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(54) **METHOD, SYSTEM, TERMINAL, AND STORAGE MEDIUM FOR RAPID GENERATION OF REFERENCE LINES**

VERFAHREN UND SYSTEM ZUR SCHNELLEN ERZEUGUNG EINER REFERENZFAHRSTRECKE, ENDGERÄT UND SPEICHERMEDIUM

PROCÉDÉ ET SYSTÈME DE GÉNÉRATION RAPIDE D’ITINÉRAIRE DE CONDUITE DE RÉFÉRENCE, TERMINAL ET SUPPORT DE STOCKAGE

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Description

FIELD OF TECHNOLOGY

[0001] The present invention relates to the field of automotive electronics technology, and in particular, to a method, system, terminal, and storage medium for rapid generation of reference lines.

BACKGROUND

[0002] Reference lines are commonly used in path planning services based on a map. After receiving a start location and a destination input by the user, the map module generates a global path, which consists of sparse path nodes along the roads of a chosen route. The path nodes are topologically connected from the start location to the destination to form the global path.

[0003] Generally, the path nodes in a global path are geometrically connected by straight lines. Nevertheless, under circumstances of different road scenarios and various vehicle models with different dynamical parameters, a reference line has to simultaneously satisfy vehicle dynamics constraints and complex road conditions in reality as the vehicle's actual driving path of L4 or even L5. In complex parking lot scenarios, reference lines are updated by algorithm every time it receives a local map. Road segments with different driving difficulties also entail different difficulties in calculating reference lines. Adopting a single universal algorithm for all road segments with different driving difficulties will result in waste of system resources and make the calculation time-consuming.

[0004] Document EP 3 370 037 A1 discloses a method for route guidance in which a difficult-to-travel section appropriately is excluded and an alternative route with favourable route quality is provided.

[0005] Document US 2017/292843 A1 discloses a route-planning system for an automated vehicle in which each of a plurality of possible-routes is characterized by a difficulty-score in order to select a preferred-route from the plurality of possible-routes based on the difficulty-score.

[0006] Document CN 109 445 444 A discloses a robot path generation method in an obstacle concentration environment in which the RRT (fast-expanding random tree) algorithm is used to search and construct an extended random tree, and it is determined whether a longest effective distance between a random point and the target point is less than a set threshold. If so, the A* algorithm is used to search to the end, and if not, RRT algorithm search is continued. The final path is composed of portions of RRT search path and A* search path.

SUMMARY

[0007] In order to solve the above and other potential technical problems, the present invention provides a method, system, terminal, and storage medium for rapid generation of reference lines. Path planning points are classified according to driving difficulty of different road segments. The segments with low driving difficulty are assigned to geometrical reference line generation while the segments with high driving difficulty are assigned to reference line generation with algorithmic processing considering vehicle dynamics constraints. Then the reference lines of all segments are combined to form a complete reference line. This method requires less system resource and time-consuming.

[0008] A method for rapid generation of reference lines, including:

S01: Accessing a preloaded map and a global path, identifying path planning points and path directions within the preloaded map;

S02: According to driving difficulty, classifying path planning points:

> When driving difficulty of a portion of the path planning points is higher than a rated value, classifying the corresponding portion into high-difficulty local path portions, assigning a high-difficulty local path classification number to the corresponding portion, extracting path planning points within the coverage of the high-difficulty local path portions, and forming a high-difficulty local path planning point set;
>
> When driving difficulty of a portion of the path planning points is lower than the rated value, classifying the corresponding portion into low-difficulty local path portions, assigning a low-difficulty local path classification number to the corresponding portion, extracting path planning points within the coverage of the low-difficulty local path portions, and forming a low-difficulty local path planning point set;
>
> The combination of the high-difficulty local path portions and low-difficulty path portions is equal to global path planning portions in the preloaded map;

S03: Extracting each high-difficulty path planning point set with a high-difficulty local path classification number one by one, wherein each path planning point in the path planning point set include X coordinate information and Y coordinate information of the path planning point,

Traversing the X coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the X coordinates of the path planning points;
Traversing the Y coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the Y coordinates of the path planning points;
Forming a high-difficulty local path area with boundaries determined by the maximum value of the x coordinates, the minimum value of the x coordinates, the maximum value of the y coordinates, and the minimum value of the y coordinates;

S04: Simulating reference lines in an algorithm based on high-difficulty path points in each high-difficulty local path area, and obtaining reference lines in a geometric manner based on path planning points in each low-difficulty local path area; splicing high-difficulty local path planning and low-difficulty local path planning according to classification numbers, forming path planning of local maps.

[0009] Further, the present disclosure provides for the following situations:
According to driving difficulty, classifying path planning points: when the driving difficulty cannot be identified, the corresponding path planning points in the preloaded map are given a unified classification number.

[0010] Further, the step S01 of accessing a preloaded map and global path planning, finding path planning points and path directions within the preloaded maps further includes step S011: determining whether height information of the preloaded map and height information of a previous local map that the vehicle traveled past are consistent; if so, the process proceeds to step S02; if not, the process ends.

[0011] Further, in step S04, the algorithm used in simulating reference lines is: the Hybrid A star Algorithm. The input layer of the Hybrid A star algorithm includes: centerline data of two lanes that require turning around, where data of each point of the centerline contains position and orientation (X, Y, theta). The Hybrid A star algorithm is used for trajectory generation calculation, which can generate a smooth trajectory with smooth curvature, so that the vehicle can turn around. The output layer of the Hybrid A star algorithm includes a complete trajectory that connects two lanes, and each point in the trajectory contains position, orientation, and curvature (X, Y, theta, kappa).

[0012] Use the Hybrid A star algorithm to find a viable trajectory. In the discrete case, the path given by the Hybrid A star is not viable, but when taking kinetic constraints of the vehicle into consideration, desired results may be reached.

[0013] The Hybrid A star algorithm includes the following steps:

S041: Using kinetic constraints to calculate a scalable region of the Hybrid A star algorithm, i.e., scalable grid cell; the HeuristicCost needs to be optimized appropriately for the U-Turn scenario while satisfying the kinetic constraints;
S042: Deleting unreasonable areas, wherein the unreasonable areas include obstacles, off-map areas, and inefficient areas;
S043: Recording continuous vehicle states and associated discrete grid cell;
S044: After the search result is obtained, retrieving the continuous poses (x, y, theta) associated with the path;
S045: Checking if the curvature is smooth.

[0014] The Hybrid A star Algorithm realizes visualization in the program: visualization is achieved by Python's Matplotlib.

[0015] Hybrid A star Algorithm Testing: The code section does not include the test framework (Gtest, Boosttest et al.), but use scripts to match the lightweight scheme of C ++ Assert, because many naked eye observations and batch reading of test files are required during development and testing, and using C ++ would have higher requirements for code maintenance, and visualization without coupling the code cannot be realized.

[0016] The Hybrid A star Algorithm uses no map of a three-dimensional array form, but uses std :: Vector <std :: map <Point, State >> . This form resembles a sparse matrix expression, which saves storage, and greatly reduces the calculation of coordinate system conversion. The final trajectory are fitted and resampled, in order to make the trajectory smooth while calculating kappa, which is given by:

$$K = \frac{|\varphi'(t)\omega''(t) - \omega'(t)\varphi''(t)|}{[\varphi'^2(t) + \omega'^2(t)]^{\frac{3}{2}}}$$

[0017] Where the curve is given by the parametric equation $\begin{cases} x = \varphi(t) \\ y = \omega(t) \end{cases}$, and the K value can be obtained by using the parametric equation.

[0018] Further, instead of the Hybrid A star algorithm, an arc can be generated as a reference line, and then optimized using quatric programing. Use the entrance of the target lane as the end-configuration space, and then use Jerk minimize to calculate the vehicle viable trajectory directly, and then check whether the trajectory is within the boundary or there is a collision. This method may result in the calculated trajectory not satisfying the vehicle dynamics constraints. For example, curves of some points may be too large.

[0019] The present disclosure further provides a system for rapid generation of reference lines, including:

a map module, where the map module includes a city-level map of a city, a district-level map of a district, a township-level map of a township, a street-level map, or a map of an indoor scene;
a global path planning module, where the global path planning module includes a starting location, and a destination of the vehicle, and road path points between the starting location and the destination;
a driving difficulty classification module, where the driving difficulty classification module is used to classify paths of a local map preloaded in the system; driving difficulty analysis is performed before the classification, where when a portion's driving difficulty is determined to be higher than a rated value, the portion is classified into high-difficulty local path portions, and path planning points in the high-difficulty local path portions are extracted, to form a high-difficulty local path planning point set; when a portion's driving difficulty is lower than the rated value, the portion is classified into low-difficulty local path portions, and path planning points in the low-difficulty local path portions are extracted to form a low-difficulty local path planning point set; and
a reference line generating module, wherein the reference line generating module, in accordance with classification results of the driving difficulty classification module, generates reference lines in different manners based on high-difficulty local path planning points and low-difficulty local path planning points respectively, then slices reference lines to obtain a complete reference line.

[0020] Further, when the driving difficulty classification module classifies the high-difficulty local path planning point set, a high-difficulty local path area is first obtained, and the method for obtaining the area is:
Extracting each high-difficulty path planning point set with a high-difficulty local path classification number one by one, wherein each path planning point in the path planning point set includes the x coordinate information and y coordinate information of the path planning point; traversing the x coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the x coordinates of the path planning points; traversing the y coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the y coordinates of the path planning points; forming a high-difficulty local path area with boundaries determined by the maximum value of the x coordinates, the minimum value of the x coordinates, the maximum value of the y coordinates, and the minimum value of the y coordinates.

[0021] The present disclosure further provides a terminal for rapid generation of reference lines, such as a smart phone capable of executing the above mentioned method for rapid generation of reference lines, or an in-vehicle terminal control equipment capable of executing the above mentioned method for rapid generation of reference lines.

[0022] The present disclosure further provides a computer readable storage medium having a computer program stored thereon, characterized in that when the program is executed by a processor, the method for rapid generation of reference lines is performed.

[0023] As described above, the present invention has the following advantages:
Path planning points are classified according to driving difficulty of different road segments, and the segments with low driving difficulty are assigned reference lines obtained by geometric processing; the segments with high driving difficulty are assigned reference lines obtained by algorithmic processing in combination with vehicle dynamics constraints. Then the reference lines of all segments are combined to form a complete reference line. This method requires little system resource and the algorithm consumes less time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] In order to more clearly illustrate the technical solutions in the embodiments of the present invention, the following is a brief description of the accompanying drawings to be used in the description of the embodiments, it is obvious that the following description of the accompanying drawings are only some embodiments of the present invention, for the person of ordinary skill in the art, without creative work, other drawings can be obtained according to these accompanying drawings.

Figure 1 shows a flow chart of the present invention.
Figure 2 shows a schematic diagram of reference driving lines in an indoor parking lot at a given moment of the present invention.
Figure 3 shows a schematic diagram of reference driving lines in the indoor parking lot at the next moment of the present invention.
Figure 4 shows a schematic diagram of reference driving lines in the indoor parking lot at the next moment of the present invention.
Figure 5 is a schematic diagram showing portions of a preloaded local map classified by a driving difficulty classification module.
Figure 6 is a schematic diagram showing a high driving difficulty portion of the preloaded local map classified by the driving difficulty classification module.
Figure 7 is a schematic diagram showing a low driving difficulty portion of the preloaded local map classified by the driving difficulty classification module.
Figure 8 is a schematic diagram showing another low driving difficulty portion of the preloaded local map classified by the driving difficulty classification module.
Figure 9 is a schematic diagram showing portions of another preloaded local map classified by the driving difficulty classification module..
Figure 10 is a schematic diagram showing another high driving difficulty portion of another preloaded local map classified by the driving difficulty classification module.

[0025] 100-First low-difficulty local path portion; 200-First high-difficulty local path portion; 300-second low-difficulty local path portion; 400-fourth low-difficulty local path portion; 500-fifth high-difficulty local path portion; 101 to 106-path points of the first low-difficulty local path portion; 201 to 211-path points of the first high-difficulty local path portion; 301 to 305-path points of the second low-difficulty local path portion; 501 to 521-path points of the fifth high-difficulty local path portion.

DETAILED DESCRIPTION

[0026] The following describes the implementation of the present disclosure through specific examples, and those skilled in the art can easily understand other advantages and effects of the present disclosure from the content disclosed in this specification. The present disclosure can also be implemented or applied through other different specific embodiments. Various details in this specification can also be modified or changed based on different viewpoints and applications without departing from the scope as set forth by the appended claims. It should be noted that the following embodiments and the features in the embodiments can be combined with each other if no conflict will result.
[0027] It should be noted that the structure, ratio, size, etc. shown in the accompanying drawings in this specification are only used to illustrate the content disclosed in the specification for the understanding and reading of those familiar with this technology, and are not intended to limit the implementation of the present invention. Any structural modification, proportional relationship change or size adjustment should still fall within the scope of the present disclosure, given that no effect and objective achievable by the present disclosure are hindered. Terms such as "upper", "lower", "left", "right", "middle", and "a" used in this specification are only for ease of description, and they are not intended to limit the scope of implementation of the present invention. Any change or adjustment of corresponding relative relationships without any substantial technical change should be regarded as within the scope of the implementation of the present disclosure.

See Figures 1to 10,

[0028] A method for rapid generation of reference lines, including:

S01: Accessing a preloaded map and a global path, identifying path planning points and path directions within the preloaded maps;
S02: According to driving difficulty, classifying path planning points:

When driving difficulty of a portion of the path planning points is higher than a rated value, classifying the corresponding portion into high-difficulty local path portions, assigning a high-difficulty local path classification number to the corresponding portion, extracting path planning points within the coverage of the high-difficulty local path portions, and forming a high-difficulty local path planning point set;
When driving difficulty of a portion of the path planning points is lower than the rated value, classifying the

corresponding portion into low-difficulty local path portions, assigning a low-difficulty local path classification number to the corresponding portion, extracting path planning points within the coverage of the low-difficulty local path portions, and forming a low-difficulty local path planning point set;
The combination of the high-difficulty local path portions and low-difficulty path portions is equal to the global path planning portions in the preloaded map;

S03: Extracting each high-difficulty path planning point set with a high-difficulty local path classification number one by one, wherein each path planning point in the path planning point set include X coordinate information and Y coordinate information of the path planning point,

Traversing the X coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the X coordinates of the path planning points;
Traversing the Y coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the Y coordinates of the path planning points;
Forming a high-difficulty local path area, with boundaries determined by the maximum value of X coordinates, the minimum value of the X coordinates, the maximum value of the Y coordinates, and the minimum value of the y coordinates;

S04: Simulating reference lines in an algorithm based on high-difficulty path points path in each high-difficulty local path area, and obtaining reference lines in a geometric manner based on path planning points in each low-difficulty local path area; slicing high-difficulty local path planning and low-difficulty local path planning according to classification numbers, forming path planning of local maps.

[0029] Further, if step S04 cannot be executed, reference lines of the high-difficulty local path area are generated by a searching method; if the searching method generates reference lines for the high-difficulty local path area, the reference lines of the high-difficulty local path area are sliced with reference lines of the remaining path areas; if the searching method fails to generate reference lines for the high-difficulty local path area, return to step S01 to re-identify for path planning points and path directions within the preloaded map.

[0030] Further, the present disclosure provides for the following situations:
According to driving difficulty, classifying path planning points: when the driving difficulty cannot be identified, the corresponding path planning points in the preloaded map are given a unified classification number.

[0031] Further, the step S01 of accessing a preloaded map and global path planning, finding path planning points and path directions within the preloaded maps further includes step S011: determining whether height information of the preloaded map and height information of a previous local map that the vehicle traveled past are consistent; if so, the process proceeds to step S02; if not, the process ends.

[0032] Further, in step S04, the algorithm used in simulating reference lines is: the Hybrid A star Algorithm. The input layer of the Hybrid A star algorithm includes: centerline data of two lanes that require turning around, where data of each point of the centerline contains position and orientation (X, Y, theta). The Hybrid A star algorithm is used for trajectory generation calculation, which can generate a smooth trajectory with smooth curvature, so that the vehicle can turn around. The output layer of the Hybrid A star algorithm includes a complete trajectory that connects two lanes, and each point in the trajectory contains position, orientation, and curvature (X, Y, theta, kappa).

[0033] Use the Hybrid A star algorithm to find a viable trajectory. In the discrete case, the path given by the Hybrid A star is not viable, but when taking kinetic constraints of the vehicle into consideration, desired results may be reached.

[0034] The Hybrid A star algorithm includes the following steps:

S041: Using kinetic constraints to calculate a scalable region of the Hybrid A star algorithm, i.e., scalable grid cell; The HeuristicCost needs to be optimized appropriately for the U-Turn scenario while satisfying the kinetic constraints;
S042: Deleting unreasonable areas, the unreasonable areas include obstacles, off-map areas, and inefficient areas;
S043: Recording continuous vehicle state and associated discrete grid cell;
S044: After the search result is obtained, retrieving the continuous poses (x, y, theta) associated with the path;
S045: Checking if the curvature is smooth.

[0035] The Hybrid A star Algorithm realizes visualization in the program: visualization is achieved by Python's Matplotlib.

[0036] Hybrid A star Algorithm Testing: The code section does not include the test framework (Gtest, Boosttest et al.), but use scripts to match the lightweight scheme of C ++ Assert, because many naked eye observations and batch reading of test files are required during development and testing, and using C ++ would have higher requirements for code maintenance, and visualization without coupling the code cannot be realized.

[0037] The Hybrid A star Algorithm uses no map of a three-dimensional array form, but uses std :: Vector <std :: map

<point, state >> . This form resembles a sparse matrix expression, which saves storage, and greatly reduces the calculation of coordinate system conversion. The final trajectory are fitted and resampled, in order to make the trajectory smooth while calculating kappa, which is given by:

$$\mathrm{K} = \frac{|\varphi'(t)\omega''(t) - \omega'(t)\varphi''(t)|}{[\varphi'^2(t) + \omega'^2(t)]^{\frac{3}{2}}}$$

[0038] Where the curve is given by the parametric equation $\begin{cases} x = \varphi(t) \\ y = \omega(t) \end{cases}$, and the K value can be obtained by using the parametric equation.

[0039] Further, instead of the Hybrid A star algorithm, an arc can be generated as a reference line, and then optimized using quatric programing. Use the entrance of the target lane as the end-configuration space, and then use Jerk minimize to calculate the vehicle viable trajectory directly, and then check whether the trajectory is within the boundary or there is a collision. This method may result in the calculated trajectory not satisfying the vehicle dynamics constraints. For example, curves of some points may be too large.

[0040] A system for rapid generation of reference lines, comprising:

a map module, where the map module includes a city-level map of a city, a district-level map of a district, a township-level map of a township, a street-level map, or a map of an indoor scene;
a global path planning module, where the global path planning module includes a starting location, and a destination location of the vehicle, and road path points between the starting location and the destination location;
a driving difficulty classification module, where the driving difficulty classification module is used to classify paths of a local map preloaded in the system; driving difficulty analysis is performed before the classification, where when a portion's driving difficulty is determined to be higher than a rated value, the portion is classified into high-difficulty local path portions, and path planning points in the high-difficulty local path portions are extracted, to form a high-difficulty local path planning point set; when a portion's driving difficulty is lower than the rated value, the portion is classified into low-difficulty local path portions, and path planning points in the low-difficulty local path portions are extracted to form a low-difficulty local path planning point set;
a reference line generating module, wherein the reference line generating module, in accordance with classification results of the driving difficulty classification module, generates reference lines in different manners based on high-difficulty local path planning points and low-difficulty local path planning points respectively, then slices reference lines to obtain a complete reference line.

[0041] Further, when the driving difficulty classification module classifies the high-difficulty local path planning point set, a high-difficulty local path area is first obtained, and the method for obtaining the area is:
Extracting each high-difficulty path planning point set with a high-difficulty local path classification number one by one, wherein each path planning point in the path planning point set includes the X coordinate information and Y coordinate information of the path planning points; traversing the X coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the X coordinates of the path planning points; traversing the Y coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the Y coordinates of the path planning points; forming a high-difficulty local path area, with boundaries determined by the maximum value of X coordinates, the minimum value of the X coordinates, the maximum value of the Y coordinates, and the minimum value of the y coordinates.

[0042] A terminal for rapid generation of reference lines, such as a smart phone capable of executing the above mentioned method for rapid generation of reference lines, or an in-vehicle terminal control equipment capable of executing the above mentioned method for rapid generation of reference lines.

[0043] A computer readable storage medium having a computer program stored thereon, characterized in that when the program is executed by a processor, the method for rapid generation of reference lines is performed.

[0044] As a preferred embodiment, the present disclosure also provides a terminal device, such as a smart phone, a tablet, a laptop, a desktop computer, a rack-mounted cloud, a blade cloud, a tower cloud, or a cabinet cloud (including a stand-alone cloud, or a cluster of clouds formed by a plurality of clouds) that can execute a program, etc. The terminal device of this embodiment includes at least, but not limited to: a memory and a processor that can be communicatively connected to each other via a system bus. It should be noted that the terminal device includes a memory and processor, but it should be understood that not all components required for implementation are shown, and that more or fewer components can be used to implement the method for rapid generation of reference lines consistent with vehicle dynamics.

[0045] As a preferred embodiment, the memory (i.e., readable storage medium) includes flash memory, hard disk, multimedia card, card-type memory (e.g., SD or DX memory, etc.), random access memory (RAM), static random access memory (SRAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), programmable read-only memory (PROM), magnetic memory, disk, CD-ROM, etc. In some embodiments, the memory can be an internal storage unit of a computer, such as a hard disk or memory of the computer. In other embodiments, the memory can also be an external storage device of a computer, such as a plug-in hard disk equipped on the computer device, a smart media card (SMC), secure digital (SD) card, flash card, etc. Of course, the memory can also include both internal and external storage units of the computer. In this embodiment, the memory is typically used to store an operating system and various application software installed on the computer, such as a program for the method for generating reference lines consistent with vehicle kinetics in an embodiment. In addition, the memory can also be used to temporarily store various types of data that have been output or will be output.

[0046] This embodiment also provides a computer readable storage medium such as flash memory, hard disk, multimedia card, card type memory (e.g., SD or DX memory, etc.), random access memory (RAM), static random access memory (SRAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), programmable read-only memory (PROM), magnetic memory, disk, CD-ROM, cloud, App Store, etc., on which computer programs are stored, and the programs perform corresponding functions when executed by the processor. The computer readable storage medium of the present embodiment is used to store a program for the method for generating reference lines consistent with vehicle kinetics, wherein when the program is executed by the processor, the method for generating reference lines consistent with vehicle kinetics is performed.

[0047] The above-mentioned embodiments only exemplarily illustrate the principles and effects of the present disclosure, but are not used to limit the present disclosure. Anyone familiar with this technology can modify or change the above-mentioned embodiments without departing from the scope of the present disclosure.

Claims

1. A computer-implemented method for rapid generation of navigation reference lines, comprising:

S01: accessing a preloaded map and a global path, identifying path planning points and path directions within the preloaded map;
S02: according to driving difficulty, classifying the path planning points:

when driving difficulty of a portion of the path planning points is higher than a rated value, classifying the corresponding portion into high-difficulty local path portions, assigning a high-difficulty local path classification number to the corresponding portion, extracting path planning points within the coverage of the high-difficulty local path portions, and forming a high-difficulty local path planning point set;
when driving difficulty of a portion of the path planning points is lower than the rated value, classifying the corresponding portion into low-difficulty local path portions, assigning a low-difficulty local path classification number to the corresponding portion, extracting path planning points within the coverage of the low-difficulty local path portions, and forming a low-difficulty local path planning point set;
wherein the combination of the high-difficulty local path portions and the low-difficulty local path portions is equal to global path planning portions in the preloaded map;

S03: extracting each high-difficulty path planning point set with a high-difficulty local path classification number one by one, wherein each path planning point in the path planning point set includes the X coordinate information and Y coordinate information of the path planning point,

traversing the X coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the X coordinates of the path planning points;
traversing the Y coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the Y coordinates of the path planning points;
forming a high-difficulty local path area, with boundaries determined by the maximum value of X coordinates, the minimum value of the X coordinates, the maximum value of the Y coordinates, and the minimum value of the y coordinates;

S04: simulating first navigation reference lines in an algorithm based on high-difficulty path points in each high-difficulty local path area, and obtaining second navigation reference lines in a geometric manner based on path planning points in each low-difficulty local path portions; splicing the first reference lines and the second reference lines according to classification numbers and hereby forming a complete navigation reference line in the preloaded map.

2. The method for rapid generation of navigation reference lines according to claim 1, wherein the step of classifying the path planning points according to the driving difficulty further includes that if the driving difficulty cannot be identified, the corresponding path planning points in the preloaded map are given a unified classification number.

3. The method for rapid generation of navigation reference lines according to claim 1, wherein the step S01 of accessing a preloaded map and global path planning, identifying path planning points and path directions within the preloaded map further includes step S011: determining whether height information of the preloaded map and height information of a previous local map that the vehicle traveled past are consistent; if so, the process proceeds to step S02; if not, the process ends.

4. The method for rapid generation of navigation reference lines according to claim 1, wherein: in step S04, the algorithm used in simulating navigation reference lines is the Hybrid A star Algorithm;

an input layer of the Hybrid A star algorithm includes: centerline data of two lanes that require turning around; wherein data of each point of the centerline contains position and orientation (X, Y, theta);
the Hybrid A star algorithm is used for trajectory generation calculation, which can generate a smooth trajectory with smooth curvature, so that the vehicle can turn around;
an output layer of the Hybrid A star algorithm includes a complete trajectory that connects two lanes, and each point in the track contains data of position, orientation, and curvature (X, Y, theta, kappa).

5. The method for rapid generation of navigation reference lines according to claim 4, wherein the Hybrid A star algorithm includes the following steps:

S041: using kinetic constraints to calculate a scalable region of the Hybrid A star algorithm, i.e., scalable grid cell; the HeuristicCost needs to be optimized appropriately for a U-Turn scenario while satisfying a kinetic constraints;
S042: deleting unreasonable areas, the unreasonable areas include obstacles, off-map areas, and inefficient areas;
S043: recording continuous vehicle state and associated discrete grid cell;
S044: after a search result is obtained, retrieving continuous poses (x, y, theta) associated with the path; and
S045: checking if the curvature is smooth.

6. The method for rapid generation of navigation reference lines according to claim 4, wherein: the Hybrid A star Algorithm adopts a form of std :: Vector <std :: map <Point, State >>.

7. The method for rapid generation of navigation reference lines according to claim 5, wherein the step S045 of checking if the curvature is smooth includes fitting and resampling, wherein the curvature is given by:

$$\mathrm{K} = \frac{|\varphi'(t)\omega''(t) - \omega'(t)\varphi''(t)|}{[\varphi'^2(t) + \omega'^2(t)]^{\frac{3}{2}}}$$

8. A system for rapid generation of navigation reference lines configured to perform the method of any of the claims 1 to 7, comprising:

a map module, wherein the map module includes a city-level map of a city, a district-level map of a district, a township-level map of a township, a street-level map, or a map of an indoor scene;
a global path planning module, wherein the global path planning module includes a starting location, and a destination location of the vehicle, and road path points between the starting location and the destination location;
a driving difficulty classification module, wherein the driving difficulty classification module is used to classify paths of a local map preloaded in the system; driving difficulty analysis is performed before the classification,

wherein when a portion's driving difficulty is determined to be higher than a rated value, the portion is classified into high-difficulty local path portions, and path planning points in the high-difficulty local path portions are extracted, to form a high-difficulty local path planning point set; when a portion's driving difficulty is lower than the rated value, the portion is classified into low-difficulty local path portions, and path planning points in the low-difficulty local path portions are extracted to form a low-difficulty local path planning point set; and
a navigation reference line generating module, wherein the navigation reference line generating module, in accordance with classification results of the driving difficulty classification module, generates navigation reference lines in different manners based on high-difficulty local path planning points and low-difficulty local path planning points respectively, then splices navigation reference lines to obtain a complete navigation reference line.

9. The system for rapid generation of navigation reference lines according to claim 8, wherein when the driving difficulty classification module classifies the high-difficulty local path planning point set, a high-difficulty local path area is first obtained, and the method for obtaining the area includes:
extracting each high-difficulty path planning point set with a high-difficulty local path classification number one by one, wherein each path planning point in the path planning point set includes x coordinate information and y coordinate information of the path planning point; traversing the x coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the x coordinates of the path planning points; traversing the y coordinate information of all path planning points in the high-difficulty path planning point set, finding the maximum value and minimum value of the y coordinates of the path planning points; forming a high-difficulty local path area, with boundaries determined by the maximum value of x coordinates, the minimum value of the x coordinates, the maximum value of the y coordinates, and the minimum value of the y coordinates.

10. A terminal device, wherein the terminal device is a smart phone configured to execute the method for rapid generation of navigation reference lines according to any one of claims 1-7, or an in-vehicle terminal control equipment configured to implement the system for rapid generation of navigation reference lines according to any one of claims 8-9.

11. A computer-readable non-transitory storage medium having a computer program stored thereon, **characterized in that** when the program is executed by a processor, the method according to any one of claims 1-7 is performed.

Patentansprüche

1. Computerimplementiertes Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien, umfassend:

S01: Zugreifen auf eine vorab geladene Karte und einen globalen Pfad, Identifizieren von Pfadplanungspunkten und Pfadrichtungen innerhalb der vorab geladenen Karte;
S02: Klassifizieren der Pfadplanungspunkte gemäß Fahrtschwierigkeitsgrad:

wenn der Fahrtschwierigkeitsgrad eines Abschnitts der Pfadplanungspunkte höher als ein Nennwert ist, Klassifizieren des entsprechenden Abschnitts in lokale Pfadabschnitte mit hohem Schwierigkeitsgrad, Zuweisen einer lokalen Pfadklassifizierungsnummer mit hohem Schwierigkeitsgrad zu dem entsprechenden Abschnitt, Extrahieren von Pfadplanungspunkten innerhalb der Abdeckung der lokalen Pfadabschnitte mit hohem Schwierigkeitsgrad und Bilden eines lokalen Pfadplanungspunktsatzes mit hohem Schwierigkeitsgrad;
wenn der Fahrtschwierigkeitsgrad eines Abschnitts der Pfadplanungspunkte niedriger als der Nennwert ist, Klassifizieren des entsprechenden Abschnitts in lokale Pfadabschnitte mit niedrigem Schwierigkeitsgrad, Zuweisen einer lokalen Pfadklassifizierungsnummer mit niedrigem Schwierigkeitsgrad zu dem entsprechenden Abschnitt, Extrahieren von Pfadplanungspunkten innerhalb der Abdeckung der lokalen Pfadabschnitte mit niedrigem Schwierigkeitsgrad und Bilden eines lokalen Pfadplanungspunktsatzes mit niedrigem Schwierigkeitsgrad;
wobei die Kombination der lokalen Pfadabschnitte mit hohem Schwierigkeitsgrad und der lokalen Pfadabschnitte mit niedrigem Schwierigkeitsgrad gleich den globalen Pfadplanungsabschnitten in der vorab geladenen Karte ist;

S03: Extrahieren jedes Pfadplanungspunktsatzes mit hohem Schwierigkeitsgrad mit einer lokalen Pfadklassifizierungsnummer mit hohem Schwierigkeitsgrad eins nach dem anderen, wobei jeder Pfadplanungspunkt in dem Pfadplanungspunktsatz die X-Koordinateninformationen und Y-Koordinateninformationen des Pfadpla-

nungspunkts enthält, Durchqueren der X-Koordinateninformationen aller Pfadplanungspunkte in dem Pfadplanungspunktsatz mit hohem Schwierigkeitsgrad, Finden des Maximalwerts und Minimalwerts der X-Koordinaten der Pfadplanungspunkte; Durchlaufen der Y-Koordinateninformationen aller Pfadplanungspunkte in dem Pfadplanungspunktsatz mit hohem Schwierigkeitsgrad, Finden des Maximalwerts und Minimalwerts der Y-Koordinaten der Pfadplanungspunkte; Bilden eines lokalen Pfadbereichs mit hohem Schwierigkeitsgrad mit Grenzen, die durch den Maximalwert der X-Koordinaten, den Minimalwert der X-Koordinaten, den Maximalwert der Y-Koordinaten und den Minimalwert der y-Koordinaten bestimmt werden;
S04: Simulieren von ersten Navigationsreferenzlinien in einem Algorithmus basierend auf Pfadpunkten mit hohem Schwierigkeitsgrad in jedem lokalen Pfadbereich mit hohem Schwierigkeitsgrad und Erhalten von zweiten Navigationsreferenzlinien in einer geometrischen Weise basierend auf Pfadplanungspunkten in jedem lokalen Pfadabschnitt mit niedrigem Schwierigkeitsgrad; Verbinden der ersten Referenzlinien und der zweiten Referenzlinien gemäß Klassifizierungsnummern und dadurch Bilden einer vollständigen Navigationsreferenzlinie in der vorab geladenen Karte.

2. Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien nach Anspruch 1, wobei der Schritt des Klassifizierens der Pfadplanungspunkte gemäß dem Fahrtschwierigkeitsgrad ferner umfasst, dass, wenn der Fahrtschwierigkeitsgrad nicht identifiziert werden kann, den entsprechenden Pfadplanungspunkten in der vorab geladenen Karte eine vereinheitlichte Klassifizierungsnummer gegeben wird.

3. Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien nach Anspruch 1, wobei der Schritt S01 des Zugreifens auf eine vorab geladene Karte und der globalen Pfadplanung, Identifizieren von Pfadplanungspunkten und Pfadrichtungen innerhalb der vorab geladenen Karte ferner Schritt S011 umfasst: Bestimmen, ob Höheninformationen der vorab geladenen Karte und Höheninformationen einer vorangegangenen lokalen Karte, an der das Fahrzeug vorbeigefahren ist, konsistent sind; wenn dies der Fall ist, geht der Prozess zu Schritt S02 über; wenn dies nicht der Fall ist, endet der Prozess.

4. Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien nach Anspruch 1, wobei: in Schritt S04 der Algorithmus, der beim Simulieren von Navigationsreferenzlinien verwendet wird, der Hybrid-A-Stern-Algorithmus ist; eine Eingabeschicht des Hybrid-A-Stern-Algorithmus umfasst:

Mittelliniendaten von zwei Fahrspuren, die ein Wenden erfordern; wobei Daten jedes Punkts der Mittellinie Position und Orientierung (X, Y, Theta) enthalten;
der Hybrid-A-Stern-Algorithmus zur Trajektorienerzeugungsberechnung verwendet wird, die eine glatte Trajektorie mit glatter Krümmung erzeugen kann, so dass das Fahrzeug wenden kann;
eine Ausgabeschicht des Hybrid-A-Stern-Algorithmus eine vollständige Trajektorie umfasst, die zwei Fahrspuren verbindet, und jeder Punkt in der Spur Daten von Position, Orientierung und Krümmung (X, Y, Theta, Kappa) enthält.

5. Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien nach Anspruch 4, wobei der Hybrid-A-Stern-Algorithmus die folgenden Schritte umfasst:

S041: Verwenden von kinetischen Beschränkungen, um einen skalierbaren Bereich des Hybrid-A-Stern-Algorithmus, d. h. eine skalierbare Gitterzelle, zu berechnen; die Heuristik-Kosten müssen für ein U-Wende-Szenario angemessen optimiert werden, während sie kinetische Beschränkungen erfüllen;
S042: Löschen unzweckmäßiger Bereiche, wobei die unzweckmäßigen Bereiche Hindernisse, Bereiche außerhalb der Karte und ineffiziente Bereiche umfassen;
S043: Aufzeichnen eines kontinuierlichen Fahrzeugzustands und einer zugehörigen diskreten Gitterzelle;
S044: Abrufen von kontinuierlichen Posen (x, y, Theta), die dem Pfad zugeordnet sind, nachdem ein Suchergebnis erhalten wurde; und
S045: Prüfen, ob die Krümmung glatt ist.

6. Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien nach Anspruch 4, wobei: der Hybrid-A-Stern-Algorithmus eine Form von std ::
Vektor <std :: Karte <Punkt, Zustand >> annimmt.

7. Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien nach Anspruch 5, wobei der Schritt S045 des Prüfens, ob die Krümmung glatt ist, ein Angleichen und Neuabtasten umfasst, wobei die Krümmung durch Folgendes gegeben ist:

$$K = \frac{|\varphi'(t)\omega''(t) - \omega'(t)\varphi''(t)|}{[\varphi'^2(t) + \omega'^2(t)]^{\frac{3}{2}}}$$

8. System zur schnellen Erzeugung von Navigationsreferenzlinien, das konfiguriert ist, um das Verfahren nach einem der Ansprüche 1 bis 7 auszuführen, umfassend:

ein Kartenmodul, wobei das Kartenmodul eine Karte auf Stadtebene einer Stadt, eine Karte auf Bezirksebene eines Bezirks, eine Karte auf Gemeindeebene einer Gemeinde, eine Karte auf Straßenebene oder eine Karte einer Innenszene umfasst;
ein globales Pfadplanungsmodul, wobei das globale Pfadplanungsmodul einen Startort und einen Zielort des Fahrzeugs und Straßenpfadpunkte zwischen dem Startort und dem Zielort umfasst;
ein Fahrschwierigkeitsklassifizierungsmodul, wobei das Fahrschwierigkeitsklassifizierungsmodul verwendet wird, um Pfade einer lokalen Karte zu klassifizieren, die in dem System vorab geladen ist; wobei eine Fahrschwierigkeitsanalyse vor der Klassifizierung ausgeführt wird, wobei, wenn bestimmt wird, dass der Fahrschwierigkeitsgrad eines Abschnitts höher als ein Nennwert ist, der Abschnitt in lokale Pfadabschnitte mit hohem Schwierigkeitsgrad klassifiziert wird und Pfadplanungspunkte in den lokalen Pfadabschnitten mit hohem Schwierigkeitsgrad extrahiert werden, um einen lokalen Pfadplanungspunktsatz mit hohem Schwierigkeitsgrad zu bilden; wenn der Fahrschwierigkeitsgrad eines Abschnitts niedriger als der Nennwert ist, der Abschnitt in lokale Pfadabschnitte mit niedrigem Schwierigkeitsgrad klassifiziert wird und Pfadplanungspunkte in den lokalen Pfadabschnitten mit niedrigem Schwierigkeitsgrad extrahiert werden, um einen lokalen Pfadplanungspunktsatz mit niedrigem Schwierigkeitsgrad zu bilden; und
ein Navigationsreferenzlinienerzeugungsmodul, wobei das Navigationsreferenzlinienerzeugungsmodul gemäß den Klassifizierungsergebnissen des Fahrschwierigkeitsklassifizierungsmoduls Navigationsreferenzlinien in unterschiedlicher Weise basierend auf lokalen Pfadplanungspunkten mit hohem Schwierigkeitsgrad bzw. lokalen Pfadplanungspunkten mit niedrigem Schwierigkeitsgrad erzeugt und dann Navigationsreferenzlinien verbindet, um eine vollständige Navigationsreferenzlinie zu erhalten.

9. System zur schnellen Erzeugung von Navigationsreferenzlinien nach Anspruch 8, wobei, wenn das Fahrschwierigkeitsklassifizierungsmodul den lokalen Pfadplanungspunktsatz mit hohem Schwierigkeitsgrad klassifiziert, zuerst ein lokaler Pfadbereich mit hohem Schwierigkeitsgrad erhalten wird und das Verfahren zum Erhalten des Bereichs umfasst:
Extrahieren jedes Pfadplanungspunktsatzes mit hohem Schwierigkeitsgrad mit einer lokalen Pfadklassifizierungsnummer mit hohem Schwierigkeitsgrad eins nach dem anderen, wobei jeder Pfadplanungspunkt in dem Pfadplanungspunktsatz x-Koordinateninformationen und y-Koordinateninformationen des Pfadplanungspunkts enthält; Durchqueren der x-Koordinateninformationen aller Pfadplanungspunkte in dem Pfadplanungspunktsatz mit hohem Schwierigkeitsgrad, Finden des Maximalwerts und Minimalwerts der x-Koordinaten der Pfadplanungspunkte; Durchqueren der y-Koordinateninformationen aller Pfadplanungspunkte in dem Pfadplanungspunktsatz mit hohem Schwierigkeitsgrad, Finden des Maximalwerts und Minimalwerts der y-Koordinaten der Pfadplanungspunkte; Bilden eines lokalen Pfadbereichs mit hohem Schwierigkeitsgrad mit Grenzen, die durch den Maximalwert der x-Koordinaten, den Minimalwert der x-Koordinaten, den Maximalwert der y-Koordinaten und den Minimalwert der y-Koordinaten bestimmt werden.

10. Endgerät, wobei das Endgerät ein Smartphone ist, das konfiguriert ist, um das Verfahren zur schnellen Erzeugung von Navigationsreferenzlinien nach einem der Ansprüche 1 bis 7 auszuführen, oder eine fahrzeuginterne Endgerätsteuereinrichtung, die konfiguriert ist, um das System zur schnellen Erzeugung von Navigationsreferenzlinien nach einem der Ansprüche 8 bis 9 zu implementieren.

11. Computerlesbares nichtflüchtiges Speichermedium, auf dem ein Computerprogramm gespeichert ist, **dadurch gekennzeichnet, dass**, wenn das Programm von einem Prozessor ausgeführt wird, das Verfahren nach einem der Ansprüche 1 bis 7 ausgeführt wird.

Revendications

1. Procédé mis en oeuvre par ordinateur pour la génération rapide de lignes de référence de navigation, comprenant :

S01 : accéder à une carte préchargée et à un chemin global, identifier des points de planification de chemin et des directions de chemin à l'intérieur de la carte préchargée ;
S02 : en fonction de la difficulté de conduite, classifier les points de planification de chemin :

lorsque la difficulté de conduite d'une partie des points de planification de chemin est supérieure à une valeur nominale, classifier la partie correspondante en parties de chemin local à haute difficulté, assigner un numéro de classification de chemin local à haute difficulté à la partie correspondante, extraire des points de planification de chemin à l'intérieur de la couverture des parties de chemin local à haute difficulté, et former un ensemble de points de planification de chemin local à haute difficulté ;
lorsque la difficulté de conduite d'une partie des points de planification de chemin est inférieure à la valeur nominale, classifier la partie correspondante en parties de chemin local à basse difficulté, assigner un numéro de classification de chemin local à basse difficulté à la partie correspondante, extraire des points de planification de chemin à l'intérieur de la couverture des parties de chemin local à basse difficulté, et former un ensemble de points de planification de chemin local à basse difficulté ;
dans lequel la combinaison des parties de chemin local à haute difficulté et des parties de chemin local à basse difficulté est égale à des parties de planification de chemin global dans la carte préchargée ;

S03 : extraire chaque ensemble de points de planification de chemin à haute difficulté avec un numéro de classification de chemin local à haute difficulté un par un, dans lequel chaque point de planification de chemin dans l'ensemble de points de planification de chemin inclut les informations de coordonnées X et les informations de coordonnées Y du point de planification de chemin,

traverser les informations de coordonnées X de tous les points de planification de chemin dans l'ensemble de points de planification de chemin à haute difficulté, localiser la valeur maximale et la valeur minimale des coordonnées X des points de planification de chemin ;
traverser les informations de coordonnées Y de tous les points de planification de chemin dans l'ensemble de points de planification de chemin à haute difficulté, localiser la valeur maximale et la valeur minimale des coordonnées Y des points de planification de chemin ;
former une zone de chemin local à haute difficulté, avec des limites déterminées par la valeur maximale des coordonnées X, la valeur minimale des coordonnées X, la valeur maximale des coordonnées Y, et la valeur minimale des coordonnées Y ;

S04 : simuler des premières lignes de référence de navigation dans un algorithme basé sur des points de chemin à haute difficulté dans chaque zone de chemin local à haute difficulté, et obtenir des secondes lignes de référence de navigation d'une manière géométrique basée sur des points de planification de chemin dans chaque partie de chemin local à basse difficulté ; épisser les premières lignes de référence et les secondes lignes de référence selon des numéros de classification et former ainsi une ligne de référence de navigation complète dans la carte préchargée.

2. Procédé pour la génération rapide de lignes de référence de navigation selon la revendication 1, dans lequel l'étape consistant à classifier les points de planification de chemin selon la difficulté de conduite inclut en outre que si la difficulté de conduite ne peut pas être identifiée, les points de planification de chemin correspondants dans la carte préchargée se voient attribuer un numéro de classification unifié.

3. Procédé pour la génération rapide de lignes de référence de navigation selon la revendication 1, dans lequel l'étape S01 consistant à accéder à une carte préchargée et à une planification de chemin global, identifier des points de planification de chemin et des directions de chemin à l'intérieur de la carte préchargée inclut en outre l'étape S011 : déterminer si des informations de hauteur de la carte préchargée et des informations de hauteur d'une carte locale précédente que le véhicule a parcourue sont cohérentes ; si c'est le cas, le processus passe à l'étape S02 ; si ce n'est pas le cas, le processus se termine.

4. Procédé pour la génération rapide de lignes de référence de navigation selon la revendication 1, dans lequel : à l'étape S04, l'algorithme utilisé pour simuler des lignes de référence de navigation est l'algorithme d'étoile hybride A ;

une couche d'entrée de l'algorithme d'étoile hybride A inclut : des données de ligne centrale de deux voies qui nécessitent un tournant ; dans lequel des données de chaque point de la ligne centrale contiennent une position et une orientation (X, Y, thêta) ;
l'algorithme d'étoile hybride A est utilisé pour un calcul de génération de trajectoire, qui peut générer une

trajectoire lisse avec une courbure lisse, de sorte que le véhicule peut tourner ;
une couche de sortie de l'algorithme d'étoile hybride A inclut une trajectoire complète qui relie deux voies, et chaque point dans la piste contient des données de position, d'orientation et de courbure (X, Y, thêta, kappa).

5. Procédé pour la génération rapide de lignes de référence de navigation selon la revendication 4, dans lequel l'algorithme d'étoile hybride A inclut les étapes suivantes :

S041 : utiliser des contraintes cinétiques pour calculer une région évolutive de l'algorithme d'étoile hybride A, c'est-à-dire une cellule de grille évolutive ; le coût heuristique doit être optimisé de manière appropriée pour un scénario de tournage en U tout en satisfaisant à des contraintes cinétiques ;
S042 : éliminer des zones déraisonnables, les zones déraisonnables incluent des obstacles, des zones hors carte, et des zones inefficaces ;
S043 : enregistrer un état de véhicule continu et une cellule de grille discrète associée ;
S044 : après qu'un résultat de recherche est obtenu, récupérer des poses continues (x, y, thêta) associées au chemin ; et
S045 : vérifier si la courbure est lisse.

6. Procédé pour la génération rapide de lignes de référence de navigation selon la revendication 4, dans lequel : l'algorithme d'étoile hybride A adopte une forme de std :: Vecteur <std :: carte <Point, État >>.

7. Procédé pour la génération rapide de lignes de référence de navigation selon la revendication 5, dans lequel l'étape S045 consistant à vérifier si la courbure est lisse inclut adapter et rééchantillonner, dans lequel la courbure est donnée par :

$$\mathrm{K} = \frac{|\varphi'(t)\omega''(t) - \omega'(t)\varphi''(t)|}{[\varphi'^2(t) + \omega'^2(t)]^{\frac{3}{2}}}$$

8. Système pour la génération rapide de lignes de référence de navigation configuré pour effectuer le procédé selon l'une quelconque des revendications 1 à 7, comprenant :

un module de carte, dans lequel le module de carte inclut une carte au niveau de la ville d'une ville, une carte au niveau du district d'un district, une carte au niveau du canton d'un canton, une carte au niveau de la rue, ou une carte d'une scène intérieure ;
un module de planification de chemin global, dans lequel le module de planification de chemin global inclut un emplacement de départ, et un emplacement de destination du véhicule, et des points de chemin routier entre l'emplacement de départ et l'emplacement de destination ;
un module de classification de difficultés de conduite, dans lequel le module de classification de difficultés de conduite est utilisé pour classifier des chemins d'une carte locale préchargée dans le système ; une analyse des difficultés de conduite est effectuée avant la classification, dans lequel lorsqu'une difficulté de conduite d'une partie est déterminée comme étant supérieure à une valeur nominale, la partie est classifiée en parties de chemin local à haute difficulté, et des points de planification de chemin dans les parties de chemin local à haute difficulté sont extraits, pour former un ensemble de points de planification de chemin local à haute difficulté ; lorsqu'une difficulté de conduite d'une partie est inférieure à la valeur nominale, la partie est classifiée en parties de chemin local à basse difficulté, et des points de planification de chemin dans les parties de chemin local à basse difficulté sont extraits pour former un ensemble de points de planification de chemin local à basse difficulté ; et
un module de génération de ligne de référence de navigation, dans lequel le module de génération de ligne de référence de navigation, selon des résultats de classification du module de classification de difficultés de conduite, génère des lignes de référence de navigation de différentes manières basées sur des points de planification de chemin local à haute difficulté et des points de planification de chemin local à basse difficulté respectivement, puis épisse des lignes de référence de navigation pour obtenir une ligne de référence de navigation complète.

9. Système pour la génération rapide de lignes de référence de navigation selon la revendication 8, dans lequel lorsque le module de classification de difficultés de conduite classifie l'ensemble de points de planification de chemin local à haute difficulté, une zone de chemin local à haute difficulté est d'abord obtenue, et le procédé pour obtenir la zone inclut :

extraire chaque ensemble de points de planification de chemin à haute difficulté avec un numéro de classification de chemin local à haute difficulté un par un, dans lequel chaque point de planification de chemin dans l'ensemble de points de planification de chemin inclut des informations de coordonnées x et des informations de coordonnées y du point de planification de chemin ; traverser les informations de coordonnées x de tous les points de planification de chemin dans l'ensemble de points de planification de chemin à haute difficulté, localiser la valeur maximale et la valeur minimale des coordonnées x des points de planification de chemin ;
traverser les informations de coordonnées y de tous les points de planification de chemin dans l'ensemble de points de planification de chemin à haute difficulté, localiser la valeur maximale et la valeur minimale des coordonnées y des points de planification de chemin ; former une zone de chemin local à haute difficulté, avec des limites déterminées par la valeur maximale des coordonnées x, la valeur minimale des coordonnées x, la valeur maximale des coordonnées y, et la valeur minimale des coordonnées y.

10. Dispositif de terminal, dans lequel le dispositif de terminal est un téléphone intelligent configuré pour exécuter le procédé pour la génération rapide de lignes de référence de navigation selon l'une quelconque des revendications 1 à 7, ou un équipement de contrôle de terminal embarqué configuré pour mettre en oeuvre le système pour la génération rapide de lignes de référence de navigation selon l'une quelconque des revendications 8 à 9.

11. Support de stockage non transitoire lisible par ordinateur ayant un programme informatique stocké sur celui-ci, **caractérisé en ce que** lorsque le programme est exécuté par un processeur, le procédé selon l'une quelconque des revendications 1 à 7 est effectué.

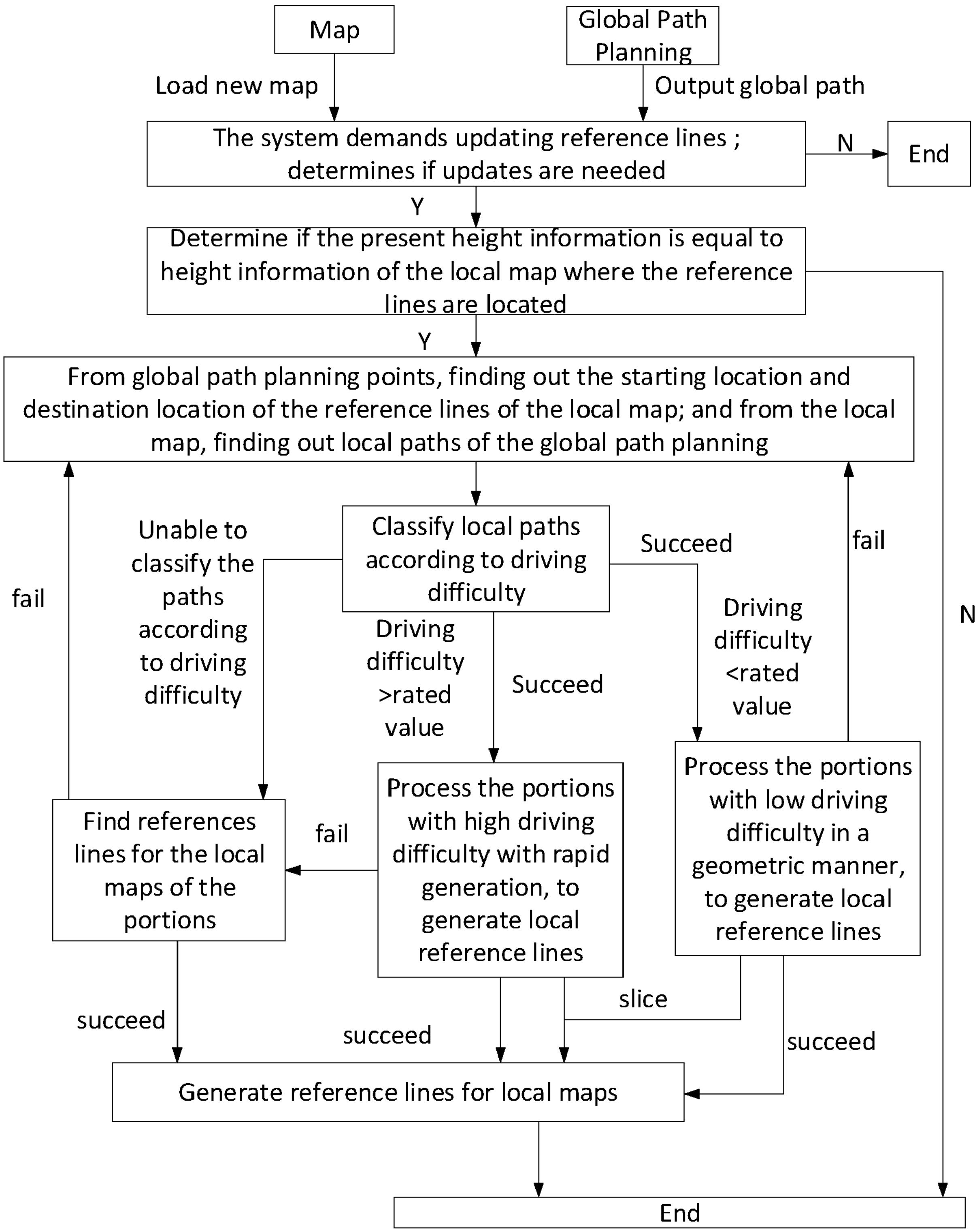
Map
Global Path Planning
Load new map
Output global path
The system demands updating reference lines ; determines if updates are needed
N
End
Y
Determine if the present height information is equal to height information of the local map where the reference lines are located
Y
From global path planning points, finding out the starting location and destination location of the reference lines of the local map; and from the local map, finding out local paths of the global path planning
Classify local paths according to driving difficulty
Unable to classify the paths according to driving difficulty
Succeed
fail
fail
N
Driving difficulty >rated value
Succeed
Driving difficulty <rated value
Find references lines for the local maps of the portions
fail
Process the portions with high driving difficulty with rapid generation, to generate local reference lines
Process the portions with low driving difficulty in a geometric manner, to generate local reference lines
slice
succeed
succeed
succeed
Generate reference lines for local maps
End

Fig. 1

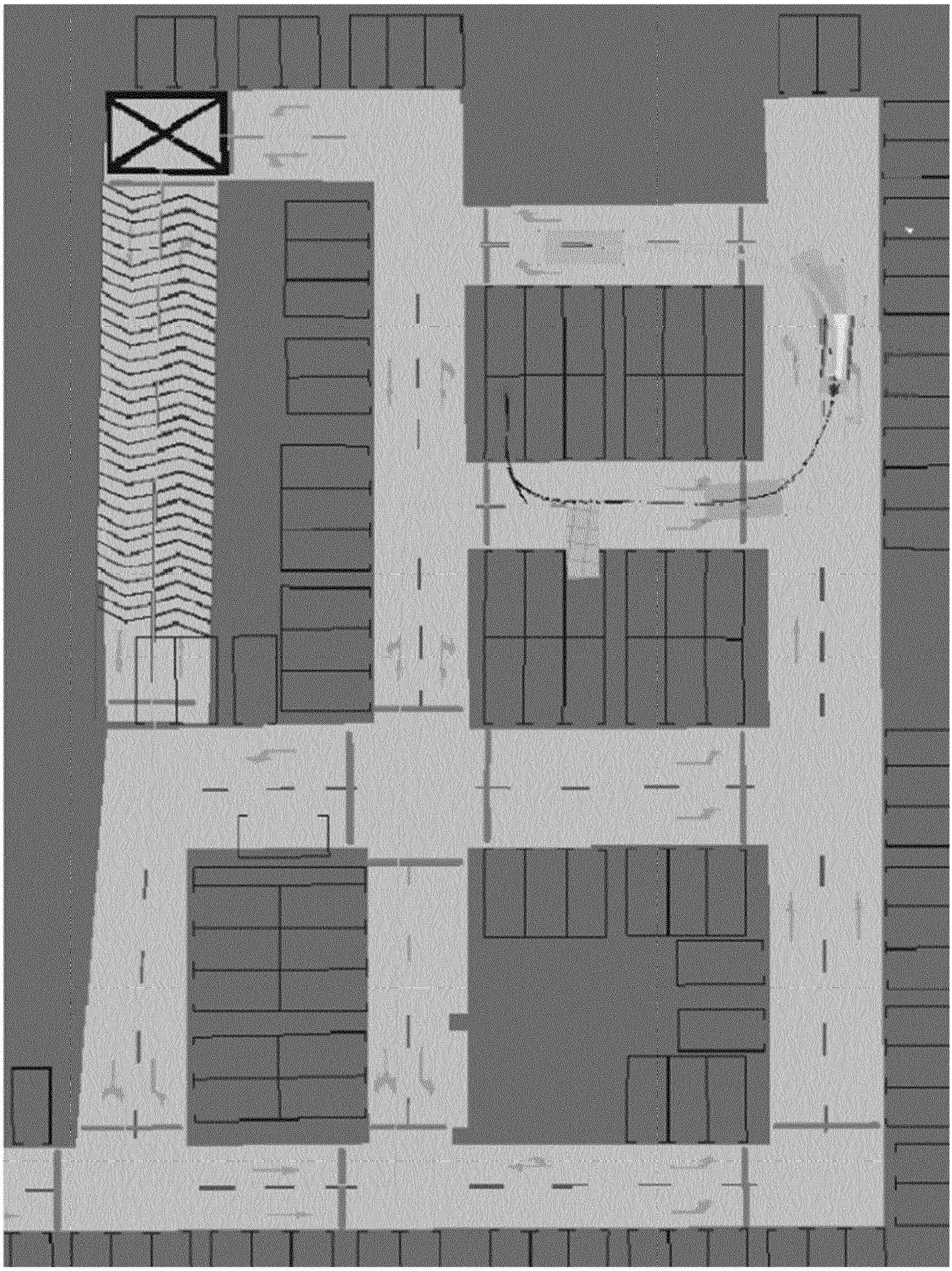

Fig. 2

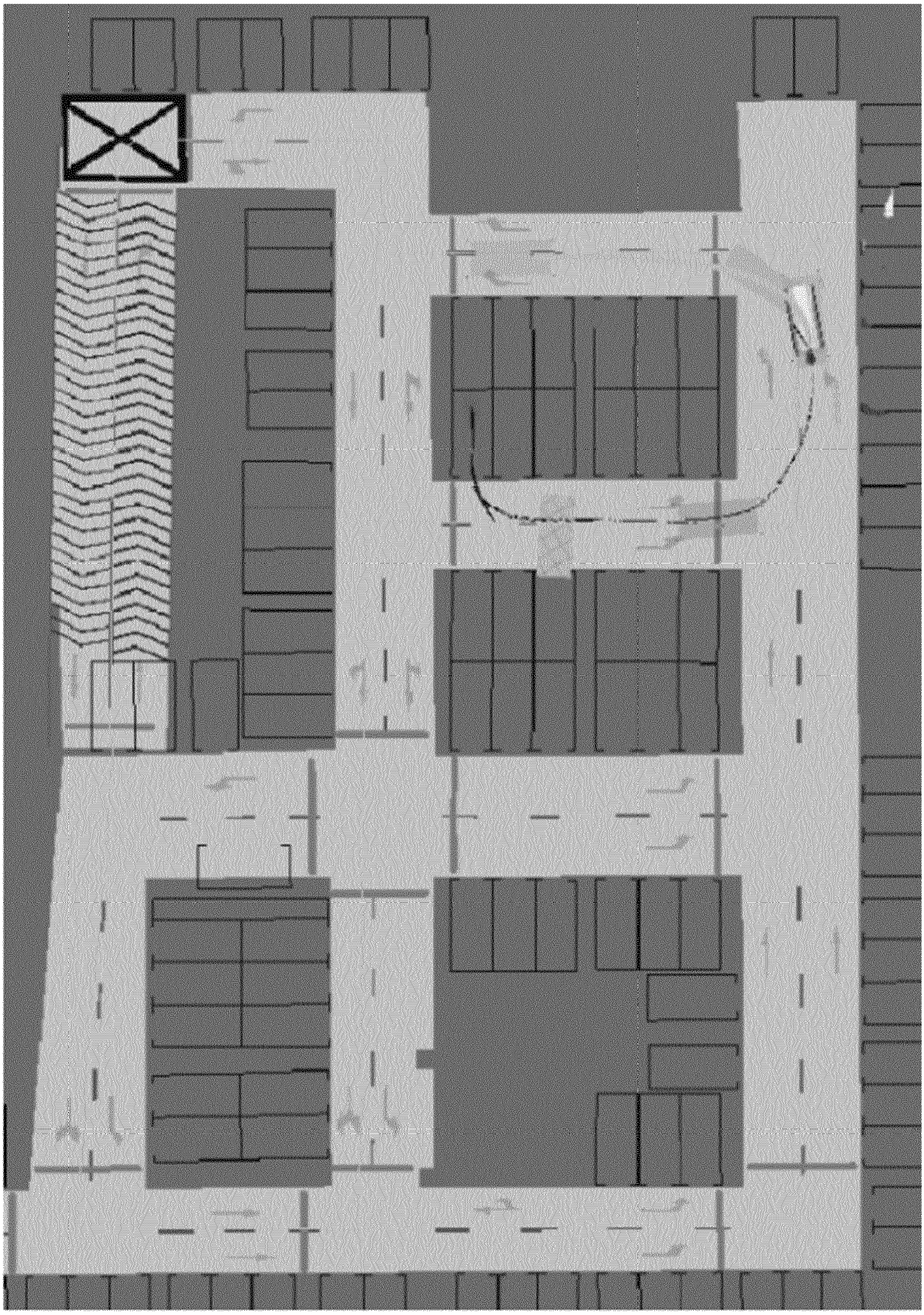

Fig. 3

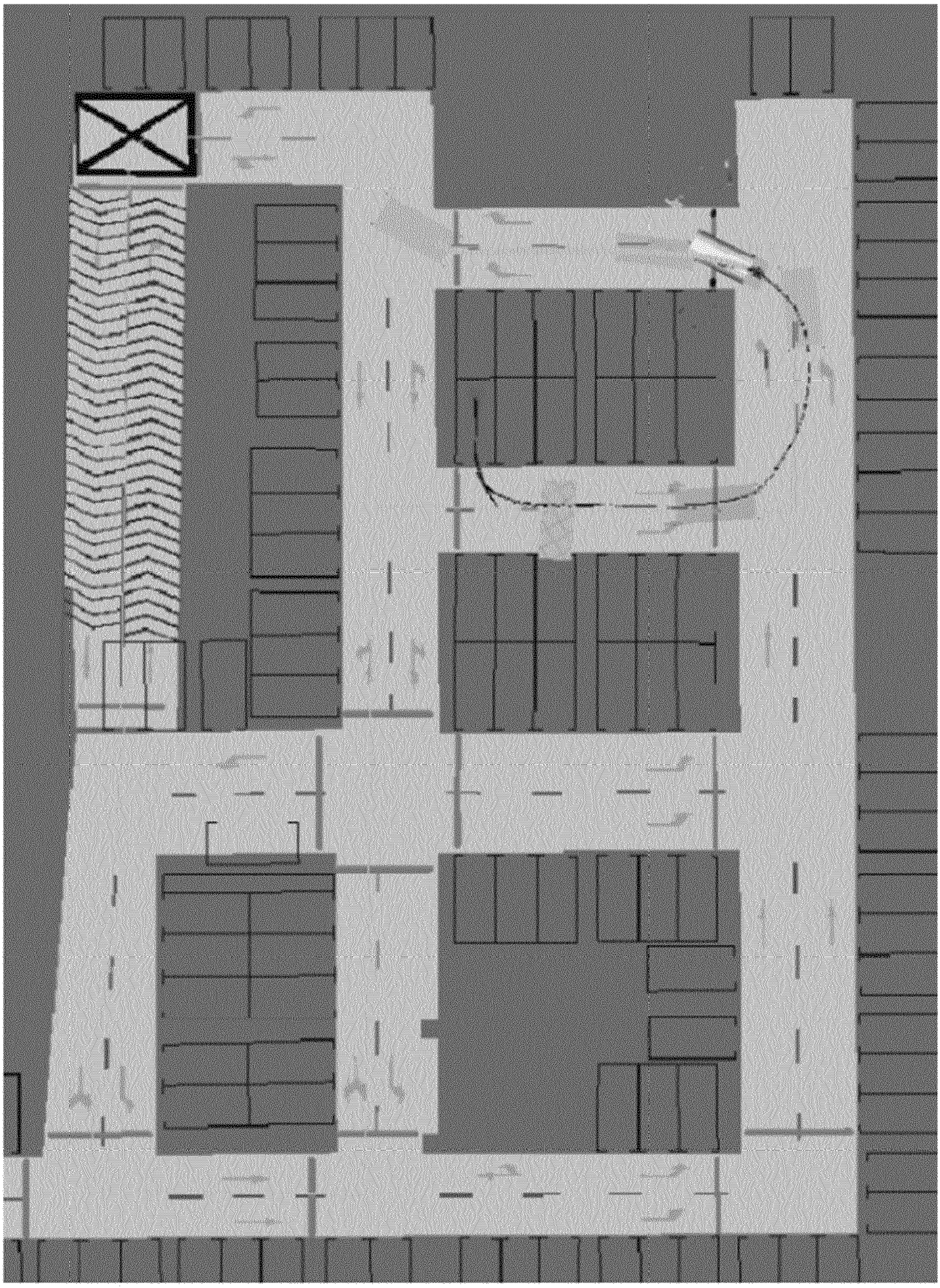

Fig. 4

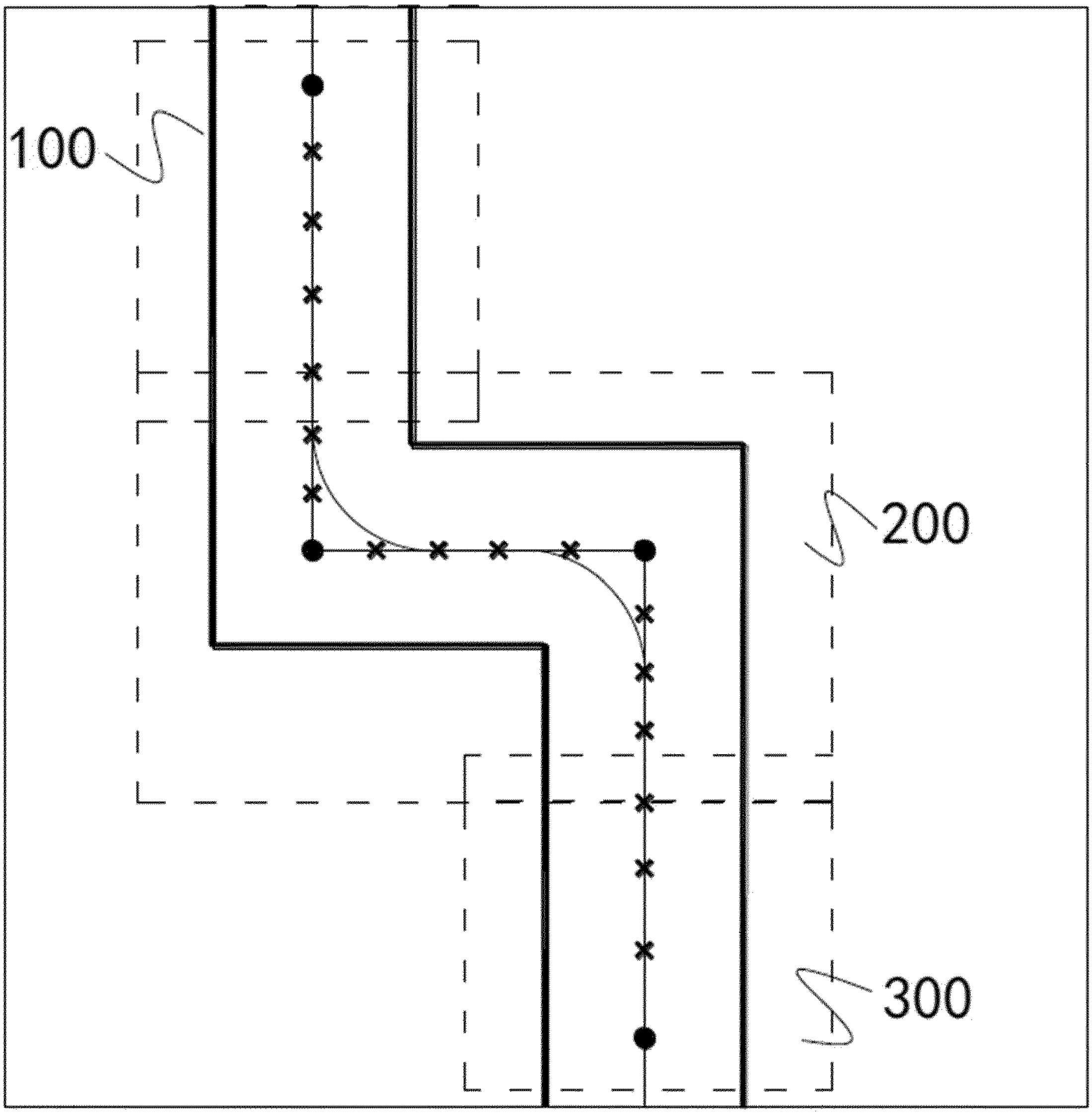

Fig. 5

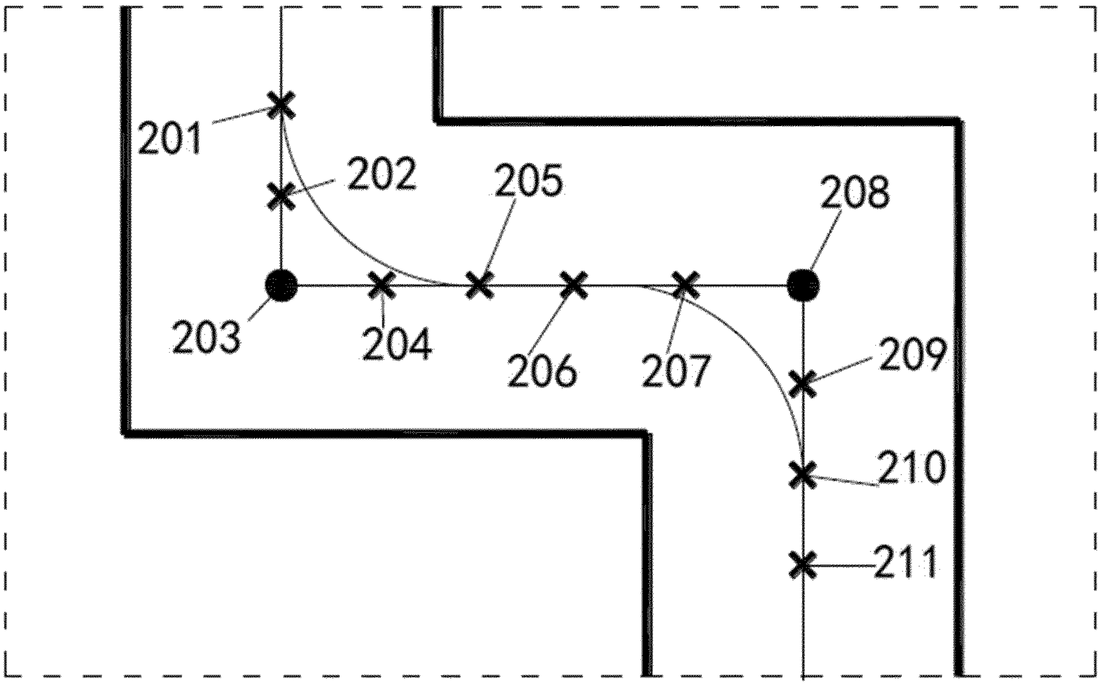

Fig. 6

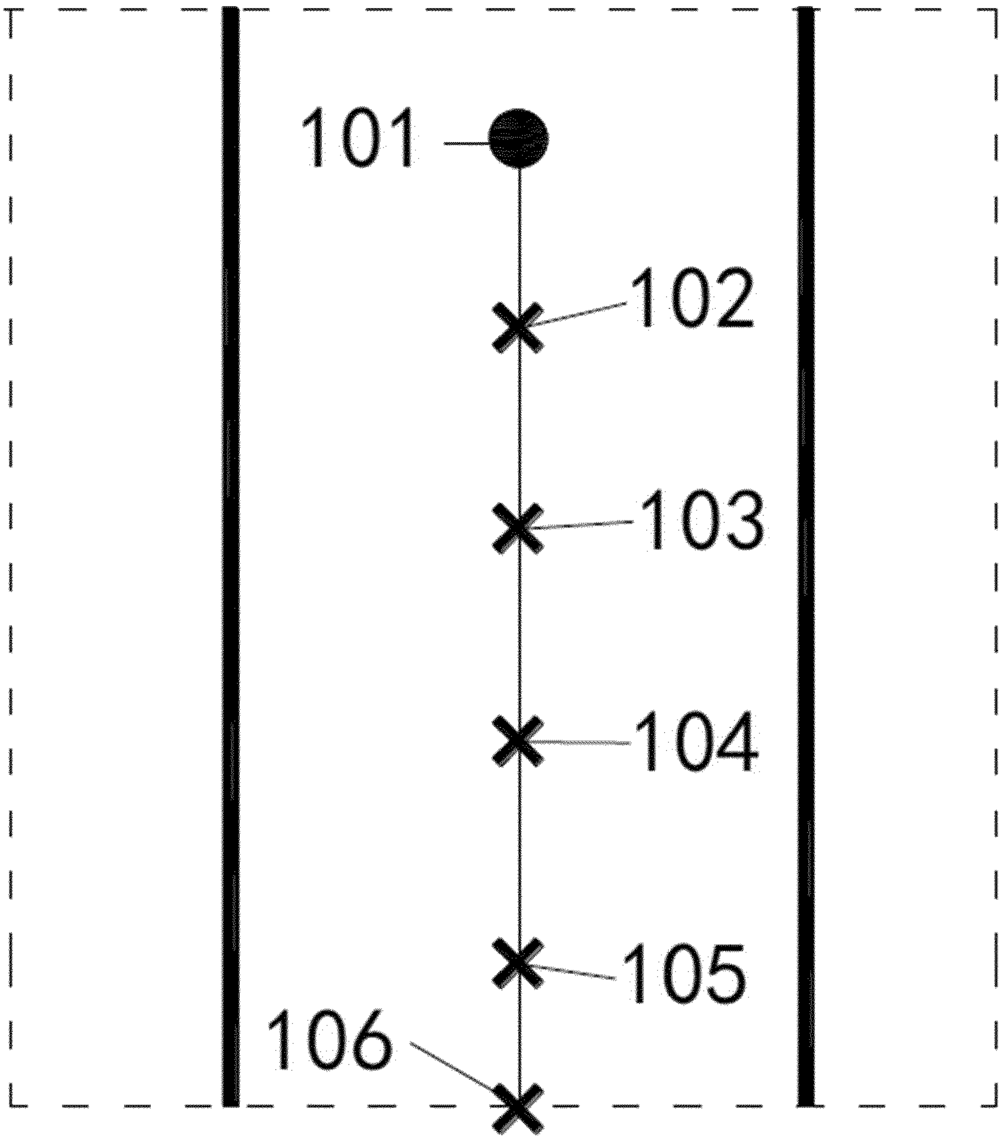

Fig. 7

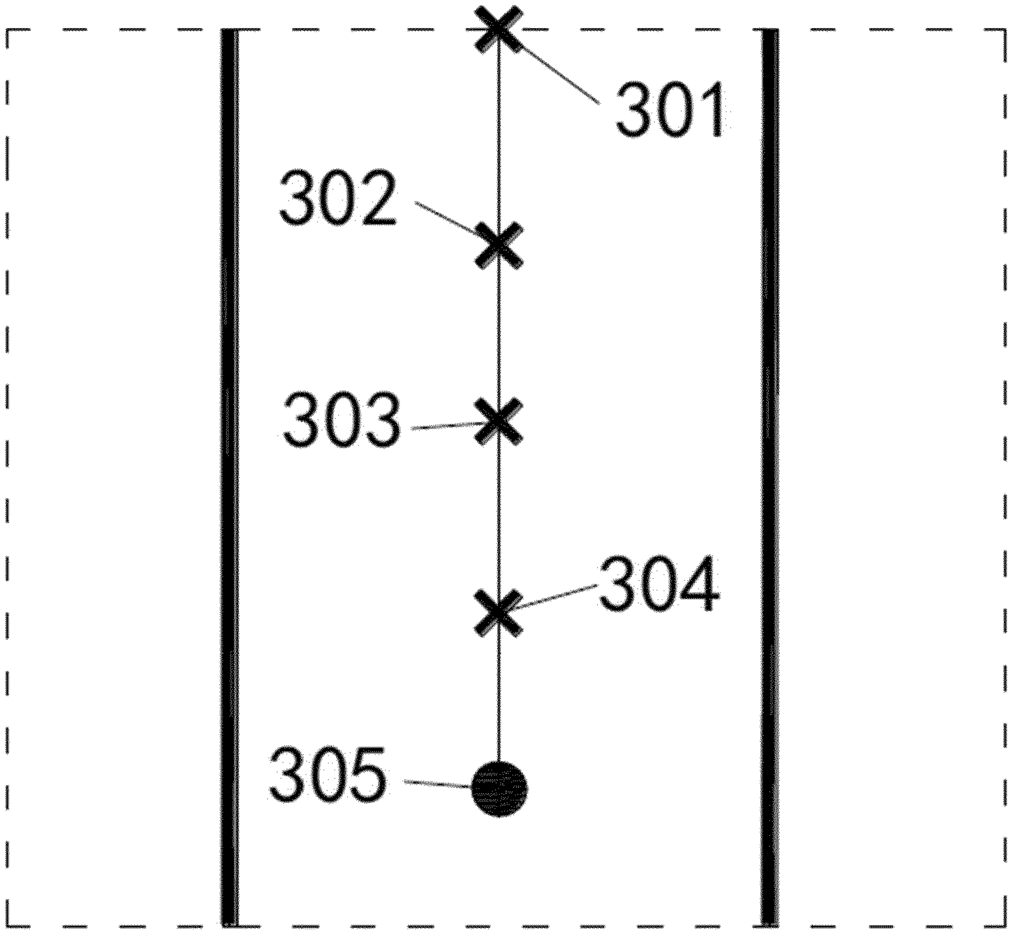

Fig. 8

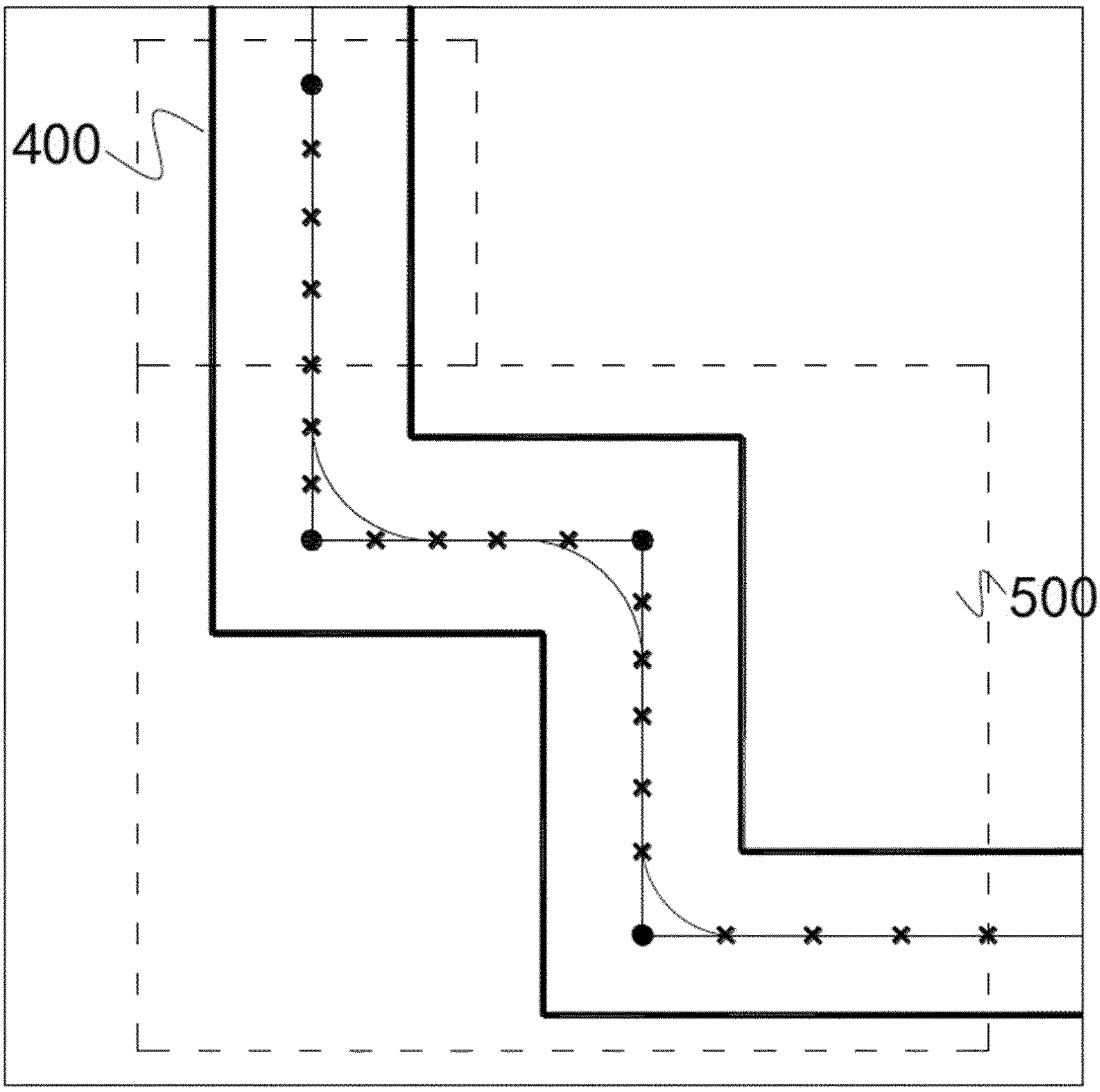

Fig. 9

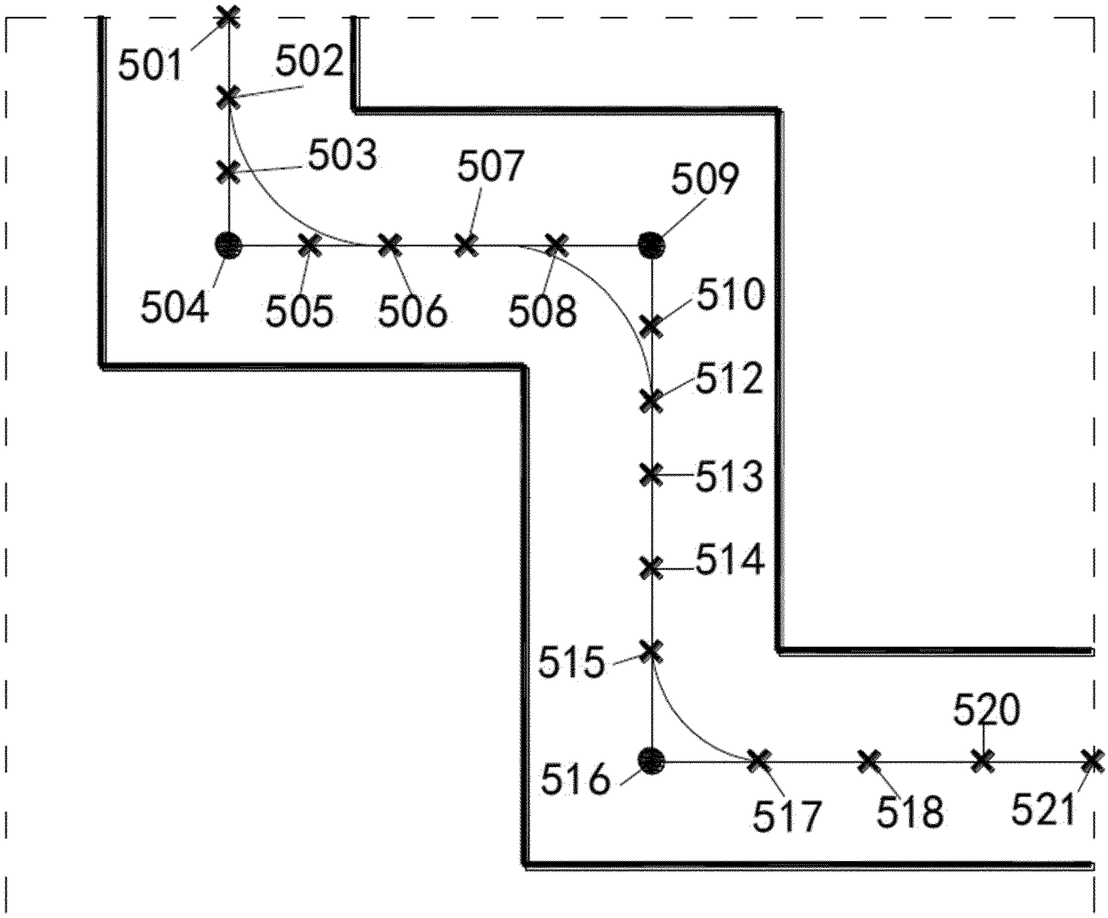
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Fig. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 3370037 A1 **[0004]**
- US 2017292843 A1 **[0005]**
- CN 109445444 A **[0006]**