to explain the technical solutions of the disclosure. It is to be understood that the following drawings only illustrate some embodiments of the disclosure, which therefore should not be regarded as limitations to the scope. For those of ordinary skill in the art, other related drawings may also be obtained in accordance with these drawings without creative efforts.

- [00102] FIG. 1 is a flowchart of a navigation method according to an embodiment of the disclosure.
- [00103] FIG. 2 is a schematic scenario diagram of an intersection in a road scenario according to an embodiment of the disclosure.
- [00104] FIG. 3 is a flowchart of a method for determining a first navigation route corresponding to a lane according to an embodiment of the disclosure.
- [00105] FIG. 4 is a schematic diagram of a first navigation route corresponding to a lane according to an embodiment of the disclosure.
- [00106] FIG. 5 is a flowchart of a method for determining a second navigation route according to an embodiment of the disclosure.
- [00107] FIG. 6 is a flowchart of a specific method for determining a second navigation route according to an embodiment of the disclosure.
- [00108] FIG. 7 is a flowchart of a method for controlling a target vehicle to travel according to an embodiment of the disclosure.
- [00109] FIG. 8 is a schematic structural diagram of a navigation apparatus according to an embodiment of the disclosure.
- [00110] FIG. 9 is a schematic diagram of an electronic device according to an embodiment of the disclosure.

DETAILED DESCRIPTION

- [00111] In order to make objectives, technical solutions, and advantages of embodiments of the disclosure clearer, the technical solutions in the embodiments of the disclosure will be clearly and completely described below in combination with the drawings in the embodiments of the disclosure. It is apparent that the described embodiments are only part of the embodiments of the disclosure, not all the embodiments. Components of the embodiments of the disclosure generally described and illustrated

here in the drawings may be arranged and designed in various different configurations. Therefore, the following detailed descriptions of the embodiments of the disclosure provided in the drawings are not intended to limit the scope of the claimed disclosure, but only represent selected embodiments of the disclosure. All other embodiments obtained by those skilled in the art based on the embodiments of the disclosure without creative efforts shall fall within the protection scope of the disclosure.

[00112] It is to be noted that similar numbers and letters indicate similar items in the following drawings, so once a certain item is defined in one drawing, no further definitions and explanations are required for same in the subsequent drawings.

[00113] The term "and/or" is merely an association relationship, which means that there may be three relationships, for example, A and/or B may indicate three cases: A exists alone, A and B exist simultaneously, and B exists alone. In addition, the term "at least one" herein refers to any combination of any of a plurality or at least two of a plurality, for example, including at least one of A, B, or C may indicate including any one or more elements selected from a set composed of A, B, and C.

[00114] In a process of autonomous traveling in a road scenario, an unmanned vehicle needs to determine a navigation route to a navigation destination in real time based on collected road scenario images and a connection relationship among various roads in a pre-built road scenario map, resulting in low efficiency of the process.

[00115] Based on the above research, the disclosure provides a navigation method. A navigation line associated with each lane where the target vehicle travels may be generated in advance. In this way, during the traveling of the target vehicle, the target navigation line from the current positioning location to the navigation destination may be rapidly determined according to the pre-generated navigation line, so that navigation efficiency can be enhanced.

[00116] For ease of understanding of the embodiment, the navigation method disclosed in the embodiment of the disclosure is first described in detail. An executive body of the navigation method provided in the embodiment of the disclosure is generally a computer device having a certain computing capability. The computer device includes, for example,

a terminal device or a server or other processing devices. The terminal device may be User Equipment (UE), a mobile device, a user terminal, a terminal, computing device, a vehicle-mounted device, a wearable device, or the like. In some possible implementations, the navigation method may be implemented in a manner that a processor calls a computer-readable instruction stored in a memory.

[00117] Referring to FIG. 1, a flowchart of a navigation method according to an embodiment of the disclosure, the navigation method includes the following steps S101 to S103.

[00118] At S101, a current positioning location and a navigation destination of a target vehicle as well as a navigation line associated with at least one lane on a road from the current positioning location to the navigation destination are acquired. The navigation line is generated in advance.

[00119] Exemplarily, the target vehicle may include an unmanned vehicle. A plurality of positioning sensors may be arranged on the target vehicle. For example, a combined navigation device consisting of an Inertial Measurement Unit (IMU) and a Global Positioning System (GPS) may be mounted, which may determine a current positioning location of the target vehicle.

[00120] Exemplarily, a collecting device may further be arranged on the target vehicle, for example, may be a monocular camera arranged on the target vehicle, and is configured to shoot during the traveling of the target vehicle. A shooting direction may be preset. Based on a shot road scenario image, the current positioning location of the target vehicle may be acquired by using a visual positioning technology.

[00121] Exemplarily, the navigation line may be formed a plurality of trajectory points configured to navigate the target vehicle. Each trajectory point corresponds to a unique identification code and geographical location information of the trajectory point in the road scenario. The target vehicle may travel according to the geographical locations of the trajectory points provided in the navigation line during the traveling in the road scenario, until the target vehicle reaches the navigation destination.

[00122] At S102, a target navigation line of the target vehicle from the current

positioning location to the navigation destination is generated based on the navigation line. The target navigation line is formed by splicing the navigation line of at least one lane.

[00123] Exemplarily, in a case where the current positioning location and the navigation destination are located in a same lane, the target navigation line of the target vehicle from the current positioning location to the navigation destination may be determined based on the pre-planned navigation line in the same lane. In a case where the current positioning location and the navigation destination are located in different lanes and need to pass through intersections, the target navigation line of the target vehicle from the current positioning location to the navigation destination may be determined based on the pre-planned navigation line respectively corresponding to different lanes and the navigation line connected to different lanes.

[00124] Exemplarily, the target navigation line may include the geographical locations of the plurality of trajectory points in the road scenario. In this way, the target vehicle may reach the destination from the current positioning location by traveling according to the geographical locations corresponding to the plurality of trajectory points in the target navigation line.

[00125] At S103, the target vehicle is controlled to travel according to the target navigation line.

[00126] Exemplarily, after the target navigation line is determined, the target vehicle may be controlled to travel according to the geographical locations where the trajectory points are located in the target navigation line, until the target vehicle reaches the navigation destination.

[00127] In the embodiment of the disclosure, the navigation line associated with each lane where the target vehicle travels may be generated in advance. In this way, during the traveling of the target vehicle, the target navigation line from the current positioning location to the navigation destination may be rapidly determined according to the pre-generated navigation line, so that navigation efficiency can be enhanced.

[00128] Steps S101 to S103 are described below with reference to specific

embodiments.

[00129] In a possible implementation, the navigation line includes a first navigation route configured to guide a traveling path of a vehicle in a lane. For S102, an optional implementation of generating the target navigation line of the target vehicle from the current positioning location and the navigation destination based on the navigation line includes steps S1021 to S1023.

[00130] At S1021, based on pre-stored lane connection relationships, a first group of lanes passed through by the target vehicle from the current positioning location to the navigation destination is acquired in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined not to pass through an intersection. The first group of lanes includes at least one lane.

[00131] Exemplarily, the lane connection relationships stored in a road scenario map corresponding to the road scenario include a predecessor lane and a successor lane of each lane. The target vehicle can travel into the lane from the predecessor lane and travel into the successor lane from the lane. Therefore, a first group of lanes through which the target vehicle needs to pass from the current positioning location to the navigation destination is determined based on a current lane, a target lane, and the lane connection relationships stored in the road scenario map.

[00132] Exemplarily, for example, a lane of the current positioning location is a lane S1, and the successor lane of the lane S1 includes a lane S2. Only the successor lane S3 of the lane S2 includes the navigation destination. Therefore, the first group of lanes through which the target vehicle passes from the current positioning location to the navigation destination includes the lane S1, the lane S2, and the lane S3.

[00133] At S1022, the first navigation route corresponding to each lane in the first group of lanes is extracted.

[00134] Exemplarily, by using a lane as an example, the pre-generated first navigation route of the lane may include N trajectory points. N trajectory points may be successively coded according to a traveling direction of the lane, to obtain a unique identification code of each trajectory point. The identification codes of the trajectory points and the

geographical locations in the road scenario are associated and stored. For example, the target vehicle travels on an east-west lane. Assuming that the current positioning location of the target vehicle matches one of the trajectory points A in the lane, the target vehicle may be indicated that how to travel in the road from the trajectory point A according to the geographical locations of the trajectory points in N trajectory points included in the first navigation route of the lane and a sequence of the trajectory points. For example, according to the traveling direction of the lane, a next trajectory point of the trajectory point A is a trajectory point B, and then a traveling trajectory of the target vehicle on the lane is from the trajectory point A to the trajectory point B. A process of determining the first navigation route is described below.

[00135] At S1023, the first navigation routes respectively corresponding to the first group of lanes are spliced in an order from the current positioning location to the navigation destination, to obtain the target navigation line.

[00136] Exemplarily, when traveling on the lane S1, the lane S2, and the lane S3, the target vehicle may travel according to traveling paths indicated by the respective first navigation routes on the lane S1, the lane S2, and the lane S3. In an order from the current positioning location to the navigation destination, the first navigation routes may be spliced, so that the target navigation line configured to indicate that the target vehicle reaches the navigation destination from the current positioning location may be obtained.

[00137] In the embodiment of the disclosure, in the case that the target vehicle is determined not to pass through the intersection in a process of reaching the navigation destination from the current positioning location, the first navigation routes respectively corresponding to at least one lane passed through may be successively connected, so as to rapidly obtain the target navigation line configured to indicate that the target vehicle reaches the navigation destination from the current positioning location.

[00138] In a possible implementation, the navigation line further includes a second navigation route corresponding to the intersection connected to the lane. The second navigation route is configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection. For S102, the optional implementation of generating the target navigation line of the target vehicle

from the current positioning location and the navigation destination based on the navigation line further includes steps S1024 to S1026.

[00139] At S1024, based on the pre-stored lane connection relationships, a second group of lanes passed through by the target vehicle from the current positioning location to the navigation destination and a first intersection set passed through are acquired, in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined to pass through an intersection. The second group of lanes includes at least two lanes, and the first intersection set includes at least one intersection.

[00140] Exemplarily, during the traveling of the target vehicle in the road scenario, In many cases, it is necessary to travel through different roads. For example, it is necessary to travel from a first road to a second road, and the first road 1 is connected to the second road 2 through the intersection shown in FIG. 2. In a case where the target vehicle needs to travel from a lane 11 in the first road 1 to a lane 21 in the second road 2 when reaching the navigation destination, the intersection connected to the lane 11 and the lane 21 needs to be passed through. In this way, the second navigation route among the lanes of different roads connected to a same intersection may be generated in advance. For example, as shown in FIG. 2, the second navigation route of the traveling path at the intersection during the traveling into the lane 21 from the lane 11 is generated. Herein, a lane traveling into the intersection may be called as the first lane, and a lane into which is traveled from the intersection is called as the second lane. That is to say, the lane 11 here is called as the first lane, and the lane 21 is called as the second lane.

[00141] Exemplarily, similar to the first navigation route, the second navigation route also includes a plurality of trajectory points. The plurality of trajectory points may be coded according to a traveling order of the target vehicle among the lanes of different roads, to obtain a unique identification code corresponding to each trajectory point in the second navigation route and geographical location information of the trajectory point in the road scenario. For example, as shown in FIG. 2, if the lane 11 is an exit lane and the lane 21 is an entry lane, the plurality of trajectory points in the generated second navigation route connecting the lane 11 and the lane 21 may be successively coded in a

direction from the lane 11 to the lane 21. The geographical location information of the trajectory points in the road scenario is stored. In this way, during the traveling of the target vehicle from the lane 11 to the lane 21, safe traveling may be achieved according to the geographical locations indicated by the trajectory points in the second navigation route.

[00142] At S1025, the first navigation route corresponding to each lane in the second group of lanes and the second navigation route corresponding to each intersection in the first intersection set are extracted.

[00143] At S1026, the first navigation routes respectively corresponding to the second group of lanes and the second navigation routes respectively corresponding to the intersection set are spliced in the order from the current positioning location to the navigation destination, to obtain the target navigation line.

[00144] Exemplarily, in a case where the target vehicle needs to switch lanes, if the intersection shown in FIG. 2 between a next lane required to be switched and a current lane is required to be passed through, the target vehicle may travel according to the traveling trajectory of the second navigation route corresponding to the intersection when traveling into the next lane from the current lane. If the intersection is not required to be switched, for example, a distance between the two lanes is very close, the lanes may be switched according to a last trajectory point in the first navigation route of the current lane and a first trajectory point in the first navigation route of the next lane.

[00145] In the embodiment of the disclosure, in the case that the target vehicle is determined to pass through the intersection in the process of reaching the navigation destination from the current positioning location, the first navigation routes respectively corresponding to at least one lane passed through and the second navigation routes respectively corresponding to at least one intersection may be successively connected, so as to rapidly obtain the target navigation line configured to indicate that the target vehicle reaches the navigation destination from the current positioning location.

[00146] In another implementation, for S102, the optional implementation of generating the target navigation line of the target vehicle from the current positioning

location and the navigation destination based on the navigation line includes steps S1027 to S1030.

[00147] At S1027, intersection information about the road from the current positioning location to the navigation destination is acquired.

[00148] Exemplarily, the intersection information may include the number of intersections and a pre-stored ID of each intersection, which may be specifically determined according to the pre-stored lane connection relationships. For example, the intersections included in a road from the current positioning location to the navigation destination are determined according to the pre-stored lane connection relationships.

[00149] At S1028, the road is divided into a plurality of road segments according to the intersection information.

[00150] Exemplarily, according to the intersections included in the road from the current positioning location to the navigation destination, the road from the current positioning location to the navigation destination is divided into a plurality of road segments. The plurality of divided road segments have first road segments including the intersections and second road segments excluding the intersections.

[00151] At S1029, a target navigation sub-line of each of the plurality of road segments is determined based on the navigation line.

[00152] Exemplarily, the target navigation sub-line of each road segment may be determined according to types of the road segments, for example, the foregoing first road segment and the second road segment. The target navigation sub-line of each road segment is configured to guide the vehicle to move from a start location of the road segment to an end location of the road segment.

[00153] At S1030, the target navigation sub-lines are spliced to obtain the target navigation line.

[00154] Exemplarily, after being obtained, each target navigation sub-line may be spliced according to the traveling order to obtain the target navigation line.

[00155] In the embodiment of the disclosure, the road may be segmented according to the intersection information about intersections included in the road from the current positioning location to the navigation destination. In this way, the target navigation line configured to indicate that the target vehicle reaches the navigation destination from the current positioning location may be further rapidly obtained based on the target navigation sub-line of each road segment.

[00156] Specifically, the navigation line includes a first navigation route configured to guide a traveling path of a vehicle in the lane and a second navigation route corresponding to an intersection connected to the lane. The second navigation route is configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection.

[00157] The plurality of road segments include at least one first road segment, and the first road segment passes through at least one intersection.

[00158] An optional implementation of determining the target navigation sub-line of each of the plurality of road segments based on the navigation line includes, for each first road segment, the following steps.

[00159] At S10291, a third group of lanes and a second intersection set in the first road segment are determined. The third group of lanes includes at least two lanes, and the second intersection set includes at least one intersection.

[00160] Exemplarily, for S1028, after the road is divided into the plurality of road segments according to the intersection information, for one of the first road segments including at least one intersection, lanes and intersections included in the first road segment may be determined based on the road scenario map corresponding to the road scenario.

[00161] At S10292, the second navigation route corresponding to each intersection of the second intersection set and the first navigation routes of target lanes indicated and connected by the second navigation route in the third group of lanes are extracted.

[00162] Exemplarily, for each intersection in the first road segment, the pre-generated

second navigation route corresponding to the intersection and the first navigation routes of the target lanes indicated and connected by the second navigation route in the third group of lanes may be extracted. For example, for the intersection shown in FIG. 2, the second navigation route P1P2 configured to guide the vehicle to travel from the lane 11 to the lane 21 in the intersection and the first navigation routes (not shown in FIG. 2) respectively corresponding to a target lane 11 and a target lane 21 that are connected by the second navigation route P1P2 in the third group of lanes may be extracted.

[00163] At S10293, the first navigation route of the target lane and the second navigation route corresponding to each intersection in the second intersection set are spliced according to a passing order in the first road segment, to obtain the target navigation sub-line of the first road segment.

[00164] Exemplarily, the passing order is a traveling order of the vehicle on the first road segment from the current positioning location to the navigation destination. For example, in a case where the passing order is from the lane 11 to the lane 21, a splicing manner is to splice the first navigation route corresponding to the target lane 11 and the second navigation route P1P2, the second navigation route P1P2 is spliced with the first navigation route corresponding to the target lane 21, and then the target navigation sub-line of the first road segment is obtained.

[00165] In the embodiment of the disclosure, in a process of determining the target navigation sub-line of each first road segment to pass through at least one intersection, the target navigation sub-line for guiding the target vehicle to pass through the first road segment may be rapidly determined according to the second navigation route corresponding to each intersection included in the first road segment and the first navigation routes indicated and connected by the second navigation route in the third group of lanes included in the first road segment.

[00166] In another implementation, the plurality of road segments further include at least one second road segment, and the second road segment does not pass through an intersection. The operation of determining the target navigation sub-line of each of the plurality of road segments based on the navigation line includes, for each second road segment, the following steps.

[00167] At S10294, a start lane and an end lane in the second road segment are determined based on the target navigation sub-line of the first road segment connected to the second road segment.

[00168] Exemplarily, a lane where the end location of the target navigation sub-line of the last first road segment connected to the second road segment is located may be used as a start lane of the second road segment. A lane where the start location of the target navigation sub-line of the next first road segment connected to the second road segment may be used as an end lane of the second road segment. In particular, when the second road segment is the first of the plurality of road segments, the start lane in the second road segment is specifically determined by the lane of the current positioning location. When the second road segment is the last of the plurality of road segments, the end lane in the second road segment is specifically determined by the lane of the navigation destination.

[00169] At S10295, based on pre-stored lane connection relationships, a first navigation route corresponding to each lane in the second road segment from the start lane to the end lane is extracted.

[00170] Exemplarily, if there are n lanes in the second road segment between the start lane and the end lane, the first navigation route corresponding to each lane in a process of successively passing through n lanes from the start lane to the end lane is required to be extracted herein.

[00171] At S10296, the first navigation route corresponding to each lane in the second road segment from the start lane to the end lane is spliced according to a passing order in the second road segment, to obtain the target navigation sub-line of the second road segment.

[00172] In the embodiment of the disclosure, in a process of determining the target navigation sub-line of each second road segment not passing through the intersection, the start lane and the end lane in the second road segment may be determined according to the target navigation sub-line of the first road segment connected to the second road segment, and based on the pre-stored lane connection relationships, the first navigation

route of each lane in the second road segment from the start lane to the end lane may be further spliced according to the passing order, so that the target navigation sub-line for guiding the target vehicle to pass through the second road segment is rapidly determined.

[00173] As shown in FIG. 3, the first navigation route of the same lane described in S101 may be generated in advance according to the following steps S201 to S203.

[00174] At S201, for any lane in a road scenario, a plurality of location points are respectively extracted from lane lines indicating boundaries on two sides of the lane and corresponding to the lane, to form a plurality of location point pairs.

[00175] Exemplarily, a center line of the lane may be used as the first navigation route. The center line may be obtained by fitting a plurality of center location points. Each of the center location points may be determined by using a pair of location points on the lane lines of boundaries on two sides of the lane.

[00176] Exemplarily, the lane includes two lane lines. A plurality of location points may be respectively extracted on the two lane lines of the lane, so that a location point pair is formed by the two location points on different lane lines. For example, a location point pair is formed by a location point K1 in a lane line L1 and a location point K1' in a lane line L2, and a location point is formed by a location point K2 in the lane line L1 and a location point K2' in the lane line L2. Then, by determining a center point of a connection line of the location point pair, the center location point of the lane may be obtained. During the extraction of the location point pairs, the connection line of the location point pair should be tried to be perpendicular to the lane lines on the two sides. In this way, the accuracy of the obtained center location points may be improved.

[00177] Exemplarily, considering that there are bends on a lane generally, in order to extract the accurate location point pairs, the operation of respectively extracting the plurality of location points from the lane lines indicating the boundaries on the two sides of the lane and corresponding to the lane, to form the plurality of location point pairs includes the following steps S2011 to S2014.

[00178] At S2011, lengths of the two lane lines included in the lane in the road scenario are acquired.

- [00179] Exemplarily, the lengths of the two lane lines included in the lane in the road scenario may be obtained from a road scenario map pre-constructed for the road scenario. For example, the lengths of the two lane lines included in the lane respectively are l_1 and l_2 .
- [00180] At S2012, the number of the plurality of location points is determined based on the length of the longest lane line of the two lane lines included in the lane.
- [00181] Exemplarily, by comparing l_1 with l_2 , in a case where l_1 is greater than l_2 , the number of the plurality of location points is determined by means of l_1 . In a case where l_2 is greater than l_1 , the number of the plurality of location points is determined by means of l_2 .
- [00182] Exemplarily, when the number of the plurality of location points is determined based on the length of the longest lane line in the two lane lines, the number of the plurality of location points may be commonly determined by combining a preset location point interval. For example, a ratio of the length of the longest lane line in the two lane lines to the preset location point interval is used as the number of the plurality of location points. The preset location point interval may be acquired according to experience.
- [00183] At S2013, based on the number of the plurality of location points, the plurality of location points are respectively extracted from the two lane lines included in the lane according to an interpolation manner.
- [00184] Exemplarily, assuming that the obtained number of the plurality of location points is N , linear interpolation may be performed on the two lane lines included in the lane according to N , so as to obtain N location points.
- [00185] At S2014, the plurality of location points on each lane line included in the lane are sorted in a traveling direction of the lane, and then two location points having a same serial number in different lane lines are formed into one location point pair.
- [00186] Exemplarily, in a case where the lane has a preset traveling direction, the plurality of location points of each lane line may be sorted according to the traveling direction. In a case where the lane does not have the preset traveling direction, the

plurality of location points of each lane line may be sorted according to a set traveling direction. Then, the location point pair is formed by two location points having a same serial number in different lane lines.

[00187] In the embodiment of the disclosure, the number of the location points is determined by means of the length of the longest lane line in the two lane lines included in the lane, and the location point pairs matching the shape of the lane may be obtained, so that the center location point with higher accuracy is obtained.

[00188] At S202, geographical locations of a plurality of center location points of the lane in the road scenario are determined based on geographical locations of the plurality of location point pairs in the road scenario. Each location point pair corresponds to one center location point.

[00189] Exemplarily, for each location point pair, a geographical location of a center location point of a connection line of the location point pair in the road scenario is determined based on the geographical location of each location point in the location point pair in the road scenario.

[00190] Exemplarily, a world coordinate system may be pre-constructed for the road scenario. Based on this, a world coordinate of each location point included in the lane line of the lane in the world coordinate system may be used as the geographical location of the location point in the road scenario.

[00191] Exemplarily, for each location point pair, a world coordinate of the center location point of the connection line between the two location points in the world coordinate system may be determined according to the world coordinates of the two location points included in the location point pair in the world coordinate system. In this way, the obtained world coordinates of the center location point of the connection line between the two location points may represent the geographical location of the center location point in the road scenario.

[00192] At S203, a first navigation route corresponding to the lane is determined based on the geographical locations of the plurality of center location points in the road scenario.

- [00193] Specifically, a possible implementation of determining a first navigation route corresponding to the lane based on the geographical locations of the plurality of center location points in the road scenario may include steps S2031 to S2033.
- [00194] At S2031, curve fitting is performed on the plurality of center location points based on the geographical locations of the plurality of center location points in the road scenario, to obtain a first fitting curve.
- [00195] Exemplarily, after the geographical locations of the plurality of center location points in the road scenario are obtained, curve fitting may be performed on the plurality of center location points in a manner of cubic spline curve fitting, so as to obtain the first fitting curve. The first fitting curve may represent the center line of the lane.
- [00196] At S2032, a plurality of points on the first fitting curve are extracted according to a preset interval, and geographical locations of the plurality of points extracted on the first fitting curve in the road scenario are acquired.
- [00197] Exemplarily, the preset interval may be determined by a distance traveling from acquisition of its current geographical location by the target vehicle to determination of a next location point based on the current geographical location. Interpolation is performed on the first fitting curve according to the preset interval. The plurality of points on the first fitting curve are extracted. Then, the geographical locations of the plurality of points in the road scenario are acquired.
- [00198] At S2033, the geographical locations of the plurality of points extracted on the first fitting curve in the road scenario are used as a traveling trajectory of the first navigation route corresponding to the lane.
- [00199] In the embodiment of the disclosure, a center line of the lane may be first obtained by fitting the plurality of center location points of the lane. Then, the plurality of points are further extracted on the center line. In this way, a traveling trajectory configured to guide the target vehicle to travel in a same lane may be accurately obtained.
- [00200] The determination of the first navigation route of the same lane is introduced with a specific embodiment with reference to FIG. 4. The following processes are

specifically included.

- [00201] (1) A length l_1 of a left lane line L_1 of a lane 1 and a length l_2 of a right lane line L_2 of the lane 1 are calculated.
- [00202] (2) l_1 is compared with l_2 , the larger length is divided by a preset value g to obtain an interpolation number T required by a target, and a target center interval value g generally takes 5 meters.
- [00203] (3) Linear interpolation is performed on L_1 and L_2 again according to the interpolation number T , to generate new L_1 and L_2 having T points.
- [00204] (4) All of points in L_1 and L_2 are traversed from front to back, and a center point of each pair of location points is calculated.
- [00205] (5) All of center points form the center location points of the lane.
- [00206] (6) Cubic spline curve fitting is performed by using sampling points, and interpolation is performed with a length being 0.2 meters, to obtain the trajectory points included in the last first navigation route, for example, the trajectory points in L_3 shown in FIG. 4.
- [00207] In an implementation, for S_{101} , lanes of different road connected to the same intersection include a first lane and a second lane. The second navigation route may be generated according to the following steps S_{301} to S_{303} , as shown in FIG. 5.
- [00208] At S_{301} , a first center location point passed through during traveling into the intersection from the first lane and a second center location point passed through during traveling into the second lane from the intersection are respectively acquired. The first center location point is a last one of center location points on the first lane, and the second center location point is a first one of center location points on the second lane.
- [00209] Exemplarily, the first lane may be used as an exit lane, and the second lane may be used as an entry lane. Herein, the second navigation route at the intersection during the traveling into the second lane from the first lane is determined.

[00210] Exemplarily, the first center location point passed through during the traveling into the intersection from the first lane 11 may be determined during determining of the first navigation route of the first lane. Likewise, the second center location point passed through during the traveling into the second lane from the intersection may be determined during the determining of the first navigation route of the second lane. As shown in FIG. 2, the first lane shown in the intersection may be the lane 11, the lane 12, or the lane 13. The second lane corresponding to the first lane 11 may include the lane 21, the lane 22, and the lane 23. The second lane corresponding to the first lane 12 may include the lane 31, the lane 32, and the lane 33. The second lane corresponding to the first lane 13 may include the lane 41, the lane 42, and the lane 43. A P1 point is the first center location point of each first lane, and P2 point is the second center location point of each second lane.

[00211] At S302, a first direction vector for characterizing the traveling into the intersection from the first lane is determined based on geographical locations respectively corresponding to two adjacent center location points on the first lane including the first center location point, and a second direction vector for characterizing the traveling into the second lane from the intersection is determined based on geographical locations respectively corresponding to two adjacent center location points on the second lane including the second center location point.

[00212] Exemplarily, in a case where the first lane is the exit lane, a previous center location point C1 adjacent to a first center location point P1 included in the first lane is used as a start point of the first direction vector, and the first center location point P1 is used as an end point of the first direction vector, so that the first direction vector $\vec{a}$ shown in FIG. 2 is obtained. In a case where the second lane is the entry lane, a second center location point P2 included in the second lane is used as a start point of the second direction vector, and a previous center location point C2 adjacent to the second center location point is used as an end point of the second direction vector, so that the second direction vector $\vec{b}$ shown in FIG. 2 is obtained.

[00213] At S303, a traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane is determined

based on the first center location point, the second center location point, the first direction vector and the second direction vector.

[00214] Exemplarily, the first center location point may represent the start point of the target vehicle at the intersection, and the second center location point may represent the end point of the target vehicle at the intersection. The first direction vector may represent a direction that the target vehicle travels into the intersection from the first lane, and the second direction vector represent a direction that the target vehicle travels into the second lane from the intersection. Based on parameter information, a traveling trajectory of the second navigation route that safely passes through the intersection may be planned for the target vehicle.

[00215] In the embodiment of the disclosure, before the second navigation route is determined, a start location and an end location of the target vehicle at the intersection, in which direction to traveling into the intersection from the start location, and in which direction to traveling into a destination from the intersection are planned. Through such a method, the traveling trajectory of the second navigation route with higher accuracy may be obtained.

[00216] Specifically, a possible implementation of determining the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the first center location point, the second center location point, the first direction vector and the second direction vector may include the following steps S401 to S403, as shown in FIG. 6.

[00217] At S401, a steering angle for traveling into the second lane from the first lane is determined based on the first direction vector and the second direction vector.

[00218] Exemplarily, an included angle between the first direction vector and the second direction vector may be used as a steering angle for traveling into the second lane from the first lane. In a case where the first lane is located on an opposite side of the second lane, for example, in a case where, as shown in FIG. 2, the lane 11 is the first lane, and the lane 31 is the second lane, the steering angle is relatively small. In a case where the second lane is located on a right side of the first lane, for example, in a case where, as

shown in FIG. 2, the lane 11 is the first lane, and the lane 21 is the second lane, the steering angle is relatively large.

[00219] At S402, a plurality of target control points configured to control a shape of the second navigation route are determined based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector.

[00220] Exemplarily, a fourth-order Bezier curve may be introduced to represent the second navigation route. A process of determining the fourth-order Bezier curve needs to determine five target control points. The five target control points may be configured to represent a shape of the fourth-order Bezier curve, and may also represent a shape of the second navigation route.

[00221] At S403, the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane is determined based on the plurality of target control points.

[00222] Exemplarily, the fourth-order Bezier curve may be determined based on geographical locations of the plurality of target control points in the road scenario, to further obtain the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane.

[00223] In the embodiment of the disclosure, it is proposed that, when the second navigation route is determined, the plurality of target control points configured to control the shape of the second navigation route may be first determined through the steering angle for traveling from the first lane to the second lane, the first center location point, the second center location point, the first direction vector, and the second direction vector, so that the traveling trajectory of the second navigation route with higher accuracy is obtained.

[00224] A process of determining the plurality of target control points of the fourth-order Bezier curve based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector may be divided into two different determination modes according to the steering angle. One

mode is to determine a linear Bezier control point, and the other mode is to determine a steering Bezier control point. Details are described below.

[00225] In an implementation, a possible implementation of determining the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector includes the following steps S4021 to S4023.

[00226] At S4021, a center point of a connection line between the first center location point and the second center location point and a first distance between the first center location point and the second center location point are determined, in a case where the steering angle is less than a preset angle.

[00227] Exemplarily, in the case that the steering angle is less than the preset angle, the plurality of target control points are determined according to the mode of determining the linear Bezier control point. A world coordinate of a center point M1 of a connection line between the first center location point P1 and the second center location point P2 in the world coordinate system may be determined based on the world coordinates of the first center location point P1 and the second center location point P2 in the world coordinate system. A first distance D1 between the first center location point P1 and the second center location point P2 may be determined based on the world coordinates of the first center location point P1 and the second center location point P2 in the world coordinate system.

[00228] At S4022, a first target point that is obtained after an extension by a preset multiple of the first distance is made from the first center location point in a direction indicated by the first direction vector is acquired.

[00229] Exemplarily, the first center location point P1 is used as the start point. A first target point B1 may be obtained after an extension by $nD1$ is made according to the first direction vector $\vec{a}$, where n represents a preset multiple, which may set according to experience according to a size of the intersection. A value of n is greater than 0 and less than 1.

[00230] At S4023, a second target point that is obtained after an extension by the preset multiple of the first distance is made from the second center location point in a direction indicated by a vector opposite to the second direction vector is acquired.

[00231] The plurality of target control points are formed by the first center location point, the first target point, the center point of the connection line between the first center location point and the second center location point, the second target point, and the second center location point.

[00232] Exemplarily, the second center location point P2 is used as the start point. A second target point B2 may be obtained after an extension by nD1 is made according to a vector $-\vec{b}$ opposite to the second direction vector $\vec{b}$.

[00233] The obtained first center location point P1, the first target point B1, the center point M1 of the connection line between the first center location point P1 and the second center location point, the second target point B2, and the second center location point P2 are used as the five target control points of the fourth-order Bezier curve.

[00234] A process of determining the linear Bezier control point is introduced below with a specific embodiment, and specifically includes the following steps.

[00235] (1) The first center location point P1 is used as a first control point of the Bezier curve.

[00236] (2) The center point M1 of the first center location point P1 and the second center location point P2 is determined.

[00237] (3) A length D1 between the first center location point P1 and the second center location point P2 is determined.

[00238] (4) An extension by a length of 0.3D1 is made from the first center location point P1 according to the first direction vector $\vec{a}$ to obtain the first target point B1, and the first target point is used as a second control point of the Bezier curve.

[00239] (5) The center point M1 of the first center location point P1 and the second center location point P2 is used as a third control point of the Bezier curve.

[00240] (6) An extension by the length of $0.3D1$ is made from the second center location point $P2$ according to the vector $-\vec{b}$ opposite to the second direction vector $\vec{b}$ to obtain the second target point $B2$, and the second target point is used as a fourth control point of the Bezier curve.

[00241] (7) The second center location point $P2$ is used as a fifth control point of the Bezier curve.

[00242] In the embodiment of the disclosure, it is proposed that, in a case where the steering angle between the two lanes is less than the preset angle, the second navigation route corresponding to the two lanes at the intersection may be rapidly determined based on the first center location point, the second center location point, the first direction vector and the second direction vector.

[00243] In another implementation, for $S402$, a possible implementation of determining the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector includes the following steps $S4024$ to $S4026$.

[00244] At $S4024$, a first safe obstacle-avoidance distance of the target vehicle traveling into the intersection from the first lane is determined based on size information of the target vehicle and an obstacle area corresponding to the first lane, in a case where the steering angle is greater than or equal to the preset angle.

[00245] Exemplarily, in the case that the steering angle is greater than or equal to the preset angle, the plurality of target control points are determined according to the mode of determining the steering Bezier control point. Before the plurality of target control points are determined, the first safe obstacle-avoidance distance of the target vehicle traveling into the intersection from the first lane may be first determined based on the size information of the target vehicle and the obstacle area corresponding to the first lane.

[00246] Exemplarily, in some intersections, static obstacles configured to divide two roads may exist between the two parallel roads. A corresponding area of these obstacles

in the road scenario is called as the obstacle area. As shown in FIG. 2, the intersection includes an obstacle area A, an obstacle area B, an obstacle area C, and an obstacle area D. For example, the first lane is the lane 13 shown in FIG. 2, and the second lane is the lane 43 shown in FIG. 2. During the traveling of the target vehicle from the lane 13 to the lane 43 by passing through the intersection, a distance is required to be traveled forward to pass through the obstacle area A when the target vehicle exits from the lane 13. The distance required to be traveled forward may be called as the first safe obstacle-avoidance distance. In particular, in a case where there is no obstacle area A, the first safe obstacle-avoidance distance here may be 0.

[00247] Exemplarily, the first safe obstacle-avoidance distance may be determined according to the following method.

[00248] (1) An obstacle search direction vector $\vec{w} = (P2 - P1)$ is determined based on the first center location point P1 in the lane 13 and the second center location point P2 in the lane 43.

[00249] Exemplarily, the obstacle search direction vector is configured to determine an obstacle area associated with the lane 13 and an obstacle area associated with the lane 43. For example, as shown in FIG. 2, the obstacle area associated with the lane 13 is A, and the obstacle area associated with the lane 43 is D.

[00250] (2) An obstacle search direction vector $i\vec{1} = \vec{w} - \vec{a}$ is determined based on the obstacle search direction vector and the first direction vector $\vec{a}$ corresponding to the lane 13.

[00251] Exemplarily, the obstacle sensitive direction vector is configured to indicate a direction of the obstacle area that is prone to collision with the target vehicle.

[00252] (3) For the lane 13, a plurality of boundary points Q_i included in an outline of the obstacle area A are traversed, to respectively construct a vector $\vec{r}_i = Q_i - P1$, and a length d_i of a projection of the $\vec{r}_i$ on the $i\vec{1}$ is determined. Q_i represents the i-th boundary point along the plurality of boundary points; $\vec{r}_i$ represents an i-th vector that is

constructed based on the i -th boundary point and the first center location point; and d_i represents a length of a projection of the i -th vector on the $i\vec{1}$.

[00253] Exemplarily, the length d_i is configured to screen out a target boundary point that is prone to collision with the target vehicle if the target vehicle does not travel forward according to the first safe obstacle-avoidance distance.

[00254] (4) Based on the d_i and a first preset range (for example, the first preset range is greater than 0 and less than h , where h is related to a width of a vehicle body and may be equal to the width of the vehicle body), the target boundary point that causes the d_i to conform to a preset range is selected.

[00255] (5) In a case where it is determined that there is at least one target boundary point, a projection length N_x of the vector $\vec{z} = Q_x - P1$ formed by each target boundary point and the first center location point P1 on the first direction vector $\vec{a}$ is determined (Q_x represents an x -th target boundary point in at least one target boundary point, and N_x represents a projection length corresponding to the x -th target boundary point).

[00256] (6) Based on the projection length N_x and a second preset range (for example, the second preset range is greater than 0 and less than m , where m is preset according to experience based on a size of the obstacle area and is configured to indicate that an obstacle area belongs to the obstacle area on the lane 13 side), N1 that conforms to the second preset range and has the longest length is screened out as the first safe obstacle-avoidance distance, as shown in FIG. 2.

[00257] At S4025, a second safe obstacle-avoidance distance of the target vehicle traveling into the second lane from the intersection is determined based on the size information of the target vehicle and an obstacle area corresponding to the second lane.

[00258] Exemplarily, an obstacle search direction vector that is used during determination of the second safe obstacle-avoidance distance is $i\vec{2} = -\vec{w} - \vec{a}$. In the case that the second lane is the lane 43 shown in FIG. 2, the second safe obstacle-avoidance distance N2 may be determined based on the obstacle area D, the size information of the

target vehicle, and the obstacle search direction vector $\vec{i_2}$. As shown in FIG. 2, a determination process is same as the above principle of determining the first safe obstacle-avoidance distance N1, which is not described herein again.

[00259] At S4026, the plurality of target control points are determined based on the first center location point, the second center location point, an intersection point of the first direction vector and the second direction vector, the first safe obstacle-avoidance distance and the second safe obstacle-avoidance distance.

[00260] In the embodiment of the disclosure, in a process of determining the second navigation route corresponding to large angle steering, a start point and an end point during the traveling of the target vehicle at the intersection and an obstacle-avoidance distance are required to be considered, to enhance the safety during the traveling of the target vehicle at the intersection.

[00261] Specifically, a possible implementation of determining the plurality of target control points based on the first center location point, the second center location point, the intersection point of the first direction vector and the second direction vector, the first safe obstacle-avoidance distance and the second safe obstacle-avoidance distance includes the following steps S40261 to S40263.

[00262] At S40261, a third target point that is obtained after an extension by the first safe obstacle-avoidance distance is made from the first center location point in a direction indicated by the first direction vector is acquired.

[00263] Exemplarily, the first center location point P1 is used as the start point. The third target point B3 may be obtained after an extension by N1 is made according to the first direction vector $\vec{a}$.

[00264] At S40262, a fourth target point that is obtained after an extension by the second safe obstacle-avoidance distance is made from the second center location point in a direction indicated by the second direction vector is acquired.

[00265] Exemplarily, the second center location point P2 is used as the start point. The fourth target point B4 may be obtained after an extension by N2 is made according to a

vector $-\vec{b}$ opposite to the second direction vector $\vec{b}$.

[00266] At S40263, a plurality of other target points in addition to the third target point and the fourth target point are determined based on the third target point, the fourth target point, and the intersection point.

[00267] The plurality of target control points are formed by the third target point, the plurality of other target points that are determined, and the fourth target point.

[00268] Exemplarily, the third target point may be used as the first target control point of the steering Bezier control point. The fourth target point may be used as the fifth target control point of the steering Bezier control point. The plurality of other target points may respectively include the second target control point, the third target control point, and the fourth target control point of the steering Bezier control point.

[00269] Specifically, a possible implementation of determining the plurality of other target points in addition to the third target point and the fourth target point based on the third target point, the fourth target point, and the intersection point includes the following.

[00270] (1) An intersection point M2 of the first direction vector and the second direction vector is acquired.

[00271] (2) A length D2 between the third target point B3 and the intersection point M2 is determined, and a length D3 between the fourth target point B4 and the intersection point M2 is determined.

[00272] (3) A ratio r1 of $(D2+D3)/4$ to D2 is determined, and a ratio r2 of $(D2+D3)/4$ to D3 is determined.

[00273] (4) A segmentation point is selected between the third target point B3 and the intersection point M2 as a fifth target point B5, to cause a ratio of a distance between B3 and B5 to a distance between B3 and M2 to be equal to r1, and the fifth target point B5 is used as the second target control point in the steering Bezier control point.

[00274] (5) A segmentation point is selected between the fourth target point B4 and the intersection point M2 as a sixth target point B6, to cause a ratio of a distance between B4

and B6 to a distance between B4 and M2 to be equal to r_2 , and the sixth target point B6 is used as the fourth target control point in the steering Bezier control point.

[00275] (6) $e=D_2-D_3$ is determined, in a case where D_2 is greater than D_3 , a segmentation point M3 of $(D_2+D_3)/2$ on D_2 is determined, then a seventh target point B7 is obtained by adding M3 and $e \times \vec{b}$, and the seventh target point B7 is used as the third target control point of the steering Bezier control point; in a case where D_2 is less than D_3 , a segmentation point M4 of $(D_2+D_3)/2$ on D_3 is determined, then an eighth target point B8 is obtained by adding M4 and $e \times \vec{a}$, and the eighth target point B8 is used as the third target control point of the steering Bezier control point; and in a case where D_2 equals D_3 , the intersection point M2 of the first direction vector and the second direction vector is used as the third target control point of the steering Bezier control point.

[00276] In an implementation, for S403, a possible implementation of determining the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the plurality of target control points may include the following steps S4031 to S4033.

[00277] At S4031, a second fitting curve at the intersection during the traveling into the second lane from the first lane is determined based on the plurality of target control points.

[00278] Exemplarily, the geographical locations of the plurality of target control points in the road scenario may be inputted into a fourth-order Bezier curve function, to obtain the second fitting curve.

[00279] At S4032, a plurality of points on the second fitting curve are extracted according to a preset interval, and geographical locations of the plurality of points extracted on the second fitting curve in the road scenario are acquired.

[00280] Exemplarily, the preset interval may be determined by a distance traveling from acquisition of its current geographical location by the target vehicle to determination of a next location point based on the current geographical location. Interpolation is performed on the second fitting curve according to the preset interval.

The plurality of points on the second fitting curve are extracted. Then, the geographical locations of the plurality of points in the road scenario are acquired.

[00281] At S4033, the geographical locations of the plurality of points extracted on the second fitting curve in the road scenario are used as a traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane.

[00282] Exemplarily, FIG. 2 shows the traveling trajectories of three second navigation routes, which are the traveling trajectory U1 of the second navigation route at the intersection from the lane 11 to the lane 21, the traveling trajectory U2 of the second navigation route at the intersection from the lane 12 to the lane 32, and the traveling trajectory U3 of the second navigation route at the intersection from the lane 13 to the lane 43.

[00283] In the embodiment of the disclosure, the traveling trajectory configured to guide the target vehicle to travel at the intersection may be accurately obtained by means of the planned second navigation route configured to indicate the traveling of the target vehicle at the intersection and the geographical locations of the plurality of points in the second navigation route in the road scenario.

[00284] In an implementation, for S103 of controlling the target vehicle to travel according to the target navigation line, as shown in FIG. 7, the following steps S501 to S502 may be included.

[00285] At S501, a geographical location of an obstacle in the road scenario is acquired in a case where the obstacle is detected during the traveling of the target vehicle according to the target navigation line.

[00286] Exemplarily, the obstacle here is a dynamic obstacle, such as a pedestrian and a vehicle.

[00287] Exemplarily, a road scenario image may be acquired by using a collecting device mounted on the target vehicle, such as a monocular camera. In a case where the dynamic obstacle is detected in the road scenario image, a coordinate location of the

obstacle in a vehicle body coordinate system may be determined based on an image location of the obstacle in the road scenario image and a conversion relationship between an image coordinate system corresponding to the road scenario image taken by the pre-determined monocular camera and the vehicle body coordinate system corresponding to the target vehicle, so that the geographical location of the obstacle in the road scenario is further determined based on the geographical location of the target vehicle in the road scenario.

[00288] At S502, the target navigation line is adjusted based on the geographical location of the obstacle to control the target vehicle to bypass the obstacle, in a process of controlling the target vehicle to travel according to the target navigation line.

[00289] Exemplarily, during the traveling of the target vehicle according to the target navigation line, if the obstacle is detected to be located in the traveling front of the target vehicle, the target vehicle may be controlled to stop. After the obstacle is detected to leave the traveling front of the target vehicle, the target vehicle is then controlled to continuously travel according to the target navigation line. Alternatively, in a case where the obstacle is detected to be located in the traveling front of the target vehicle, the target vehicle may be controlled to transfer to the first navigation route corresponding to the adjacent lane for continuous traveling; and in a case where there is no obstacle detected on an initial lane, the target vehicle is then controlled to travel in the initial lane, and travels continuously according to the target navigation line.

[00290] In the embodiment of the disclosure, in the process of controlling the target vehicle to travel according to the target navigation line, if a dynamic obstacle is detected, obstacle avoidance may be performed based on the geographical location of the dynamic obstacle in the road scenario, so that traveling safety can be enhanced.

[00291] It can be understood by those skilled in the art that, in the above method of the specific implementation modes, the writing sequence of each step does not mean a strict execution sequence and is not intended to form any limitation to the implementation process and a specific execution sequence of each step should be determined by functions and probable internal logic thereof.

[00292] Based on the same inventive concept, the embodiments of the disclosure also provide a navigation apparatus corresponding to the navigation method. Since the principle of solving problems by the apparatus in the embodiments of the disclosure is similar to the depth detection method described above in the embodiments of the disclosure, the implementation of the apparatus may refer to the implementation of the method, and the repetitions are not repeated here.

[00293] FIG. 8 is a schematic diagram of a navigation apparatus 600 according to an embodiment of the disclosure. The navigation apparatus 600 includes an acquisition module, a generation module, and a control module.

[00294] The acquisition module 601 is configured to acquire a current positioning location and a navigation destination of a target vehicle as well as a navigation line associated with at least one lane on a road from the current positioning location to the navigation destination. The navigation line is generated in advance. The generation module 602 is configured to generate a target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line. The target navigation line is formed by splicing the navigation line of at least one lane. The control module 603 is configured to control the target vehicle to travel according to the target navigation line.

[00295] In a possible implementation, the navigation line includes a first navigation route configured to guide a traveling path of a vehicle in a lane. The generation module 602 is configured to generate the target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line, by means of: based on pre-stored lane connection relationships, acquiring a first group of lanes passed through by the target vehicle from the current positioning location to the navigation destination in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined not to pass through an intersection, the first group of lanes comprising at least one lane; extracting the first navigation route corresponding to at least one lane in the first group of lanes; and splicing the first navigation routes respectively corresponding to the first group of lanes in an order from the current positioning location to the navigation destination, to obtain

the target navigation line.

[00296] In a possible implementation, the navigation line further includes a second navigation route corresponding to the intersection connected to the lane. The second navigation route is configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection. The generation module 602 is configured to generate the target navigation line of the target vehicle from the current positioning location to the navigation destination by means of: based on the pre-stored lane connection relationships, acquiring a second group of lanes passed through by the target vehicle from the current positioning location to the navigation destination and a first intersection set passed through, in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined to pass through an intersection, where the second group of lanes includes at least two lanes, and the first intersection set includes at least one intersection; extracting the first navigation route corresponding to at least one lane in the second group of lanes and the second navigation route corresponding to at least one intersection in the first intersection set; and splicing the first navigation routes respectively corresponding to the second group of lanes and the second navigation routes respectively corresponding to the intersection set in the order from the current positioning location to the navigation destination to obtain the target navigation line.

[00297] In a possible implementation, the generation module 602 is configured to generate the target navigation line of the target vehicle from the current positioning location to the navigation destination by means of: acquiring intersection information about the road from the current positioning location to the navigation destination; dividing the road into a plurality of road segments according to the intersection information; determining a target navigation sub-line of at least one of the plurality of road segments based on the navigation line; and splicing the target navigation sub-lines to obtain the target navigation line.

[00298] In a possible implementation, the navigation line includes a first navigation route configured to guide a traveling path of a vehicle in the lane and a second navigation route corresponding to an intersection connected to the lane. The second navigation route

is configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection. The plurality of road segments include at least one first road segment, and the first road segment passes through at least one intersection. The generation module 602 is configured to, for at least one first road segment, determine a target navigation sub-line of at least one of the plurality of road segments by means of: determining a third group of lanes and a second intersection set in the first road segment, where the third group of lanes includes at least two lanes, and the second intersection set includes at least one intersection; extract the second navigation route corresponding to at least one intersection of the second intersection set and the first navigation routes of target lanes indicated and connected by the second navigation route in the third group of lanes; and splice the first navigation routes of the target lanes and the second navigation route corresponding to at least one intersection in the second intersection set according to a passing order in the first road segment, to obtain the target navigation sub-line of the first road segment.

[00299] In a possible implementation, the plurality of road segments further include at least one second road segment, and the second road segment does not pass through an intersection. The generation module 602 is configured to, for at least one second road segment, determine a target navigation sub-line of at least one of the plurality of road segments by means of: determining a start lane and an end lane in the second road segment based on the target navigation sub-line of the first road segment connected to the second road segment; based on pre-stored lane connection relationships, extracting a first navigation route corresponding to at least one lane in the second road segment from the start lane to the end lane; and splicing the first navigation route corresponding to at least one lane in the second road segment from the start lane to the end lane according to a passing order in the second road segment, to obtain the target navigation sub-line of the second road segment.

[00300] In a possible implementation, the generation module 602 is configured to pre-generate the first navigation route by means of: for any lane in a road scenario, respectively extracting a plurality of location points from lane lines indicating boundaries on two sides of the lane and corresponding to the lane, to form a plurality of location point pairs; respectively determining geographical locations of a plurality of center

location points of the lane in the road scenario in geographical locations in the road scenario based on the plurality of location point pairs, where each location point pair corresponds to one center location point; and determining the first navigation route corresponding to the lane based on the geographical locations of the plurality of center location points in the road scenario.

[00301] In a possible implementation, the generation module 602 is configured to respectively extract the plurality of location points from the lane lines indicating the boundaries on the two sides of the lane and corresponding to the lane, to form the plurality of location point pairs by means of: acquiring lengths of the two lane lines included in the lane in the road scenario; determining the number of the plurality of location points based on the length of the longest lane line of the two lane lines included in the lane; based on the number of the plurality of location points, respectively extracting the plurality of location points from the two lane lines included in the lane according to an interpolation manner; and sorting the plurality of location points on at least one lane line included in the lane in a traveling direction of the lane, and forming two location points having a same serial number in different lane lines into one location point pair.

[00302] In a possible implementation, the generation module 602 is configured to determine the geographical locations of the plurality of center location points of the lane in the road scenario based on geographical locations of the plurality of location point pairs in the road scenario by means of: for at least one location point pair, determining a geographical location of a center location point of a connection line of the location point pair in the road scenario based on the geographical location of at least one location point in the location point pair in the road scenario.

[00303] In a possible implementation, the generation module 602 is configured to determine the first navigation route corresponding to the lane based on the geographical locations of the plurality of center location points in the road scenario by means of: performing curve fitting on the plurality of center location points based on the geographical locations of the plurality of center location points in the road scenario, to obtain a first fitting curve; extracting a plurality of points on the first fitting curve

according to a preset interval, and acquiring geographical locations of the plurality of points extracted on the first fitting curve in the road scenario; and using the geographical locations of the plurality of points extracted on the first fitting curve in the road scenario as a traveling trajectory of the first navigation route corresponding to the lane.

[00304] In a possible implementation, lanes of different road connected to the same intersection include a first lane and a second lane. The generation module 602 is configured to generate a second navigation route by means of: respectively acquiring a first center location point passed through during traveling into the intersection from the first lane and a second center location point passed through during the traveling into the second lane from the intersection, where the first center location point is a last one of center location points on the first lane, and the second center location point is a first one of center location points on the second lane; determining a first direction vector for characterizing the traveling into the intersection from the first lane based on geographical locations respectively corresponding to two adjacent center location points on the first lane including the first center location point, and determining a second direction vector for characterizing the traveling into the second lane from the intersection based on geographical locations respectively corresponding to two adjacent center location points on the second lane including the second center location point; and determining a traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the first center location point, the second center location point, the first direction vector and the second direction vector.

[00305] In a possible implementation, the generation module 602 is configured to determine the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the first center location point, the second center location point, the first direction vector and the second direction vector by means of: determining a steering angle for traveling into the second lane from the first lane based on the first direction vector and the second direction vector; determining a plurality of target control points configured to control a shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector; and determining the traveling trajectory of the second navigation route at the intersection

during the traveling into the second lane from the first lane based on the plurality of target control points.

[00306] In a possible implementation, the generation module 602 is configured to determine the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector by means of: determining a center point of a connection line between the first center location point and the second center location point and a first distance between the first center location point and the second center location point, in a case where the steering angle is less than a preset angle; acquiring a first target point that is obtained after an extension by a preset multiple of the first distance is made from the first center location point in a direction indicated by the first direction vector; and acquiring a second target point that is obtained after an extension by the preset multiple of the first distance is extended from the second center location point in a direction indicated by a vector opposite to the second direction vector. The plurality of target control points are formed by the first center location point, the first target point, the center point of the connection line between the first center location point and the second center location point, the second target point, and the second center location point.

[00307] In a possible implementation, the generation module 602 is configured to determine the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector by means of: determining a first safe obstacle-avoidance distance of the target vehicle traveling into the intersection from the first lane based on size information of the target vehicle and an obstacle area corresponding to the first lane, in a case where the steering angle is greater than or equal to the preset angle; determining a second safe obstacle-avoidance distance of the target vehicle traveling into the second lane from the intersection based on the size information of the target vehicle and an obstacle area corresponding to the second lane; and determining the plurality of target control points based on the first center location point, the second center location point, an intersection point of the first direction vector and the second direction vector, the first safe obstacle-

avoidance distance and the second safe obstacle-avoidance distance.

[00308] In a possible implementation, the generation module 602 is configured to determine the plurality of target control points based on the first center location point, the second center location point, the intersection point of the first direction vector and the second direction vector, the first safe obstacle-avoidance distance and the second safe obstacle-avoidance distance by means of: acquiring a third target point that is obtained after an extension by the first safe obstacle-avoidance distance is made from the first center location point in a direction indicated by the first direction vector; acquiring a fourth target point that is obtained after an extension by the second safe obstacle-avoidance distance is made from the second center location point in a direction indicated by a vector opposite to the second direction vector; and determining a plurality of other target points in addition to the third target point and the fourth target point based on the third target point, the fourth target point, and the intersection point. The plurality of target control points are formed by the third target point, the plurality of other target points that are determined, and the fourth target point.

[00309] In a possible implementation, the generation module 602 is configured to determine the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the plurality of target control points by means of: determining a second fitting curve at the intersection during the traveling into the second lane from the first lane based on the plurality of target control points; extracting a plurality of points on the second fitting curve according to a preset interval, and acquiring geographical locations of the plurality of points extracted on the second fitting curve in the road scenario; and using the geographical locations of the plurality of points extracted on the second fitting curve in the road scenario as a traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane.

[00310] In a possible implementation, the control module 603 is configured to control the target vehicle to travel according to the target navigation line by means of: acquiring a geographical location of an obstacle in the road scenario in a case where the obstacle is detected during the traveling of the target vehicle according to the target navigation line;

and adjusting the target navigation line based on the geographical location of the obstacle to control the target vehicle to bypass the obstacle, in a process of controlling the target vehicle to travel according to the target navigation line.

[00311] For the descriptions of the processing flow of each module in the apparatus and the interaction flow between each module, refer to related descriptions in the above method embodiments, which is not elaborated here.

[00312] Corresponding to the navigation method shown in FIG. 1, an embodiment of the disclosure further provides an electronic device 700. FIG. 9 is a schematic structural diagram of an electronic device 700 according to an embodiment of the disclosure. The electronic device includes a processor 71, a memory 72, and a bus 73.

[00313] The memory 72 is configured to store an execution instruction, and includes an internal memory 721 and an external memory 722. The internal memory 721 here is also called as an internal storage, and is configured to temporarily store operational data in the processor 71 and data exchanged with the external memory 722 such as a hard disk. The processor 71 achieves data exchange with the external memory 722 by using the internal memory 721. When the electronic device 700 is operated, the processor 71 communicates with the memory 72 by using the bus 73, to cause the processor 71 to execute the following instructions: acquiring a current positioning location and a navigation destination of a target vehicle as well as a navigation line associated with lanes on a road from the current positioning location to the navigation destination, the navigation line being generated in advance; generating a target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line, the target navigation line being formed by splicing the navigation line of at least one lane; and controlling the target vehicle to travel according to the target navigation line.

[00314] An embodiment of the disclosure further provides a computer-readable storage medium. The computer-readable storage medium stores a computer program. When the computer program is executed by a processor, steps of the navigation method in the above method embodiments are performed. The storage medium may be a volatile or non-volatile computer-readable storage medium.

[00315] An embodiment of the disclosure further provides a computer program product, including computer-readable codes or a non-volatile computer-readable storage medium carrying the computer-readable codes. When the computer-readable codes are operated in a processor of an electronic device, the processor of the electronic device performs steps of the navigation method in the above method embodiments. Details may refer to the above method embodiments, which are not described herein again.

[00316] The computer program product can be specifically implemented in a manner of hardware, software or a combination thereof. In an optional embodiment, the computer program product is embodied as a computer storage medium. In another optional embodiment, the computer program product is embodied as a software product, such as a Software Development Kit (SDK) and the like.

[00317] Those skilled in the art may clearly learn about that specific working processes of the system and apparatus described above may refer to the corresponding processes in the above method embodiments and will not be elaborated herein for ease and brevity of description. In several embodiments provided by the disclosure, it is to be understood that the disclosed system, apparatus and method may be implemented in other ways. The apparatus embodiment described above is only schematic, and for example, division of the units is only logic function division, and other division manners may be adopted during practical implementation. For another example, a plurality of units or components may be combined or integrated into another system, or some characteristics may be neglected or not executed. In addition, the displayed or discussed mutual coupling or direct coupling or communication connection may be indirect coupling or communication connection through some communication interfaces, apparatuses or units, and may be in electrical, mechanical or other forms.

[00318] The units described as separate components may or may not be physically separated. The components displayed as units may or may not be physical units, that is, the components may be located in one place, or may be distributed on the plurality of network units. Part or all of the units may be selected according to actual requirements to achieve the purposes of the solutions of the embodiment.

[00319] In addition, the functional units in the various embodiments of the present

disclosure may be integrated into one processing unit, or each unit may exist alone physically, or two or more than two units may be integrated into one unit.

[00320] When realized in form of software function unit and sold or used as an independent product, the function may be stored in a nonvolatile computer-readable storage medium executable by a processor. Based on such an understanding, the technical solutions of the disclosure substantially or parts making contributions to the conventional art or part of the technical solutions may be embodied in form of software product. The computer software product is stored in a storage medium, including a plurality of instructions configured to enable a computer device (which may be a personal computer, a server, a network device, etc.) to execute all or part of the steps of the method in each embodiment of the disclosure. The storage medium includes: various media capable of storing program codes such as a U disk, a mobile Hard Disk Drive (HDD), a Read-Only Memory (ROM), a Random Access Memory (RAM), a magnetic disk or an optical disk.

[00321] It is finally to be noted that the above embodiments are only the specific implementation modes of the disclosure and are adopted not to limit the present disclosure but to describe the technical solutions of the disclosure. The scope of protection of the disclosure is not limited thereto. Although the disclosure is described with reference to the embodiments in detail, those of ordinary skill in the art should know that those skilled in the art may still make modifications or apparent variations to the technical solutions recorded in the embodiments or make equivalent replacements to part of technical features within the technical scope disclosed in the disclosure, and these modifications, variations, or replacements do not make the essence of the corresponding technical solutions departs from the spirit and scope of the technical solutions of the embodiments of the disclosure and shall fall within the scope of protection of the disclosure. Therefore, the scope of protection of the disclosure shall be subject to the scope of protection of the claims.

CLAIMS

1. A navigation method, comprising:

acquiring a current positioning location and a navigation destination of a target vehicle as well as a navigation line associated with at least one lane on a road from the current positioning location to the navigation destination, the navigation line being generated in advance;

generating a target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line, the target navigation line being formed by splicing the navigation line of at least one lane; and

controlling the target vehicle to travel according to the target navigation line.

2. The navigation method of claim 1, wherein the navigation line comprises a first navigation route configured to guide a traveling path of a vehicle in the lane,

generating the target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line comprises:

based on pre-stored lane connection relationships, acquiring a first group of lanes passed through by the target vehicle from the current positioning location to the navigation destination in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined not to pass through an intersection, the first group of lanes comprising at least one lane;

extracting the first navigation route corresponding to at least one lane in the first group of lanes; and

splicing the first navigation routes respectively corresponding to the first group of lanes in an order from the current positioning location to the navigation destination to obtain the target navigation line.

3. The navigation method of claim 2, wherein the navigation line further comprises a second navigation route corresponding to an intersection connected to the lane; and the second navigation route is configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection,

generating the target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line comprises:

based on the pre-stored lane connection relationships, acquiring a second group of lanes passed through by the target vehicle from the current positioning location to the navigation destination and a first intersection set passed through, in a case where the road travelled by the target vehicle from the current positioning location to the navigation destination is determined to pass through an intersection, the second group of lanes comprising at least two lanes, and the first intersection set comprising at least one intersection;

extracting the first navigation route corresponding to at least one lane in the second group of lanes and the second navigation route corresponding to at least one intersection in the first intersection set; and

splicing the first navigation routes respectively corresponding to the second group of lanes and the second navigation routes respectively corresponding to the intersection set in the order from the current positioning location to the navigation destination to obtain the target navigation line.

4. The navigation method of claim 1, wherein generating the target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line comprises:

acquiring intersection information about the road from the current positioning location to the navigation destination;

dividing the road into a plurality of road segments according to the intersection

information;

determining a target navigation sub-line of at least one of the plurality of road segments based on the navigation line; and

splicing the target navigation sub-lines to obtain the target navigation line.

5. The navigation method of claim 4, wherein the navigation line comprises a first navigation route configured to guide a traveling path of a vehicle in the lane and a second navigation route corresponding to an intersection connected to the lane, the second navigation route being configured to guide a traveling path of the vehicle to travel from a first lane to a second lane, both lanes being connected to the intersection; and

the plurality of road segments comprise at least one first road segment, and the first road segment passes through at least one intersection,

determining the target navigation sub-line of at least one of the plurality of road segments based on the navigation line comprises, for the at least one first road segment:

determining a third group of lanes and a second intersection set in the first road segment, the third group of lanes comprising at least two lanes, and the second intersection set comprising at least one intersection;

extracting the second navigation route corresponding to at least one intersection of the second intersection set and the first navigation routes of target lanes indicated and connected by the second navigation route in the third group of lanes;

splicing the first navigation routes of the target lanes and the second navigation route corresponding to at least one intersection in the second intersection set according to a passing order in the first road segment, to obtain the target navigation sub-line of the first road segment.

6. The navigation method of claim 5, wherein the plurality of road segments further comprise

at least one second road segment, and the second road segment does not pass through an intersection,

determining the target navigation sub-line of at least one of the plurality of road segments based on the navigation line comprises, for the at least one second road segment:

determining a start lane and an end lane in the second road segment based on the target navigation sub-line of the first road segment connected to the second road segment;

extracting, based on pre-stored lane connection relationships, a first navigation route corresponding to at least one lane in the second road segment from the start lane to the end lane; and

splicing the first navigation route corresponding to at least one lane in the second road segment from the start lane to the end lane according to a passing order in the second road segment, to obtain the target navigation sub-line of the second road segment.

7. The navigation method of any of claims 2 to 3 and 5 to 6, wherein the first navigation route is generated in advance according to the following steps:

for any lane in a road scenario, respectively extracting a plurality of location points from lane lines indicating boundaries on two sides of the lane and corresponding to the lane, to form a plurality of location point pairs;

determining geographical locations of a plurality of center location points of the lane in the road scenario based on geographical locations of the plurality of location point pairs in the road scenario, each location point pair corresponding to one center location point; and

determining a first navigation route corresponding to the lane based on the geographical locations of the plurality of center location points in the road scenario.

8. The navigation method of claim 7, wherein respectively extracting the plurality of location points from the lane lines indicating boundaries on two sides of the lane and corresponding to

the lane, to form the plurality of location point pairs comprises:

acquiring lengths of the two lane lines comprised in the lane in the road scenario;

determining a number of the plurality of location points based on a length of a longest lane line of the two lane lines comprised in the lane;

respectively extracting, based on the number of the plurality of location points, the plurality of location points from the two lane lines comprised in the lane according to an interpolation manner; and

sorting the plurality of location points on at least one lane line comprised in the lane in a traveling direction of the lane, and forming two location points having a same serial number in different lane lines into one location point pair.

9. The navigation method of claim 7 or 8, wherein determining the geographical locations of the plurality of center location points of the lane in the road scenario based on the geographical locations of the plurality of location point pairs in the road scenario comprises:

for at least one location point pair, determining a geographical location of a center location point of a connection line of the location point pair in the road scenario based on the geographical location of at least one location point in the location point pair in the road scenario.

10. The navigation method of any of claims 7 to 9, wherein determining the first navigation route corresponding to the lane based on the geographical locations of the plurality of center location points in the road scenario comprises:

performing curve fitting on the plurality of center location points based on the geographical locations of the plurality of center location points in the road scenario, to obtain a first fitting curve;

extracting a plurality of points on the first fitting curve according to a preset interval,

and acquiring geographical locations of the plurality of points extracted on the first fitting curve in the road scenario; and

using the geographical locations of the plurality of points extracted on the first fitting curve in the road scenario as a traveling trajectory of the first navigation route corresponding to the lane.

11. The navigation method of any of claims 3 and 5 to 6, wherein the second navigation route is generated according to the following steps:

respectively acquiring a first center location point passed through during traveling into the intersection from the first lane and a second center location point passed through during traveling into the second lane from the intersection, the first center location point being a last one of center location points on the first lane, and the second center location point being a first one of center location points on the second lane;

determining a first direction vector for characterizing the traveling into the intersection from the first lane based on geographical locations respectively corresponding to two adjacent center location points on the first lane comprising the first center location point, and determining a second direction vector for characterizing the traveling into the second lane from the intersection based on geographical locations respectively corresponding to two adjacent center location points on the second lane comprising the second center location point; and

determining a traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the first center location point, the second center location point, the first direction vector and the second direction vector.

12. The navigation method of claim 11, wherein determining the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the

first lane based on the first center location point, the second center location point, the first direction vector and the second direction vector comprises:

determining a steering angle for traveling into the second lane from the first lane based on the first direction vector and the second direction vector;

determining a plurality of target control points configured to control a shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector; and

determining the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the plurality of target control points.

13. The navigation method of claim 12, wherein determining the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector comprises:

determining a center point of a connection line between the first center location point and the second center location point and a first distance between the first center location point and the second center location point, in a case where the steering angle is less than a preset angle;

acquiring a first target point that is obtained after an extension by a preset multiple of the first distance is made from the first center location point in a direction indicated by the first direction vector; and

acquiring a second target point that is obtained after an extension by the preset multiple of the first distance is made from the second center location point in a direction indicated by a vector opposite to the second direction vector,

wherein the plurality of target control points are formed by the first center location point, the first target point, the center point of the connection line between the first center

location point and the second center location point, the second target point, and the second center location point.

14. The navigation method of claim 12, wherein determining the plurality of target control points configured to control the shape of the second navigation route based on the steering angle, the first center location point, the second center location point, the first direction vector and the second direction vector comprises:

determining a first safe obstacle-avoidance distance of the target vehicle traveling into the intersection from the first lane based on size information of the target vehicle and an obstacle area corresponding to the first lane, in a case where the steering angle is greater than or equal to the preset angle;

determining a second safe obstacle-avoidance distance of the target vehicle traveling into the second lane from the intersection based on the size information of the target vehicle and an obstacle area corresponding to the second lane; and

determining the plurality of target control points based on the first center location point, the second center location point, an intersection point of the first direction vector and the second direction vector, the first safe obstacle-avoidance distance and the second safe obstacle-avoidance distance.

15. The navigation method of claim 14, wherein determining the plurality of target control points based on the first center location point, the second center location point, the intersection point of the first direction vector and the second direction vector, the first safe obstacle-avoidance distance and the second safe obstacle-avoidance distance comprises:

acquiring a third target point that is obtained after an extension by the first safe obstacle-avoidance distance is made from the first center location point in a direction indicated by the first direction vector;

acquiring a fourth target point that is obtained after an extension by the second safe

obstacle-avoidance distance is made from the second center location point in a direction indicated by a vector opposite to the second direction vector; and

determining a plurality of other target points in addition to the third target point and the fourth target point based on the third target point, the fourth target point, and the intersection point,

wherein the plurality of target control points are formed by the third target point, the plurality of other target points that are determined, and the fourth target point.

16. The navigation method of any of claims 12 to 15, wherein the determining the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane based on the plurality of target control points comprises:

determining a second fitting curve at the intersection during the traveling into the second lane from the first lane based on the plurality of target control points;

extracting a plurality of points on the second fitting curve according to a preset interval, and acquiring geographical locations of the plurality of points extracted on the second fitting curve in a road scenario; and

using the geographical locations of the plurality of points extracted on the second fitting curve in the road scenario as the traveling trajectory of the second navigation route at the intersection during the traveling into the second lane from the first lane.

17. The navigation method of any of claims 1 to 16, wherein controlling the target vehicle to travel according to the target navigation line comprises:

acquiring a geographical location of an obstacle in the road scenario in a case where the obstacle is detected during the traveling of the target vehicle according to the target navigation line; and

adjusting the target navigation line based on the geographical location of the obstacle

to control the target vehicle to bypass the obstacle, in a process of controlling the target vehicle to travel according to the target navigation line.

18. A navigation apparatus, comprising:

an acquisition module, configured to acquire a current positioning location and a navigation destination of a target vehicle as well as a navigation line associated with at least one lane on a road from the current positioning location to the navigation destination, the navigation line being generated in advance;

a generation module, configured to generate a target navigation line of the target vehicle from the current positioning location to the navigation destination based on the navigation line, the target navigation line being formed by splicing the navigation line of at least one lane; and

a control module, configured to control the target vehicle to travel according to the target navigation line.

19. An electronic device, comprising a processor, a memory and a bus, wherein the memory stores machine-readable instructions executable by the processor; when the electronic device is operated, the processor communicates with the memory by using the bus; and steps of the navigation method of any of claims 1 to 17 are performed when the machine-readable instructions are executed by the processor.

20. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program; and when the computer program is executed by a processor, steps of the navigation method of any of claims 1 to 17 are performed.

21. A computer program product, comprising computer-readable codes or a non-volatile

computer readable storage medium carrying the computer-readable codes, wherein when the computer-readable codes are operated in a processor of an electronic device, the processor of the electronic device performs the method of any of claims 1 to 17.